A MISTRA PROGRAM

FOOD 21

Sustainable Food Production

PROGRAM PLAN

Year 2002 (2001-2004)

Uppsala November 2001 First revision

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Section 1

1.1 The vision and program approach

The program has passed its first phase and is now proceeding to a second period 2001 – 2004. The sustainability problems of the food chain are thoroughly discussed in the Program plan for the first period. Thus, they are assumed to be known and will not be further discussed here. The focus of the present plan will be mainly program activities and deliverables.

The vision and goals for sustainable food production were presented in the original program plan dated 16th of September 1996. What was proposed there is highly valid for guiding the second phase and will be summarised as below.

"The overall long-term goal of the FOOD 21 Program is to define optimal conditions and to develop systems and technologies for a sustainable food chain that offer the consumers high quality products".

The program philosophy

The philosophy for guiding our research and synthesis work towards more sustainable methods in the food chain is *to search for prophylactic solutions rather than corrective measures*. For the farming activities, this means that future agriculture will be managed in a way that enhances natural processes and nature's ability to produce healthy crops and animals, rather than focusing on control tools to deal with and combat the negative effects of inappropriate methods. New technical solutions in line with such a development will be based on biological and ecological requirements, taking advantage of both existing and emerging technologies.

Solutions in sight

Some examples of plausible solutions to sustainability problems are given below together with suggestions for successful implementation of relevant solutions.

Nitrogen pollution of ground waters and eutrophication of surface waters is one of the major non-sustainable aspects of modern agriculture. Thus, nutrient leaching to waters is a main research concern in the subprogram on arable soils and crop production. In this respect, decomposition of soil organic matter and nitrogen turnover are some of the main issues. The guiding vision is to grow green manure crops with different decomposition patterns in order to direct mineralisation to periods of active crop uptake. Initial studies on the characterisation of crop residues in terms of their decomposition pattern seem promising, and the next step

will be to go from laboratory studies to field trials. Data have also been collected about emissions of greenhouse gases from a variety of crops and from crop rotations. Such knowledge will be useful for meeting the challenge of modifying cropping practices to avoid leaching losses of nitrogen to waters without a concomitant increase of air emissions.

The most common opinion is that phosphorus (P) losses occur, bound to particles with surface runoff. Elaborate studies on undisturbed soil columns have shown that internal P transport in the macro-pores of clay soils can be a hundred times higher than from sandy soils, amounting to several kg per hectare. Therefore, buffer strips along open waterways alone will not be sufficient to reduce the phosphorus load to surface waters. Preliminary results show that the incorporation of P fertiliser within the topsoil is an important measure to reduce P losses. In addition, reducing internal P transport by promotion of a well developed soil structure, and breaking the soil cracks by shallow cultivation at the soil surface are important. Preliminary data suggest that high concentrations of phosphorus in soil profiles, found mainly in association with high livestock density, promote phosphorus leaching. Identification of threshold values for the relationships between soil concentration and phosphorus losses would provide arguments for adjustment of the phosphorus levels in soils to match crop demand, without unacceptable loads on waters.

Initial studies on element balances and fluxes on a dairy farm have provided valuable knowledge about risks for element accumulation and the depletion of soils, and the corresponding risks for negative effects on product quality and losses to waters. System studies have been conducted on several levels, i. e. the whole farm, the field, the feed-animal-manure level and the soil level. These have demonstrated that a specific element flux, which is of no importance on one level, turns out to be highly salient on another level. Furthermore, a survey of manure quality has shown that there is a high variation in element concentrations of manure. This suggests that it is necessary to introduce element flow bookkeeping on the farm level in sustainable agriculture.

One example of the above problem is the fact that several sources contribute to the continuous increase of cadmium levels in arable soil. The two most important are deposition and phosphate fertilisers. Studies within FOOD 21 have demonstrated that some feed components, used in pig production, although quantitatively small, contribute large proportions of cadmium in the feed. Due to the low intestinal absorption of cadmium, most of the cadmium from these ingredients are excreted in the manure and will be added to arable soil through application of farmyard manure. By controlling even the minor feed components for levels of contaminants and restricting the use of highly contaminated ingredients, the increase of cadmium levels in soil will be reduced.

To approach the goals for animal welfare, it seems that allowances for a closer relationship between mother and offspring would be beneficial for udder health as well as for calf health.

Furthermore, this seems to offer possibilities for reducing the use of antibiotics. This would require new types of constructions of stables for dairy production. Our research collaborators in Colombia and Mexico have demonstrated very promising results in this area, which is also true for some experiences from Finland.

The co-operation between researchers on genetics and animal behaviour within FOOD 21 has contributed new opportunities for more precise and skilful breeding by which negative side effects may be avoided in breeding for productivity. Increased knowledge has been gained about how breeding mainly for increased production efficiency can threaten animal welfare and severely limit the sustainability of animal production. Extensive resources and facilities for analysis of genetic effects on animal welfare have been acquired, and co-operation has been established with the Product Quality sub-program.

Studies on consumer attitudes and behaviour, and the role of established habits, have made valuable contributions to the understanding of consumer choice of organically produced foods. In particular, it has illustrated the limited importance of general attitudes, and the central role of consumer perceptions of various purchase criteria for the choice of food products. One conclusion is that organically produced food items need to match or surpass conventional products with respect to those food choice criteria that are given high priority by consumers. Other studies illustrate the potential importance of activating specific attitudes in crucial choice situations (e.g. in food stores). Health, as well as the motive of "environmental friendliness" appears to be central for consumer choice of organic food items. Preliminary analyses indicate that health is the stronger of these two motives, even in "environmentally conscious" groups. Another practical implication concerns the differential use of health and environmental arguments in the marketing of such products. Consumers in an early phase of the transition to new purchase habits are sensitive to other criteria than are consumers later in the process.

Crops and animal products leaving the farm gates is nowadays often transported over long distances and most of it also processed in food industry before reaching the retailers and the consumers. Along this line, finite fossil energy is consumed giving rise to environmental pollution. A more sustainable national food supply system will operate on different scales from local to nation-wide. Some products such as milk and cereal products will preferably be processed and distributed in regional and nation-wide systems. Just a few decades ago, the main food supply was much more local. Because of increasing concerns for food security, the need for minimal transports and consumers growing interest in the traceability aspect of food, local supply solutions will once again expand. This will concern mainly grazing-based meat, potatoes and a range of niche products.

The implementation of innovative, environmentally sustainable methods on the farm level has proceeded relatively slowly in Sweden as of today. One reason for this may be that farmers do

not share the views of the authorities on the major problems facing farming today. New methods may also be costly and difficult to implement in practice. Bringing concerned stakeholders together to deliberate a common agenda and to decide on priorities appears to be a promising way to facilitate implementation. We subsume all these processes under the concept of collaborative learning and decision making processes in natural resource management.

Participation in problem clarification and analysis of desirable and feasible changes enables the development of general guidelines, site-specific solutions and a higher commitment among stakeholders engaged in the agri-food system. A couple of collaborative processes, involving farmers, as well as ongoing implementation of environmental management schemes, have been studied in detail within the farmer subprogram of FOOD 21. Our research suggests that participation in the identification of reasonable remedial actions is crucial. The participatory action research approach will result in concrete measures within the Swedish agricultural sector, but also to the development of applicable conceptual models.

Comments on sustainability

Three aspects are of main concern when dealing with sustainability: system boundaries, system characteristics/properties, and system indicators.

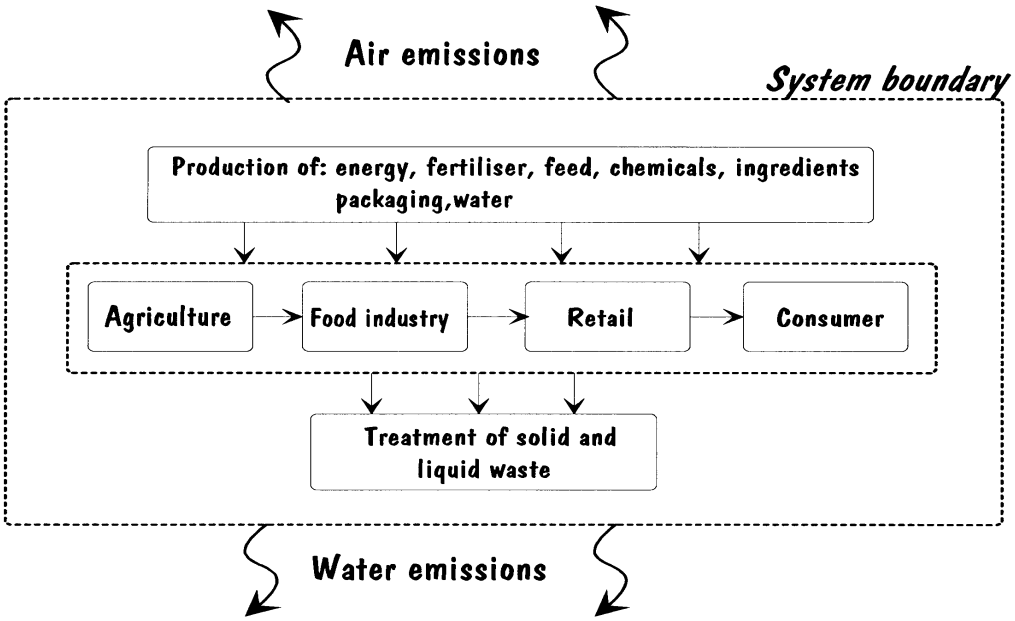

Figure 1. The figure illustrates the system boundaries of the FOOD 21 Research Program.

A prerequisite for an analysis of system sustainability is a clear description of system boundaries. For the FOOD 21 program, these boundaries were identified as a basis for systems analysis and are here illustrated in Figure 1.
The sustainability of the food chain can be analysed with respect to three aspects:

- ability to satisfy contemporary and future goals in terms of; productivity, economy, natural resources etc
- efficiency in the use of production means; energy, fertilisers, pesticides, animal feeds etc
- ability to withstand disturbances; buffering capacity or robustness.

At the start of the FOOD 21 Program, a set of Sustainability goals were formulated with the objective to serve as a compass for guiding research on the ability of proposed solutions to improve food chain sustainability. These goals will be kept and revised at the start of Phase II. Furthermore, as a basis for the scenario work, visions will be set up describing future more sustainable production systems and a sustainable food chain.

To be able to measure current system status and results of corrective measures with respect to sustainability, there is a need for appropriate indicators. During the first phase of the program, farm indicators have been developed for crop and animal production. Indicators for product quality are under preparation. This work will be finalised at the beginning of the second phase of the program.

Research and synthesis activities related to the food chain will include the topics covered by the sub-programs Crop production, Animal production, Product quality and Producer/Consumer and Systems analysis of the food chain from farm to consumer. Individual sub-area topics and deliverables are presented in Program Section 2 below.

1.2 Deliverables at program level

Deliverables at Program Level concern issues related to the entire food chain or larger portions than those that are dealt with in individual projects. Results from individual projects as well as synthesis outcomes, will provide the basis for program level deliverables. The deliverables therefore are listed under two headings “Synthesis work” and “Research projects”.

Project	Outcome on Program Level
Project leader	Prof. Rune Andersson;SLU
Collaborating scientists	The Program Management Group: Agr. Mona Nordberg, SLU Prof. Bo Algers, SLU Prof. Lars Bergström, SLU Prof. Kerstin Lundström, SLU Prof. Thomas Nybrant, SLU Prof. Per-Olow Sjödén, Uppsala university
Project deliverables for the total project	**Synthesis work** • Sustainable concepts and plans for farm production systems with emphasis on crops, beef/milk and pork. • Analytical methods at system level to assess and evaluate sustainability characteristics of different food chain solutions (primary production, food industry, transports, retailers and consumers). • Methods based on scenario techniques to develop such solutions together with researchers and stakeholders. • An economic analysis of biological and sociological driven requirements for sustainability of farm operations - driving forces and implications for the structural organisation of the primary sector of the Swedish agriculture. • Indicators for measuring the degree of sustainability along the food chain. **Research projects** • Knowledge about the role of personal environmental values and earlier purchase habits in food choice, and the impact of environmental labelling and priming information in food stores. • Quantitative estimates of consumer contributions to the environmental impact of food purchase and food/waste handling in the home environments. • Innovative and applied approaches which enhance farmers' and other local actors' participation in the development of sustainable agri-food systems. • Knowledge about farmers' adoption behaviour and strategies in farming in relation to perceived social and institutional environment. • A decision support system for selection of “Best Management Practices” to reduce P emissions to natural waters. • Management strategies to steer the mineralization of N from organic manures to periods of high crop uptake and thereby avoid losses of N. • A system to assess element fluxes and balances in dairy-, pig- and crop production at farm level to avoid accumulation and depletion of elements within farms. • Guidelines on how to design well functioning housing and management systems for suckling calves in dairy herds. This will lead to improved cow and calf health and welfare, which will decrease the use of antibiotics in milk production. • Suggestions on how to improve the breeding programmes for commercial poultry stock, to reduce the risk of behavioural disorders and related health problems. This will be based on detailed knowledge about the link between poultry genetics and behaviour. • A description of sustainable housing systems for farm animals (cows, pigs and laying hens) enhancing natural behaviour, animal health and environmental quality. • Conclusions regarding the effect of more sustainable production systems on overall product quality. • Knowledge about safety aspects of cadmium in the food chain, from soil, via feed and livestock to man. Basic knowledge on bioavailability of cadmium in the food chain will also be compiled. • Twenty-four graduated PhD students trained in interdisciplinary research.

Deliverables for year 2001; • Revision of the FOOD 21 goals for a sustainable food chain. • Sustainability indicators for crop production, animal production and product quality (wheat). • Seminars about "Perspectives of sustainability" with internationally invited speakers arranged in co-operation with the Centre for Sustainable Agriculture, SLU. • An international conference dealing with sustainability issues of the Food Chain.	**Results year 2001;** • Revised sustainability goals for the food chain (Annual report 2000). • Eight indicators for measuring environmental status and changes in relation to crop production (SLU FAKTA Jordbruk nr 4, 5, 6 and 7; 2001). • A framework for indicators on product quality – exemplified with wheat (MAT 21 Rapport nr 2). • An international EU conference "Food Chain 2001- safe, sustainable, ethical", Uppsala (Conference Report to the EU Agricultural Ministers, SLU). • A seminar about the effects of calculated climate change on agriculture (Report on the FOOD 21 Web Home Page). • Two seminars about "Perspectives of Sustainability". • Start of a PhD project on co-operation between firms. • Four graduated PhD students (4 Theses).
Deliverables for year 2002; • Two seminars about "Perspectives of Sustainability" • A series of seminars bridging traditional discipline boundaries. • Sustainability indicators for animal production. • Start of a PhD project on rot uptake of Cd in crops. • Outcome from the synthesis and scenario work as it is described in chapter 1.4. • Five graduated PhD students.	**Results year 2002;**

In order to successively bridge the gaps between traditional disciplines along the food chain, a number of seminars will also be held covering larger parts of the food chain; e.g. from grain to bred, from pig breeding to bacon on the plat, to mention a couple of examples.

1.3 The program structure and management

The program structure of phase one will be largely maintained. However, systems analysis will expand from its current status as a separate research field into a central tool for the synthesis work. Furthermore, the research sub-programs will be more highly integrated than in Phase I.

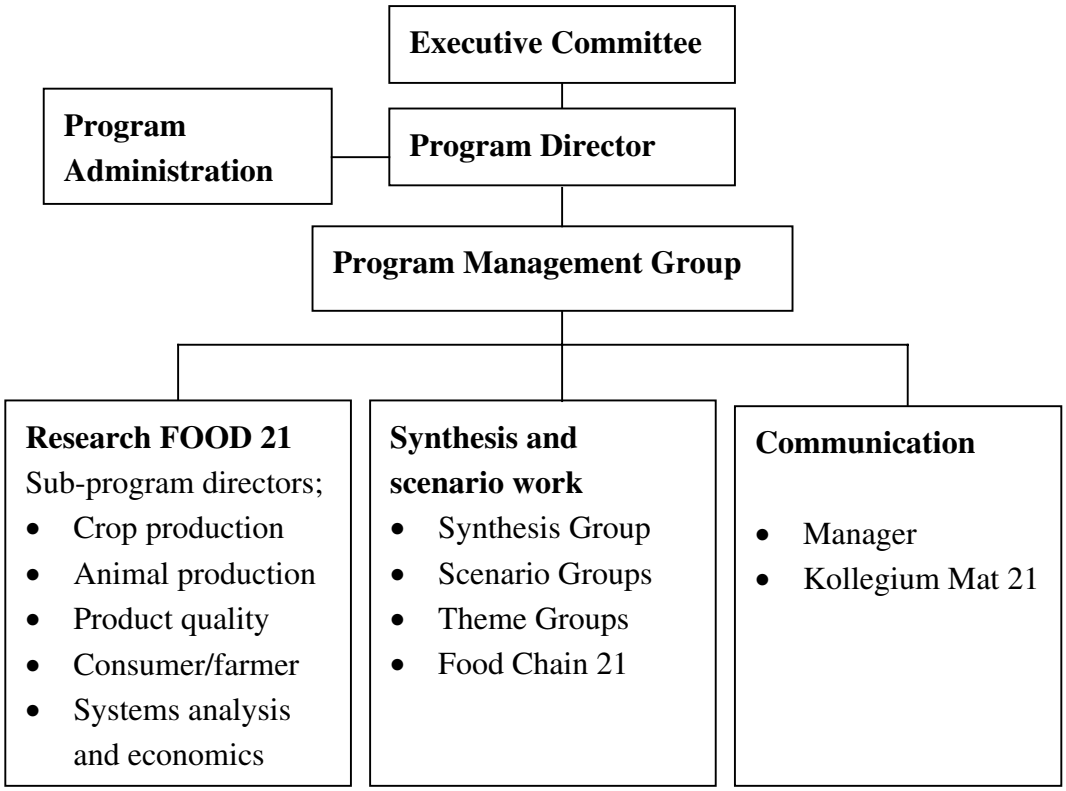

Figure 2. Program organisation during Phase II.

The Executive committee, and a Program Management Group is managing the Program, supported by a Kollegium MAT 21 representing the stakeholders according to figure 2.

The Program Director together with the Sub-Program Directors and the Program Administrator constitute the Program Management Group (PMG). A Synthesis Management Group is running the synthesis work in close co-operation with the PMG.

The results from the individual projects will to a large extent be processed within the scenario and synthesis work. Together with results from other research, this will be employed in an analysis of how suggestions for new solutions may fit into larger food chain systems with respect to economic competitiveness, ecological acceptance and practical applicability. Another information flow goes in the opposite direction into the synthesis box from the stakeholders e.g. members of Kollegium MAT 21.

Communication activities, with the objective to make the results of the FOOD 21 Research Program known among the food chain stakeholders, is an essential part of the Program.

1.4 Synthesis work

In the Letter of Intent it was proposed that the synthesis work should be organised around a number of scenarios which could be seen as *foci for the development and evaluation of proposed production systems*. This idea was fully supported by the Scientific Review Panel that concluded that: "The proposed scenario approach is appealing and will be instrumental in the implementation phase". In the MISTRA board decision it was stated that the main focus of the Phase-II activities within FOOD 21 should move towards synthesis with less emphasis on discipline-oriented research.

Structure of the Synthesis Work

The synthesis work consists of two parts. The first one is dealing with ***theme work*** where different problems that have been identified to be important are dealt with. This work has been in progress in Phase 1 and has, for example, dealt with "Indicators for sustainability in food production" and "Beef production based on grazing". In Phase 2, the theme work can be similar but also theme work dealing with the integration of research results emerging within FOOD 21 will be initiated.

The second part of the synthesis work is the ***scenario work.*** This work consists of working groups organised as "round table discussions" where people from different disciplines, as well as stakeholders, meet. The task is to analyse sustainability issues and develop solutions according to different principles and concepts such as low input systems, high technology farming, improved animal welfare etc.

System boundaries

The research in FOOD 21, as already stated in the first Program Plan for Phase 1, covers in principle the whole food chain from the producer to the consumer. However, the main focus for the research has been on the farms and the remaining part of the food chain has been dealt with through the food quality and consumer aspects sub-programs.

In 1999 MISTRA funded a new project, Food Chain 21, which has been carried out in close co-operation with FOOD 21. Food Chain 21 deals with environmental systems analysis of the food industry, packaging, transports, retailers etc; rather than research and development regarding the different processes and activities involved. It relies on a reference/working

group in which researchers and stakeholders participate together in a continuous process where different scenarios and system solutions are suggested and evaluated. In Phase 2, Food Chain 21 is incorporated in FOOD 21 as part of the Synthesis work.

Organisation

The Synthesis Group (SG), headed by Thomas Nybrant, consists of seven people who represent general, as well as more specific competences, with respect to the food chain. The group works in very close contact with the Program Management Group (PMG) and has also a big network of people (stakeholders and researchers) for support and participate in the different activities in the synthesis work. The "Kollegium MAT21" has a crucial role since it includes key persons representing important stakeholders.

Theme Work

As described in the introduction, the theme work in Phase 2 can be seen as:

- a continuation of the theme work activities that were carried out in Phase 1 *(General themes)* complemented by
- themes working on integration and synthesis of research results emerging within or close to the program (*FOOD 21 Research Themes).*

General themes

There can be different reasons to deal with a subject or an issue in the form of a theme work. Some examples are:

- State of the art and future development of a relevant area need to be analysed.
- The subject is important for the overall synthesis but is not subject to Food 21 research.
- Some special production concepts are developed and evaluated.
- Stakeholders need to meet, communicate and harmonise their views regarding important issues.

Some examples of themes in Phase 2 identified and initiated so far are

- Structure and sustainability in primary production.
- Sustainable pest management.
- Sustainability issues in feed production and consumption.

It is anticipated that more such themes will be initiated during the course of Phase 2.

FOOD 21 research themes

An already initiated theme dealing with integration of research results within the program is "Integrated approach on nutrient management". In this theme researchers working in the Crop Production sub-program are developing field management strategies based on integrated views of nitrogen, phosphorous and trace element issues.

Scenario work

The scenario work is conceptualised in terms of working groups organised as "round-tables" around which researchers from different disciplines, each representing specific fields of competence, will assemble to discuss their findings. The scenarios/round-tables will also serve as meeting points for the discussion of sustainability issues, the "state-of-the-art", and feasible solutions to problems raised by the scenario in question. Other stakeholders in the food chain will participate in the synthesis of feasible solutions. This is especially important with regard to synthesis and evaluation of proposed new solutions.

The scenarios will be set up to allow analyses of food production and supply problems at different scales. Furthermore, the scenarios will be formulated to represent different degrees of intensity, e.g. in terms of dependence on external resource inputs.

Revision of the scenario groups

In the program plan it was stated that initially in Phase 2, two main types of scenarios for agricultural production should be dealt with, namely "Business As Usual" (BAU) and "Low Input Systems" (LIS). However, these names have caused some misunderstanding and confusion since they indicate that a choice of scale and intensity already has been made.

The basic idea with the two types is that the BAU scenarios deal with solutions that are fairly close to today´s agricultural practice, carried out under approximately the same conditions regarding economy and subsidies. The LIS scenarios, on the other hand, were meant to deal with future solutions that are more or less independent of today´s economical realities, but instead focus on solutions that are sustainable from an ecological and social point of view. In practice, there is no sharp line between the two groups and to avoid further misunderstandings the BAU amd LIS classification will be abandoned and we will work with solutions that are applicable on a continuous time scale, ranging from today up to possibly half a century from now.

It should be stressed that, regardless of time perspective, it is possible to work on solutions that are based on different scales, intensity, use of chemicals, technology levels etc., including conventional, integrated and organic farming.

Products and communication of results

The results of the theme works will be compiled in packages based on the needs of the main problem owners of the respective themes. The scenario work is anticipated to yield concepts of possible solutions to solve non-sustainable issues along the food chain, or parts of it. These concepts may be presented in the form of guidelines or as a collection of examples encompassing important stakeholders such as farmers and their organisations, food industries, wholesalers, retailers, consumers, authorities and consumers.

The form of these packages may be different and adapted to the actual content and assumed target groups. Besides publication in scientific journals, reports, seminars and fact sheets we will consider how Internet, CD-rom and possibly TV can be used for communication of results.

Deliverables from the scenario and synthesis work are an essential part of the deliverables specified at the Program level.

Project	**Synthesis and scenario work**
Project leader	Prof. Thomas Nybrant, SLU
Collaborating scientists	Prof. Rune Andersson, SLU Dr. Lotta Berg, SLU Dr. Stefan Gunnarsson, SLU Dr. Carl-Johan Lagerkvist, SLU Dr. Ulf Sonesson, SIK Dr. Susanne Stern, SLU Dr. Ingrid Öborn, SLU
Project deliverables for the total project	**Scenario work** • Sustainable concepts and plans for farm production systems with emphasis on crops, beef/milk and pork. • System analytical methods to assess and evaluate sustainability characteristics of different food chain solutions (primary production, food industry, transports, retailers and consumers). • Methods based on scenario techniques to develop such solutions jointly together with researchers and stakeholders. • Formulation of operative sustainability goals to be used in the analysis of food chains **Theme Work** • Management practices based on integrated views of nutrients and trace elements in cropping systems. • Operative tools to evaluate chemical and non-chemical plant protection strategies from a sustainability perspective. • Production economy and the FOOD 21 sustainability goals - analysis and conclusions regarding different structures of the primary production and the food chain. • Evaluation of different strategies for the production and use of animal feed in beef/milk and pork production. • Analysis of other possible critical sustainability issues in all parts of the food chain identified during the course of the program, such as food security, use of antibiotics in animal production, cadmium etc.

Deliverables for year 2001:	**Results year 2001:**
• A detailed plan for the scenario and synthesis work, i.e. appropriate methods, management and scenario descriptions (visions). • Analysis and suggestions for the use of urban organic rest products in agricultural production. • Analysis and suggestions for chemical pest control and its alternatives in agriculture.	• A detailed plan for the scenario and synthesis work (Synthesis Plan, May 2001). • Formation of an operational Synthesis Group. • A problem inventory report (under preparation). • A project plan for synthesis work within the sub-program crop production (see section 2.3). • Initiation of three problem oriented synthesis themes (agricultural structure, sustainable feeding, sustainable plant protection). • Preliminary conceptual scenario models.
Deliverables for year 2002:	**Results year 2002:**
• Development and evaluation of alternative scenarios and concepts for the three prototype farms (a dairy farm, an arable farm and a pig farm). • Development and evaluation of production concepts in long term future scenarios. • Preliminary results from the three synthesis themes (agricultural structure, sustainable feeding, sustainable plant protection). • An international workshop and first drafts of scientific articles in the theme dealing with Integrated nutrient management in crop production.	

1.5 Collaboration

International co-operation
During the first phase, there has been extensive collaboration with international research partners on the level of individual research projects. Several FOOD 21 researchers have also been actively involved in applications to the European Union (EU). Collaboration partners are listed in the plans for individual projects.

International collaboration has been established within the subprograms concerned with crop and animal production. Most of this has been funded by MISTRA and organised by the International Foundation for Science (IFS), entailing collaboration with strong research groups in Colombia and Mexico. There are several fundamental differences in climate and production methods between these countries and Sweden. In spite of this, the overall approach to sustainability issues, and visions about urgent corrective measures have to a large extent been found to constitute a common meeting ground. It is our experience that this collaboration has been very profitable for the FOOD 21 program, especially when it comes to principles for efficient food production with low resource input and efficient re-circulation systems. Collaboration with Mexico and Colombia will continue. Funds have been allocated by the IFS.

Several attempts have been made to identify other research programs on an international basis, sharing the same goals, visions and scope as FOOD 21, with which to initiate collaboration. So far, this search has achieved very little. Some similar interdisciplinary programs are under way but these have not yet been initiated. Contact has been established with a Dutch program (directed by dr. Gerrit Merdink, Wageningen), and we will continue to strive for co-operation with additional programs during the second phase. We do believe that collaboration with other similar research programs will be beneficial for both parties, and contribute to a stimulating research environment.

National co-operation
Besides co-operation within the SLU and other national universities, mainly on program level, co-operation will take place with three MISTRA programs;

- **Urban Water** concerning recycling of urban organic wastes within the fields of 1) Crop production, and 2) Consumer aspects.
- **Pasture-MISTRA** within the fields of 1) Product quality, 2) Consumer aspects, and 3) Systems analysis.
- **VASTRA** within the interface between the environmental impact on waters and the environmental consequences.

This co-operation will occur in the form of jointly arranged seminars and participation in the synthesis work of these programs.

1.6 Internal education

To improve skills for the people involved with the scenario and synthesis work and to start the sturdy building of scenarios, a number of meetings and group discussions will be conducted. Discussions and training of skills will partly be elaborated with synthesis people participating in other MISTRA programs.

The PhD students recruited at the start of Phase I are approaching their doctoral exams, most of them within a year or two. Courses for the theoretical part of their work have in most cases been completed. However, some courses focusing on more practical aspects such as "How to meet media" and "Agricultural EU policies and environmental subsidies" will be considered.

<table>
<tr><td>Project</td><td colspan="2">Internal education</td></tr>
<tr><td>Project leader</td><td colspan="2">Prof. Rune Andersson, SLU</td></tr>
<tr><td>Collaborating scientists</td><td colspan="2">The Program Management Group (PMG)</td></tr>
<tr><td>Project deliverables for the total project</td><td colspan="2">• Competence building in identified strategic subjects</td></tr>
<tr><td colspan="2">Deliverables for year 2001:
• A course on how to meet media
• Lectures on Life Cycle Analysis (LCA) and Systems Analysis</td><td>Results year 2001:
• A course for the scientists and PhD students on "How to meet media" (Journalist Lars Åkerman at Blidö, October).
• Three lectures on Life Cycle Analysis (LCA) and Systems Analysis (AgrD Ulf Sonesson, SIK).</td></tr>
<tr><td colspan="2">Deliverables for year 2002:
• A course focusing; " The political and legislative EU-landscape where Swedish agriculture is obliged to operate" is under preparation in co-operation with the MISTRA Program "Management of Seminatural Grasslands".
• Lectures on Environmental Systems Analysis.
• A course for scientists and PhD students on advanced interdisciplinary research and synthesis.</td><td>Results year 2002:</td></tr>
</table>

1.7 Collaboration and communication

Owing to the fact that there are a great number of stakeholders in the program, communication has become very important as a tool to fulfil the Program aims. Communication in traditional academic media like scientific journals, fact sheets, annual reports etc. will constitute important channels. In addition other more public forms such as seminars, workshops, special events, synthesis and scenario works will all take place under the common sign *Meeting Point Food 21.* Furthermore, everyone involved in FOOD 21 (the Executive Committee, the program management group, the researchers, and the Ph.D. students) has a continuous commitment and responsibility for the communication in his or her

special field. The PMG will provide communication training in order to stimulate and involve the researchers in this work (section 1.6).

The following activities constitutes the communication work:

- Co-ordination of all communication activities
- Journalistic support in preparing stakeholder oriented products
- Continuous check for emerging sustainable issues of the food chain actors

The communication plan is a totally integrated part of the overall program of Phase II.

The strategy for communication

The needs for information of the stakeholders must be the starting point for all communication.
Groups of stakeholders are defined and the best means of communication with each group are mapped.

The following groups of stakeholders have been identified;

- The agricultural community of Sweden, The food industry, The retailers, The wholesalers, Consumer groups, The political system, Other researchers, The Swedish community

Kollegium MAT 21

The most important issue in communication is to have a proper network. That is why the Program Management Group and the Executive Committee, in accordance with the suggestions of the reviewers, have decided to invite persons representing different categories among the stakeholders in order to create a focused and effective group acting as a communication link between the researchers and the stakeholders. Their commitment is to act as a bridge in both directions.

Project	**Communication**
Project leader	Agr. Mona Nordberg, SLU
Collaborating staff	Agr. Anna Blomberg, LRF CEO Lars Hällbom, LRF
Project deliverables for the total project	• Annual reports, publications and special activities for target groups • Development of an information network promoting stakeholder participation in program activities.

Deliverables for year 2001;	**Results year 2001;**
• A more detailed communication plan will be elaborated and presented in the beginning of the year. • Three meetings with Kollegium MAT 21. • An annual report. • A brochure about Food 21 (Swedish/English). • Two seminars on Sustainability in collaboration with other organisations. • An updated Web site including an English version. • Special events/seminars/workshops directed at target groups including press seminars. • Four fact sheets. • Collaboration with SLU Info will be continued and extended to include media contacts. • Monthly Newsletters.	• A more detailed communication plan (under prep.). • Three meetings with Kollegium MAT 21 held at the stakeholders arenas with presentations of results obtained within the sub-programs. • An annual report 2000. • Brochure: A Taste of Food 21 (Swedish/English). • EU conference; FOOD CHAIN 2001. • Two seminars on “Perspectives on Sustainability”. • An updated Web site. • Two seminars. • Six fact sheets (SLU Fakta Jordbruk). • Monthly Newsletters. • Two Food 21 reports. • Poster presentations at conferences and other arrangements in the country e.g. Swedish championship in ploughing, Elmia, farmer oriented activities etc.
Deliverables for year 2002: • Two seminars on “Perspectives on Sustainability”. • An annual report 2001. • A Web site (English version). • Special events/seminars/workshops directed at target groups. • Three meetings with Kollegium MAT 21. • Monthly Newsletters. • Four Food 21 reports. • Three fact sheets.	**Results year 2002:**

Section 2

2.1 Research on new subjects

In the planning of Phase II, the scope of the program has been reconsidered with respect to subjects not dealt with. Such considered fields are: pesticide use and its environmental consequences, human health aspects of sustainably produced food, recycling of urban organic waste to arable land, and social aspects on farmers' situation in sustainable agriculture.

Much international and national research concerns studies of benefits and risks of pesticide use in crop production. The initial analysis of research, made at the start of Phase I, resulted in the conclusion that it would not be profitable to perform environmental pollution studies with available program funds. This conclusion is still held to be valid. Furthermore, within the MISTRA program "Microbial Antagonism against Fungi", possibilities to replace chemical pest control by biological control are in focus. That work runs successfully and seems promising for a range of different areas of pest control. Pesticide use is an important issue in sustainable food production and our conclusion is that we will include this as a part of the synthesis work.

A similar conclusion has been drawn with respect to suggestions on extended studies of human health effects of food produced in more sustainable agricultural systems. Diet intervention studies of selected human populations, which have been considered, appear to be too expensive and are judged to give only marginally relevant knowledge. Consequently, health aspects will be included in our synthesis work. Expertise in this field already participates in the FOOD 21 Program both on the scientific level and in the Kollegium -MAT 21.

In Phase I, recycling of organic urban waste to arable land has been dealt with within one of our eight Synthesis Themes. In Phase II, the recycling issue will be processed as a synthesis issue.

Project on social aspects
The social aspects related to the farmer and his family have been the subject of a new project " The social aspects in sustainable agriculture" (See project CF6).

Project on economy
At the beginning of phase II, a doctoral project will start within the field of sustainable economy, with the project title "Co-operation, integration and economic adjustments in the agricultural firm".

To share machinery and to make joint purchases of production means are examples of already existing forms of collaboration between farmers. What is new in this project is the aim to analyse whether collaboration between two or more specialised enterprises may create advantages when environmental and social goals are addressed besides the economic outcome. For example, collaboration between a dairy farm and an arable farm may lead to a more sustainable use of manure and of soil resources in general. Another question is: will the market competitiveness improve as a consequence of the achieved added values? Special competence of involved parties may also create benefits for all.

A project plan has been elaborated and is available at the FOOD 21 secretariat. Project characteristics and deliverables are presented within the subprogram Systems Analysis (see project SA4). LRF (Federation of Swedish Farmers) and FOOD 21/MISTRA share the financing of the project.

Project on cadmium crop uptake
A second doctoral project is under preparation regarding crop uptake of cadmium. The title is "Regulating mechanisms in crop uptake of cadmium from soils".

The subject is identified in discussions with representatives for the agricultural sector, especially Cerealia. The background is that the cadmium content of cereals often exceeds health limits and the average concentration is increasing over time. The reason for this is both a continuous release of bedrock cadmium through mineral weathering and input to soils through atmospheric fallout and fertilises. No clear relationship is found between the concentration in the soil solution and crop uptake, suggesting an existing lack of knowledge about mechanisms behind root uptake.

Also the costs for this new project are supposed to be shared between LRF and FOOD 21/MISTRA. Project characteristics and deliverables are presented within the subprogram Crop Production (see project CP4). A project plan is under preparation.

2.2 Research projects

A project plan has been developed for each research project. These plans will serve as "contracts" between the PMG and the individual researchers. All plans are available at the office of the Assistant Program Manager.

Figure 3 illustrates the total food chain, and the main points at which FOOD 21 research activities are concentrated.

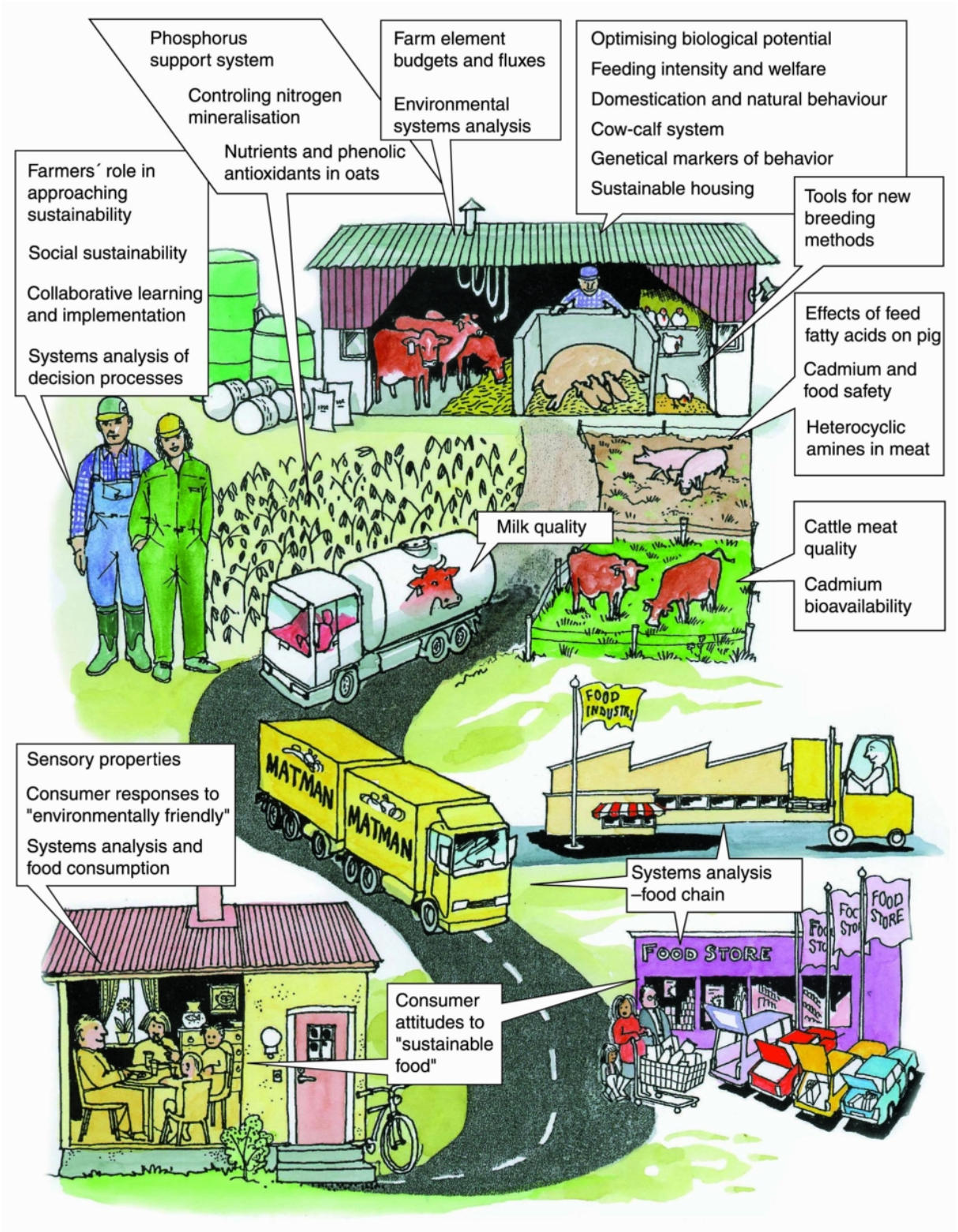

Figure 3. An overview of the FOOD 21 Research Program, from soil to table.

Crop Production (CP) – Projects

CP1 a) Decision support system for selection and evaluation of 'Best Management Practices' to reduce P emissions to natural waters.
b) P sorption and desorption in relation to leaching losses from some cultivated Swedish soils – PhD project
c) Displacement of P in structured soils – PhD project

CP2 a) Optimising mineralisation of N from organic materials
Field implementation
b) Optimising mineralisation of N from organic materials - PhD project

CP3 a) Fluxes and balances of nutrients and trace elements in different farming systems
b) Fluxes and balances of nutrients and trace elements in the soil-crop system in organic and conventional dairy farming – PhD project
c) Contribution from mineral weathering – PhD projects
d) Modelling fluxes and balances of heavy metals in farming systems

CP4 Methods to better predict and to lower Cd content in wheat/cereals – a PhD project

CP1a

Project	**Decision support system for selection and evaluation of 'Best Management Practices' to reduce P emissions to natural waters**
Project leader	Prof. Lars Bergström, SLU
Collaborating scientists	Dr. Faruk Djodjic, SLU PhD stud. Katarina Börling, SLU PhD stud. Monica Kling, SLU Dr Erasmus Otabbong, SLU Prof. Adel Shirmohammadi, Univ. of Maryland (UVM) Dr Lennart Torstensson, SLU Dr Barbro Ulén, SLU
Project deliverables for the total project	• Based on the P related research done in Phase 1, we will develop and apply a multi-component 'Decision Support System' to identify sensitive areas for which probable causes behind P losses can be evaluated, and appropriate 'Best Management Practices' can be prescribed and tested.

Deliverables for year 2001:	**Results year 2001:**
• The project will be started during the 2nd year and will last for 2 years.	• According to plan, no results have yet been obtained.
Deliverables for year 2002: • During the first year of the project (year 2), a database with information on a selected watershed will be compiled. • A tested and evaluated software package to be used for various applications will be selected.	**Results year 2002:**

CP1b

Project	**P sorption and desorption in relation to leaching losses from some cultivated Swedish soils**
Project leader	Dr Erasmus Otabbong, SLU
Collaborating scientists	Prof. Elisabetta Barberis, Turin Univ PhD stud. Katarina Börling, SLU Dr Gerd Johansson, SLU
Project deliverables for the total project	• Methods to identify P-AL and Olsen-P values critical for P losses, and soils prone to P losses, as a basis for reduction of such losses.

Deliverables for year 2001: • Publish an article containing information on 'P sorption and desorption on 10 Swedish soils, each of them fertilized at four different P levels'.	**Results year 2001:** • An article ('Phosphorus sorption in relation to soil properties in some cultivated Swedish soils') was published in Nutrient Cycling (2001, 1:1-8).
Deliverables for year 2002: • Publish articles containing information on 'Comparison on soil-P methods with particular reference to the resin-, Olsen- and AL-methods in Swedish soils', and 'Sorption/desorption properties and potential P leaching in non-calcareous Swedish soils'.	**Results year 2002:**

CP1c Terminated

Project	**Displacement of P in structured soils**
Project leader	Prof. Lars Bergström, SLU
Collaborating scientists	PhD stud. Faruk Djodjic, SLU Prof. Adel Shirmohammadi, UVM Dr Barbro Ulén, SLU
Project deliverables for the total project	• Evaluation of the role of macropores for leaching of P through soils. This knowledge will be used for development of counter measures to reduce P leaching.

Deliverables for year 2001: • PhD thesis by Faruk Djodjic, which contains information on 'Displacement of P in structured soils'. This is the final year of the project, which was started in autumn 1997.	**Results year 2001:** • The PhD thesis ('Displacement of P in structured soils') was completed and successfully defended by Faruk Djodjic on Sept. 21, 2001.

CP2a

Project	**Optimising mineralisation of N from organic materials -Field implementation**
Project leader	Dr Håkan Marstorp, SLU
Collaborating scientists	Dr Sigrun Dahlin, SLU
Project deliverables for the total project	• We will identify and evaluate quality properties of plant materials that may be used to steer or manipulate net N mineralisation under field conditions. This research is based on the results obtained in model experiments in the first phase of the project. • We will develop knowledge of how crop management affects these plant material quality properties. • We will suggest management strategies that optimise the mineralisation of N from organic materials.

Deliverables for year 2001: • Identify quality properties of legumes and grasses that may be used to steer or manipulate net N mineralisation under field conditions. • Develop knowledge of how crop management affects these plant material quality properties.	**Results year 2001:** • Screening of the variation in chemical composition and degradability of a number of grasses and legumes has been performed. A micro-plot experiment has been started in the field. • A literature review dealing with 'how the quality of plant materials is affected by management practices' is being completed.
Deliverables for year 2002: • Evaluate quality properties of legumes, grasses and other plant materials that may be used to steer or manipulate net N mineralisation under field conditions.	**Results year 2002:**

CP2b

Project	**Optimising mineralisation of N from organic materials** **PhD project**
Project leader	Dr Håkan Marstorp, SLU
Collaborating scientists	Dr Ernst Witter, SLU PhD stud. Sophie Gunnarsson, SLU
Project deliverables for the total project	• We will identify quality properties of plant material that may be used to steer or manipulate net N mineralisation. • We will develop knowledge of how crop management affects these plant material quality properties. • We will develop methods to steer net N mineralisation in model experiments by means of the quality of the plant material.

Deliverables for year 2001: • Identify quality properties of plant material that can be used to steer or manipulate the net N mineralisation. • Knowledge of how crop management affects these plant material quality properties. • Develop methods to steer net N mineralisation in model experiments by means of the quality of the plant material.	**Results year 2001:** • An article ('Carbohydrate composition of plant materials determines N mineralisation') is in the process of being published in the journal Nutrient Cycling in Agroecosystems. • A literature review is being completed (see above). • PhD-thesis by Sophie Gunnarsson will be completed during 2002.
Deliverables for year 2002: • PhD-thesis by Sophie Gunnarsson.	**Results year 2002:**

CP3a

Project	**Fluxes and balances of nutrients and trace elements in different farming systems**
Project leader	Dr Ingrid Öborn, SLU
Collaborating scientists	PhD stud. Helena Bengtsson*, SLU PhD stud Johan Holmqvist*, Lund University (JH will continue in this project as post doc). Dr Gunnela Gustafson, SLU PhD stud. Anna-Karin Modin*, Lund University Prof. Ingvar Nilsson, SLU MSc Anna Richert Stintzing, JTI Dr Eva Salomon, JTI Prof. Harald Sverdrup, Lund University *) see separate project plans
Project deliverables for the total project (excl PhD students)	• New knowledge about flows and balances/imbalances of elements in a variety of production systems on field, farm and regional scale will form the basis for recommendations and measures to avoid long term soil accumulation or depletion. • Sampling/monitoring strategy for farm specific input data to farm and field balances. • Methods to evaluate the output from farm and field budgets and suggest measures both related to efficiency in the production system and the potential environmental impact. • Methods to predict the inherent capacity of different soil types to deliver essential nutrients for crop growth

Deliverables for year 2001: • Further evaluation and writing up of results from Phase 1, 'Fluxes and balances of nutrients and trace elements in conventional and organic dairy farming systems'. These papers will form a basis for system analyses and implementation. • Evaluation and publication of data from Phase 1 dealing with partitioning of 17 nutrient and trace elements in feed among growth, faeces and urine by growing dairy breed steers. • Survey of feeding strategies and identification of hot spots regarding flows and balances of nutrients and trace elements in production of fattening pigs.	**Results year 2001:** • The results have been presented at national and international conferences and a manuscript ('Field balances of some mineral nutrients and trace elements in organic and conventional dairy farming - a case study at Öjebyn, Sweden') is being published in the Eur. J. Agric. A 2-day workshop has been held as a starting point for the systems analyses. • The data on partitioning of 17 nutrients and trace elements in feed has been evaluated and a manuscript is under preparation*. • The work on feeding strategies has been started.
Deliverables for year 2002: • Data on annual variations (3years) in fluxes and balances of nutrients and trace elements in conventional and organic dairy farming will be estimated and published. • Estimates of the weathering potentials of agricultural soils at a regional scale. • Data on fluxes and balances of nutrients and trace elements at a farm which is based on fattening pigs in Southern Sweden.	**Results year 2002:**

*Additional funding has been received from the Swedish Agricultural Board.

CP3b

Subproject	**Fluxes and balances of nutrients and trace elements in the soil-crop system in organic and conventional dairy farming**
Project leader	Dr Ingrid Öborn, SLU
Collaborating scientists	PhD stud. Helena Bengtsson, SLU Prof. Ingvar Nilsson, SLU Prof. Arne Andersson, SLU
Project deliverables for the total project	• One PhD thesis, including 4 publications dealing with fluxes and balances of elements in soil/crop systems in organic and conventional dairy farming.

Deliverables for year 2001: • Quantification of soil content of nutrients and trace elements at the Öjebyn farm. • Evaluation of soil quality and fertility with respect to element balances and the influence of historical management practices.	**Results year 2001:** • The work has proceeded according to the plan. A manuscript ('Field balances of some mineral nutrients and trace elements in organic and conventional dairy farming - a case study at Öjebyn, Sweden') is under preparation to be published in the Eur. J. Agric. • Soil water has been sampled by tension lysimeters and the chemical composition has been analysed*.
Deliverables for year 2002: • PhD thesis by Helena Bengtsson, which contains information on 'Fluxes and balances of nutrients and trace elements in the soil-crop system in organic and conventional farming systems'.	**Results year 2002:**

*Additional funding from Formas (SJFR) has been received for this part of the study.

CP3c Terminated

Subproject	**Contribution from mineral weathering**
Project leader	Prof. Harald Sverdrup, Lund University
Collaborating scientists	PhD stud. Johan Holmqvist, Lund University Dr Ingrid Öborn, SLU
Project deliverables for the total project	• One PhD thesis, including 5 publications dealing with the contribution from mineral weathering to soil nutrient status.

Deliverables for year 2001: • PhD thesis by Johan Holmqvist. 'Chemical weathering –in different scales' (partly financed by FOOD 21).	**Results year 2001:** • The PhD thesis ('Modelling Chemical Weathering –in Different Scales') has been completed and successfully defended on Nov. 23, 2001.

CP3d

Subproject	**Modelling fluxes and balances of heavy metals in farming systems**
Projectleader	Prof. Harald Sverdrup, Lund University
Collaborating scientists	PhD stud. Anna-Karin Modin, Lund University PhD stud. Helena Bengtsson, SLU PhD stud. Johan Holmqvist, Lund University Dr Ingrid Öborn, SLU Dr Gunnela Gustafson, SLU Prof. Ingvar Nilsson, SLU MSc Anna Richert Stintzing, JTI Dr Eva Salomon, JTI Prof Agneta Oskarsson, SLU
Project deliverables for the total project	• One PhD thesis, consisting of about five peer-reviewed publications dealing with modelling heavy metals in the system soil-crops-livestock-manure-soil.

Deliverables for year 2001: • A calibrated and tested dynamic process-oriented biogeochemical model, describing the uptake of cadmium from soil to plant at field scale.	**Results year 2001:** • The Cd model has been developed and tested, and presented at an international conference. An article describing the model will be submitted to an international journal before the end of 2001.
Deliverables for year 2002: • A dynamic model describing fluxes and balances of P at farm scale will be developed, calibrated and tested, using data from Öjebyn. • The model will be extended to also include N, K, Zn and Cd.	**Results year 2002:**

CP4

Project	**Methods to better predict and to lower Cd content in wheat/cereals – a PhD project in soil and plant science**
Project leader	Assoc. Prof. Jan Eriksson, SLU
Collaborating scientists	PhD student NN Assoc. Prof. Ingrid Öborn, SLU
Project deliverables for the total project	• One PhD thesis, consisting of about four peer-reviewed publications on methods to predict Cd content in wheat/cereals from soil and plant analyses. Effects of fertilisation on plant availability of Cd and on correlation between conditions in the rhizosphere and plant uptake of Cd will be investigated.

Deliverables for year 2002: • Data on correlations between Cd content in harvested grain and Cd content of the crop at earlier growth stages and how it varies with seasonal conditions and soil type.	**Results year 2002:**

Animal Production (AP) - Projects

AP1	Animal welfare and sustainable breeding: Behavioural and genetical markers
AP2	”Cow-calf systems” - effects of dairy calf rearing systems on present and future health, behaviour and production of cow and calf
AP3	Sustainable housing systems for farm animals
AP4	Domestication and natural behaviour – completing project from Phase 1
AP5	Feeding intensity in relation to animal welfare and productivity
AP6	Optimising the animals biological potential
AP7	Animal welfare and sustainable breeding: mapping of Quantitative Trait Loci (QTL) in an intercross between the Red Jungle Fowl and White Leghorn chicken

AP1

Project	**Animal welfare and sustainable breeding: Behavioural and genetical markers**
Project leader	Prof. Per Jensen, SLU
Collaborating scientists	Prof. Leif Andersson, SLU Dr Linda Keeling, SLU Prof. Kerstin Lundström, SLU
Project deliverables for the total project	• Detailed genomic analysis of behavioural disorders in poultry, with identification of candidate genes for stress susceptibility, feather pecking and cannibalism.

Deliverables for year 2001:	**Results year 2001:**
• Second and third generation of breeding population of F2 intercrosses between jungle fowl and laying hens. • First genome analysis of feather pecking in poultry. • First results from genome analysis of meat and egg quality parameters. • Identification of behavioural markers for decreased stress tolerance in relation to production capacity in poultry. • Development of behavioural tests for stress tolerance and behavioural disorders.	• Second generation hatched, and third generation under planning. • QTL for feather condition (as a result of feather pecking) identified. Analysis of phenotypical traits correlated to feather pecking almost finished. • Meat and egg quality parameters not analysed yet. • Contrafreeloading and social behaviour has been identified as one behavioural marker for adaptability. Other markers still being analysed are open field reactivity, tonic immobility, and novel object reactivity. • Behavioural tests for contrafreeloading and social behaviour have been developed.
Deliverables for year 2002: • Maintainance of progressive generations of fowl intercrosses. • Further analysis of candidate genes for feather condition. • Data from behavioural tests of parental generations. • First preliminary analyses of gene expression data for different behavioural parameters. • 1-2 scientific papers.	**Results year 2002:**

AP2

Project	**"Cow-calf systems" - effects of dairy calf rearing systems on present and future health, behaviour and production of cow and calf**
Project leader	Dr Charlotte Berg, SLU
Collaborating scientists	**An already formed working group consisting of (among others)** Dr Lena Lidfors, SLU Dr Kerstin Svennersten-Sjaunja, SLU AgrL Michael Ventorp, SLU Dr Ingemar Olsson, SLU PhD stud. Annette Herrloff, SLU
Project deliverables for the total project	• A presentation of well functioning systems for suckling calves in dairy herds. Evaluations and descriptions of different types of housing systems, which promote calf health and welfare. • Knowledge about the important behavioural components to take into consideration during the weaning process. • Suggestions on calf rearing systems, which improve udder health and decrease the use of antibiotics in milk production. • Scientific and popular publications related to the optimal suckling period and weaning methods for dairy calves suckling their own mother, and the effects on udder health and milk quality when dairy calves are allowed to suckle their dams or other cows. • Results on the effect of early interaction between cow and calf on the physiology, behaviour and growth of the calf and the behaviour, milk production and udder health of the cow. • In co-operation with a commercial medium sized dairy farm, some of the results achieved will be applied and demonstrated in practice.

Deliverables for year 2001: • A presentation of well functioning systems for suckling calves in dairy herds. • Results on the effect of early interaction between cow and calf on the physiology, behaviour and growth of the calf. • Results on the effect of early cow-calf interaction on the behaviour, milk production and udder health of the cow.	**Results year 2001:** • Results on the effect of early interaction between cow and calf on the behaviour and growth of the calf and on the behaviour, milk production and udder health of the cow. The practical part of this study has now been fully completed. • Popular presentations: The FOOD21 cow-calf project has been presented on posters at the following exhibitions: FoodChain2001, Uppsala, March 2001; Elmia Lantbruk 2001, Jönköping, October 2001. • A slide and video presentation of different methods of milk feeding dairy calves, aimed at agriculture students, farmers and advisors. • A sheet of facts about milk feeding methods on organic dairy farms, and results from a study of foster cows. • We have initiated discussions with several farmers who want to try keeping cow and calf together. • A study on effects of cow-calf separation after 1, 4 or 7 days with or without visual-auditory contact have started as a co-operation with the University of Prague. • Participation in an application to EU to study suckling calves in a larger project.
Deliverables for year 2002: • A book with presentations of well functioning systems for suckling calves in dairy herds (slightly delayed due to the restrictions on farm visits during the outbreak of FMD in Europe in spring 2001). • Two scientific papers on the effect of early interaction	**Results year 2002:**

between cow and calf on the behaviour and health of the calf and cow. • Results on the effect of different calf age at separation on cow and calf behaviour. • A seminar for advisors about rearing of dairy calves. To be held during autumn. • Study of the effect of different suckling and separation regimes on milk quality, udder health, onset of ovarian activity and welfare in cattle raised under tropical and highland conditions in Mexico. • Continue discussions with several farmers who want to try keeping cow and calf together. Establish some as exhibition farms for advisors and farmers to visit.	

AP3

Project	**Sustainable housing systems for farm animals**
Project leader	Prof. Bo Algers, SLU
Collaborating scientists	Prof. Pascal Oltenacu, Cornell University Vet Lic. Jan Hultgren, SLU Prof. Per Jensen, SLU Dr Linda Keeling, SLU Dr Stefan Gunnarsson, SLU Dr. Lars Vikinge, Univ. of Linköping. Dr Michael Ventorp, SLU Agr Ann-Charlotte Olsson, SLU Agr Eva von Wachenfeldt, SLU
Project deliverables for the total project	• A description of a housing system for cows, pigs and layers respectively that meets the FOOD 21 sustainability goals on behaviour and health.

Deliverables for year 2001: • Results from a workshop on housing systems for pigs.	**Results year 2001:** • Workshop on housing system for cattle. • Contacts with farms and planning of demonstration housing system for cattle. • Additional research competence attached to the project.
Deliverables for year 2002: • Workshops on housing systems for pigs, cattle and poultry.	**Results year 2002:**

AP4

Project	**Domestication and natural behaviour** (completing project from Phase 1)
Project leader	Prof. Per Jensen, SLU
Collaborating scientists	Prof. Leif Andersson, SLU PhD stud. Karin Schütz, SLU
Project deliverables for the total project	• Results on behavioural effects of selection for increased production in broilers, together with a first QTL-analysis of the behavioural variables recorded.

Deliverables for year 2001: • Totally five scientific papers (two are already available) on the relationship between production capacity, behavioural strategies in relation to feeding, and the genetical bases for these strategies and their inter-relations.	**Results year 2001:** • Two more scientific papers (two of the planned papers were merged to one) submitted, i e totally four papers produced.
Deliverables for year 2002: • A PhD thesis to be presented in February 2002.	

AP5

Project	**Feeding intensity in relation to animal welfare and productivity** (completing project from Phase 1)
Project leader	Prof. Bo Algers, SLU
Collaborating scientists	PhD stud. Margret Wülbers-Mindermann, SLU Dr. Charlotte Berg, SLU PhD stud. Eva Persson, SLU Prof. Kerstin Uvnäs-Moberg, SLU
Project deliverables for the total project	• Recommendations on how to use behavioural and physiological indicators as a measure of health to better utilise the animals' biological potential.

Deliverables for year 2001: • Results from a workshop on effects of feeding frequency on physiology and health.	**Results year 2001:** • PhD-student on maternity leave, project postponed.
Deliverables for year 2002: • Results from a workshop on effects of feeding frequency on physiology and health.	**Results year 2002:**

AP6

Project	**Optimizing the animals biological potential** (completing project from Phase 1)
Project leader	Prof. Bo Algers, SLU
Collaborating scientists	PhD stud. Jonica Östlund, SLU Dr Erling Strandberg, SLU Prof. Yrjö Gröhn, Cornell University Dr Ulf Emanuelsson, Interbull
Project deliverables for the total project	• A model taking into account effects of rearing methods, disease incidence at different production levels, etc. on the overall economical outcome of dairy farms. • A model describing effects on early or late separation (weaning) in cattle on future production capacity and health of the animal.

Deliverables for year 2001: • Models on effects of calf housing on later performance of dairy cows.	**Results year 2001:** • PhD-student on maternity leave. Project postponed.
Deliverables for year 2002: • Models on effects of calf housing on later performance of dairy cows.	**Results year 2002:**

AP7

Project	**Animal welfare and sustainable breeding: mapping of Quantitative Trait Loci (QTL) in an intercross between the Red Jungle Fowl and White Leghorn chicken**
Project leader	Prof. Leif Andersson, SLU
Collaborating scientists	Prof. Per Jensen, SLU Prof. Kerstin Lundström, SLU PhD stud. Örjan Carlborg, SLU
Project deliverables for the total project	• Mapping of Quantitative Trait Loci (QTL) in an intercross between the Red Jungle Fowl and White Leghorn chicken. • The provision of tools for new breeding methods, by which breeding for productivity could be performed without negative effects on behaviour, health and welfare.

Deliverables for year 2001: • Final development of software for QTL analysis including search for gene interaction. • QTL analysis of phenotypic data (behavioural traits, egg production, growth, etc,) from the F2 generation.	**Results year 2001:** • Final development of software for QTL analysis including search for gene interaction. • QTL analysis of phenotypic data from the F2 generation.
Deliverables for year 2002: • One PhD thesis on the mapping of Quantitative Trait Loci (QTL) in an intercross between the Red Jungle Fowl and White Leghorn chicken. • The provision of tools for new breeding methods, by which breeding for productivity could be performed without negative effects on behaviour, health and welfare.	**Results year 2002:**

Product Quality (PQ) - Projects

PQ1	Nutrients and phenolic antioxidants in oats which are produced in ecological and conventional systems
PQ2	The effect of genetic and environmental variation on the formation of heterocyclic amines in meat
PQ3	Meat quality in a sustainable production system utilising various cattle breeds and crosses – a comparison with conventional feeding systems
PQ4a	Effect of different rearing conditions on the fatty acid composition, antioxidant content and oxidation stability of pig meat
PQ4b	Effect of feed fatty acid composition on metabolism and welfare, a model
PQ5	Milk quality in sustainable systems
PQ6	Evaluation of sensory properties
PQ7	Food Safety Aspects of Cadmium
PQ8	Food Safety Aspects of Cadmium with focus on bioavailability

PQ1

Project	**Nutrients and phenolic antioxidants in oats which are produced in ecological and conventional systems**
Project leader	Dr Lena Dimberg, SLU
Collaborating scientists	Prof. Per Åman, SLU
Project deliverables for the total project	• Publications of data on the levels of proteins, starch, glucans and phenolic antioxidants in oats grown under ecological and conventional conditions and from controlled experiments with different fertilisation regimes. • Evaluation of avenanthramides (phenolic antioxidants), as non-specific marker for cultivation conditions.
Deliverables for year 2001: • Analysis of proteins, starch, glucans and phenolic anti-oxidants in oats samples (ca 60 samples) grown with different cultivation conditions will be performed.	**Results year 2001:** • Project start delayed 6 months. • Oat groats and hulls cultivated due to “Svenskt sigill” or to KRAV- specifications (in total 48 samples) have been analysed for avenanthramide levels. Furthermore, oat samples (10 cultivars), susceptible or resistant to fungal infection, with varying score of fungal infection have been analysed for avenanthramides.
Deliverables for year 2002: • Cont. of chemical analysis.	**Results year 2002:**

PQ2

Project	**The effect of genetic and environmental variation on the formation of heterocyclic amines in meat**
Project leader	Prof. Kerstin Lundström, SLU Prof. Magaretha Jägerstad, SLU
Collaborating scientists	PhD stud. Viktoria Nilzén, SLU
Project deliverables for the total project	• Effect of more sustainable rearing systems for pigs on the overall meat quality. • Monitoring the effect of environmental and genetic variation on the formation of heterocyclic amines (HCAs) in pork. • Design of a study accounting for consumer preferences of cooked pork to evaluate exposure of HCAs. • One PhD thesis including 4-5 peer-reviewed publications on environmental and genetic effects on overall pig meat quality and the formation of HCAs in pork.

Deliverables for year 2001:	**Results year 2001:**
• Publication of data from a study monitoring the effect of environmental and genetic variation on the formation of HCAs. • Design of a study accounting for consumer preferences of cooked pork to evaluate exposure of HCAs.	• Olsson, V. et al., 2001. Natural variations of precursors in pig meat affect the yield of heterocyclic amines - Effects of genotype, feeding regime and sex. Submitted. • Olsson, V. et al., 2001. Sustainable pig meat production - will the meat quality be affected? In manuscript. • Publication of several abstracts on the effect of more sustainable rearing systems for pigs on the overall meat quality.
Deliverables for year 2002:	**Results year 2002:**
• Publication of data on the effect of more sustainable rearing systems for pigs on the overall meat quality. • Completion of a study on the relative importance in precursor levels and frying temperatures on the formation of HCAs.	

PQ3

Project	**Meat quality in a sustainable production system utilising various cattle breeds and crosses – a comparison with conventional feeding systems**
Project leaders	Prof. Kerstin Lundström, SLU Dr Ingemar Hansson, SLU Dr Lucia Ballerini, post doc SLU
Collaborating scientists	Dr Sölve Johnsson, SLU Dr Gunnar Malmfors, SLU PhD stud. Anna Hessle, SLU
Project deliverables for the total project	• Meat quality in general from young bulls, steers and heifers on various feeding systems and feed intensity. • Meat quality from steers and heifers slaughtered directly after grazing in comparison with after a finishing period. • The effect of various feeding intensity on eating quality. • The effect of various feeding intensity on instrumental tenderness. • The importance of animal sex and intra-muscular fat content on eating quality. • Use of image analysis for estimation of intra-muscular fat.

Deliverables for year 2001:	**Results year 2001:**
• Meat quality in steers and heifers slaughtered after grazing or after a finishing period.	• Sensory and functional meat quality in steers slaughtered after grazing or after a finishing period. First trial slaughtered; meat collected and sensory tested; several instrumental and chemical analysis will be performed; preliminary results presented at board meeting. • Sensory and functional meat quality in heifers slaughtered after grazing or after a finishing period. First trial slaughtered. • Computer program finished for estimation of intra-muscular fat with the use of image analysis. • Östergren, K. 2001. Effect of ageing and salt injection on tenderness of meat from young bulls and heifers. Student project work. • PhD-student working with beef meat quality accepted; will be associated to Food21.
Deliverables for year 2002: • Continuation: Meat quality in steers and heifers slaughtered after grazing or after a finishing period. • The effect of various feeding intensity on instrumental tenderness. • The importance of animal sex and intra-muscular fat content on eating quality. • Use of image analysis for estimation of intra-muscular fat. • Publication of data.	**Results year 2002:**

PQ4a

Project	**Effect of different rearing conditions on the fatty acid composition, antioxidant content and oxidation stability of pig muscle**
Project leader	PhD stud. Anders Högberg, SLU
Collaborating scientists	Dr Jana Pickova, SLU; Prof Kerstin Lundström, SLU; Prof Ann-Christin Bylund, SLU, Ass Prof Paresh Dutta, SLU; Dr Jakub Babol, SLU; Prof Kerstin Uvnäs-Moberg, SLU
Project deliverables for the entire project	• To evaluate the effect of outdoor rearing, different feed stuffs and sex on the fatty acid composition in different lipid classes of pig muscle. • To evaluate the effect of outdoor rearing, different feed stuffs and sex on the antioxidant content and oxidation stability of pig muscle.

Deliverables for year 2001: • Two articles in international scientific journals.	**Results year 2001:** • Högberg, A., J. Pickova, J. Babol, K. Andersson and P. C. Dutta. 2001. Muscle lipids, vitamin E and A, and lipid oxidation as affected by diet and RN genotype in female and castrated male Hampshire crossbred pigs. Meat Science, in press. • Högberg, A., J. Pickova, P. C. Dutta, J. Babol and A. C. Bylund. 2001. Effect of rearing system on muscle lipids of gilts and castrated male pigs. Meat Science, 58, 223-229.
Deliverables for year 2002: • 2-3 articles in international scientific journals. • PhD thesis Anders Högberg.	**Results year 2002:**

PQ4b

Project	**Effect of feed fatty acid composition on metabolism and welfare, a model study on pig**
Project leader	Dr Jana Pickova, SLU
Collaborating scientists	Dr Maria Neil, SLU PhD stud. Anders Högberg, SLU
Project deliverables for the entire project	• To evaluate the importance of n-3/n-6 fatty acids on animal health and welfare in general. • To evaluate to which extent C 18 fatty acids can replace C22 fatty acid (DHA) in pig dietary requirements. • To draw conclusions between the above mentioned factors, with regard to importance for human health.

Deliverables for year 2001: • Samples on sow milk and piglet tissue (nervous tissue and liver) will be analysed for fatty acids in piglets from sow groups fed four different diets.	**Results year 2001:** • Project start delayed 6 months. • Feed trials on pregnant sows initiated.
Deliverables for year 2002: • Samples on sow milk and piglet tissue (nervous tissue and liver) will be analysed for fatty acids in piglets from sow groups fed four different diets	**Results year 2002:**

PQ5

Project	**Milk quality in sustainable systems**
Project leader	Prof. Lennart Björck, SLU
Collaborating scientists	Dr Anders Andrén, SLU PhD stud. Patricia Toledo, SLU
Project deliverables for the total project	• Detailed information regarding the composition of milk from KRAV certified dairy farms. • Increased understanding between the relation between "ecological dairy farming" and raw milk composition. • Results published in international journals. • PhD thesis on "Sustainable milk production – effects on raw milk quality.

Deliverables for year 2001:	**Results year 2001:**
• Publication on composition of ecological raw milk. • Dissemination of obtained results to stakeholders.	• Toledo, P., Andrén, A. and Björck, L. 2001. Composition of raw milk from sustainable production system. International Dairy Journal, in press. • Seminar 2001-04-24, presentation of results.
Deliverables for year 2002: • Investigation of spontaneous off-flavour in organic milk. • Publication of results in international journal. • Translate results into advice on feeding practices.	**Results year 2002:**

PQ6

Project	**Evaluation of sensory properties**
Project leader	Prof. Einar Risvik, Uppsala University
Collaborating scientists	Associate prof. Åsa Öström, Uppsala University Prof. Kerstin Lundström, SLU PhD stud. Iwona Kihlberg, Uppsala University
Project deliverables for the total project	• Appoint a panel and training according to international standards. • Evaluate performance of panel. • Run tests on ecological beef and plant products. • PhD thesis on "sensory quality and consumer perception of bread processed of wheat from different growing systems".

Deliverables for year 2001:	**Results year 2001:**
• Appoint a panel and training according to international standards. • Evaluate performance of panel. • Run tests on ecological beef and plant products. • Two scientific publications submitted.	• New panel appointed, trained and evaluated. • Run tests on white bread baked of wheat from different growing systems. • Consumer test performed on attitudes, values and preferences for bread baked of wheat from different growing systems. • Image analysis of bread correlated to sensory texture perception. • Sensory test performed on beef meat from young bulls and steers. • Two scientific publications in manuscript.
Deliverables for year 2002: • Sensory tests performed on beef meat from young bulls, heifers and steers. • Three scientific publications submitted. • PhD-thesis on sensory quality of wheat products finished, Iwona Kihlberg.	**Results year 2002:**

PQ7

Project	**Food Safety Aspects of Cadmium**
Project leader	Prof. Agneta Oskarsson, SLU
Collaborating scientists	Dr Ingrid Öborn, SLU Dr Gunnela Gustafson, SLU Prof. Staffan Skerfving, Universitetssjukhuset Lund PhD stud. Ing-Marie Olsson, SLU PhD stud. Anna Lindén, SLU
Project deliverables for the total project	• Publication of data on the cadmium and zinc levels in bovine kidney, liver and mammary tissue and the impact of agricultural system as well as age of livestock. • Analysis and compilation of pig and human data from 49 farms in Skåne. • Two PhD theses (partly financed from FOOD 21) including 8 to 10 peer-reviewed publications, on cadmium in the food chain from soil, via feed and livestock to man.

Deliverables for year 2001:	**Results year 2001:**
• Publication of data on the cadmium and zinc levels in bovine kidney, liver and mammary tissue and the impact of agricultural system as well as age of livestock. • Analysis and compilation of pig and human data from 49 farms in Skåne.	• Olsson and Oskarsson. 2001. Sampling of kidneys from cattle and pigs for cadmium analysis. Analyst 126, 114-120. • Olsson et al. 2001. Cadmium and zinc in kidney, liver, muscle and mammary tissue from dairy cows in conventional and organic farming. J. Environ. Monit. 3, 531-538. • Lindén et al. 2001. Cadmium in organic and conventional pig production. Arch. Environ. Contamin. Toxicol. 40, 425-431. • Lindén et al. Pig kidney as a bioindicator of cadmium in the environment. In manuscript. • Olsson et al. Dietary cadmium exposure, blood levels and renal function in men and women living at pig-producing farms. In manuscript.
Deliverables for year 2002: • PhD thesis: Ing-Marie Olsson, Cadmium in the chain: crops-animal-man. • PhD thesis: Anna Lindén, Pig kidney for biomonitoring of cadmium in the agricultural environment.	**Results year 2002:**

PQ8

Project	**Food Safety Aspects of Cadmium with focus on bioavailability**
Project leader	Prof. Agneta Oskarsson, SLU
Collaborating scientists	
Project deliverables for the total project	• Basic knowledge on bioavailability of cadmium from different food and feed sources.

Deliverables for year 2001: The project will be started during the 2nd year and will last for 1 year.	**Results year 2001:** • Method development has started.
Deliverables for year 2002: • Method development for *in vitro* studies on cadmium solubility after gastric digestion and cellular uptake of cadmium in Caco-2 cell. • Publication of data on cadmium solubility in different pig feed components after gastric and intestinal digestion and cellular uptake in intestinal epithelial Caco-2 cells.	**Results year 2002:**

Consumer/Farmer (CF) – Projects

CF1 Consumer acceptance of ecological and sustainable food products

CF2 Health, environmental impact and animal welfare: Determinants of consumer responses to "environmentally friendly" food production

CF3 Environmental aspects of food consumption

CF4 Farmers' role in developing sustainable food production systems

CF5 Collaborative learning in the agri-food system

CF6 The social aspects in sustainable agriculture

CF1

Project	**Consumer acceptance of ecological and sustainable food products**
Project leader	Prof. Anders Biel, Göteborg University
Collaborating scientists	Lektor Ulf Dahlstrand, Göteborg University PhD student Gunne Grankvist, Göteborg University
Project deliverables for the total project	• Data on: the role of personal environmental values and earlier food purchase habits in food choice, the interaction between such values and types of environmental food labels, the impact of priming information in food stores, and the extent of "spill-over" effects between categories of environment-related behaviour. • Evaluation of a model for change of food purchase habits. • Two PhD theses.

Deliverables for year 2001:	**Results year 2001:**
• Data on effects of positively and negatively designed environmental labels and on effects of positive and negative priming on product choice.	• Data on positive and negative environmental labeling in consumer food choice. • Data on the role of values in moderating the effects of positive and negative environmental labeling.in consumer food choice. • One PhD-student completed the Licentiate exam.
Deliverables for year 2002: • Two PhD-students to have completed their studies. • Data on priming information on product choice in the food store environment. • Data on the role of morality and obligation as determinants of choice of organic foods.	**Results year 2002:**

CF2

Project	**Health, environmental impact and animal welfare: Determinants of consumer responses to "environmentally friendly" food production**
Project leader	Prof. Per-Olow Sjödén, Uppsala University
Collaborating scientists	Dr Ulla-Kaisa Koivisto-Hursti, Uppsala University PhD student Maria Magnusson, Uppsala University
Project deliverables for the total project	• Quantitative estimations of: the impact of health, environmental and animal welfare motives, the relative stability of consumer responses to organic foods, and the willingness to change food selection with a more environmentally "sustainable profile". • One PhD thesis.

Deliverables for year 2001: • Data from first replication of questionnaire study (original data collection 1998). • Interview data on motives for purchase of organic foods.	**Results year 2001:** • Replication study completed: results forthcoming successively from December 2001 on. • Methodology for interviews developed. • Data published on the role of health and environmental motives in organic food purchase (British Food Journal). • Questionnaire data on perceptions of animal welfare in food production. • Half-time control completed for one PhD-student.
Deliverables for year 2002: • Data on comparisons of original (1998) and replication (2001) questionnaire studies. • Interview data on motives for purchase of organic foods. • Methodology for the study of changes of food habits and consumers´ "willingness to change".	**Results year 2002:**

CF3

Project	**Environmental aspects of food consumption** (Collaboration with: Environmental systems analysis of consumer-related activities in the food chain, FC2)
Project leader	Prof. Per-Olow Sjödén, Uppsala University
Collaborating scientists	Prof. Thomas Nybrant, SLU Dr Ulf Sonesson, SIK
Project deliverables for the total project	• Quantitative estimations of consumer contributions to the environmental impact of food purchase and food/waste handling in the home.

Deliverables for year 2001: • Interview and diary data concerned with consumer behavior. • "Consumption Diary" and "Questionnaire" developed.	**Results year 2001:** • Review completed of methodology for collecting data on food-related consumer behaviour with potential environmental impact. • Collaboration initiated with FC 2.
Deliverables for year 2002: • Interview and diary data concerned with consumer behavior. • "Consumption Diary" and "Questionnaire" developed. • Questionnaire data on consumers´ food-related behaviour with potential environmental impact.	**Results year 2002:**

CF4 Terminated

Project	**Farmers' role in developing sustainable food production systems**
Project leader	Prof. Ulrich Nitsch, SLU
Collaborating scientists	PhD student Magnus Ljung, SLU
Project deliverables for the total project	• Literature review and empirical data on farmers' attitudes and values related to sustainable production systems. • Data and case studies concerning farmer participation in ongoing environmental schemes and dialogue processes. • Innovative and applied, but theoretically based approaches which enhance farmers' and other local actors' participation in the development of sustainable agri-food systems. • Empirical data on farmers' participation in new approaches organised within Food 21. • One PhD thesis.

Deliverables for year 2001:	**Results year 2001:**
• PhD dissertation covering the deliverables specified in the project description..	• A PhD dissertation defended 2001-12-14. • Literature review on farmers´ views on environmental work and sustainable development (department report series) (2002). • Fact sheet on "Farmers´ dialogue" (2002). • Popular version of dissertation, focusing on practical implications (in Swedish) (2002).

CF5

Project	**Collaborative learning in the agri-food system**
Project leader	PhD student Lotten Westberg, SLU
Collaborating scientists	PhD student Magnus Ljung, SLU
Project deliverables for the total project	• The primary focus of this research is outcome oriented—the products are implementable improvements applicable to the different situations at hand. The deliverables are thus both concrete improvements of sustainability problems in the agri-food system, and deeper and sustained relations among the participating stakeholders.

Deliverables for year 2001:	**Results year 2001:**
• Empirical data from three case studies concerned with collaborative learning in the agri-food system.	• Report on evaluation of the Gotland project**.** • Report on formative evaluation of the Skåne project.
Deliverables for year 2002: • Master´s thesis on constraints and possibilities for collaborative learning on local and regional scales. • Fact sheet on collaborative learning for sustainable development of agri-food systems. • Empirical data on how actors manage constraints and opportunities in collaborative processes.	**Results year 2002:**

CF6

Project	**The social aspects in sustainable agriculture**
Project leader	Prof. Ulrich Nitsch, SLU
Collaborating scientists	PhD student Magnus Ljung, SLU PhD student Lotten Westberg, SLU
Project deliverables for the total project	• Knowledge about farmers' adoption behaviour and strategies in farming in relation to their perceived social and institutional environment, with respect to farming in the past, present adaptation strategies, expectations for the future and suggestions for appropriate measures.

Deliverables for year 2001:	**Results year 2001:**
• Literature review on farmers' adaptation behaviour and strategies in farm management practices with respect to their social, ecological and institutional environment. The institutional environment includes markets, agricultural policies, legislation, subsidies as well as technology. • Interview instrument based on exploratory interviews with farm families.	• Literature review report on farmers´adaptation behaviour and strategies published by the Swedish Board of Agriculture. • Exploratory interview data from three case studies in Småland and Västerbotten.
Deliverables for year 2002:	**Results year 2002:**
• Case studies on farmers´ coping and adaptation**.** • Initiation of collaboration on socio-economic synthesis theme (SA 4). • Data concerning farmers´ perceptions of their social and institutional environment.	

Systems Analysis (SA) – Projects

SA1 Systems Analysis of Physical Flows at Farms
SA2 Systems Analysis of Decision Processes at Farms
SA3 Scenario modelling
SA4 Co-operation, integration and economic adjustments in the agricultural firm

SA1

Project	**Systems Analysis of Physical Flows at Farms**	
Project leader	Prof. Thomas Nybrant, SLU	
Collaborating scientists	PhD stud. Helena Elmquist, SLU PhD stud. Ingrid Strid Eriksson, SLU	
Project deliverables for the total project	• System analytical methods to assess and evaluate sustainability characteristics of different farm production methods. • Two doctoral thesises.	
Deliverables for year 2001: • 3 articles in peer-reviewed scientific journals, seminars. • Executable models and results regarding sustainability of all the three prototype farms (arable, specialised animal and combined dairy and beef farms).		**Results year 2001:** • 3 manuscripts to be submitted. • Executable models of an arable farm and a pig farm.
Deliverables for year 2002: • Further refined models of an arable farm and a pig farm. • Executable model of a combined dairy and beef farm. • 6 articles in peer-reviewed scientific journals.		**Results year 2002:**

SA2 Terminated

Project	**Systems Analysis of Decision Processes at Farms**	
Project leader	Prof. Sture Öberg, Uppsala University Prof. Einar Holm, Umeå University	
Collaborating scientists	Dr Urban Lindgren, Umeå University Fil. kand. Kalle Mäkkilää, Umeå University	
Project deliverables for the total project	• Computer models describing the strategic decision taking at a farm as affected by farm specific and external factors.	
Deliverables for year 2001: • Two articles in peer-reviewed scientific journals, executable models of decisions at an arable farm and a pig farm.		**Results year 2001:** • One article ready to be submitted. • An executable model of strategic decision taking.

SA3

Project	**Scenario modelling**	
Project leader	Prof. Thomas Nybrant, SLU	
Collaborating scientists	Dr Helena Elmquist, SLU Dr Ingrid Strid Eriksson, SLU	
Project deliverables for the total project	• General systems analysis tools to evaluate sustainability of farm production scenarios and concepts. • Evaluations and conclusions regarding sustainability of the scenarios and concepts which are continuously developed during the coarse of the synthesis work.	
Deliverables for year 2001: • The project will be started during the 2nd year and will then last to the end of Phase 2.		**Results year 2001:**
Deliverables for year 2002:		**Results year 2002:**
Deliverables for year 2003:		**Results year 2003:**

SA4

Project	**Co-operation, integration and economic adjustments in the agricultural firm.**	
Project leader	Prof. Hans Andersson, SLU Acting associate prof. Carl-Johan Lagerkvist, SLU	
Collaborating scientists	PhD student Karin Larsén	
Project deliverables for the total project	• A theoretical and empirical analysis of factors contributing to successful co-operation between agricultural producers. Special emphasis is devoted to the introduction of biological, social and economically motivated quality policy programs. • A graduated PhD student (Thesis).	
Deliverables for year 2002: • An empirical analysis of optimal risk sharing contracts between dairy and crop farmers. (Master thesis). • An analysis of evolutionary stable contracts between producers – effects of sustainable cost and risk sharing arrangements. (Working paper).		**Results year 2002:**

Food Chain 21 (FC) - Projects

(In phase 2 organised in the synthesis and scenario work)

FC1 Environmental Systems Analysis of Food Industries

FC2 Environmental Systems Analysis of Consumer-related Activities in the Food Chain

FC3 Environmental systems analysis of Combined Food Chains.

FC1

Project	**Environmental Systems Analysis of Food Industries**	
Project leader	Ulf Sonesson, SIK Göteborg	
Collaborating scientists	Johanna Thuresson, PhD student, SIK Göteborg	
Project deliverables for the total project	• System analytical tools to evaluate sustainability of the part of the food chain ranging from the farm gate to the consumer. • Doctoral Thesis by Johanna Thuresson.	
Deliverables for year 1: • Basic models of dairy production systems. • One article in international scientific publication. • Presentation of the project and results at an international conference. • One seminar in the Food 21 seminar series.		**Results year 1:** • Models of dairy production systems. • One article submitted to Journal of Cleaner Production • One oral presentation at ”SETAC Europe 12th Annual Meeting, Madrid” • ”One poster presentation at The International Conference on LCA in Foods, Göteborg”
Deliverables for year 2002: • Refined models of dairy production systems. • Models of systems based on potatoes as raw product. • Two articles in international scientific publication. • One Licentiate exam, including an open seminar. • One presentation of the project and results at an international conference.		**Results year 2002:**

FC2

Project	**Environmental Systems Analysis of Consumer-related Activities in the Food Chain** (Collaboration with the project “Environmental aspects of food production” in the Consumer/Farmer sub-program).	
Project leader	Ulf Sonesson, SIK Göteborg	
Collaborating scientists	Magnus Stadig, SIK Göteborg Erica Wallén, SIK Göteborg	
Project deliverables for the total project	• Models for assessing the environmental impact of the later parts of the food chain (retailer to consumer plate).	
Deliverables for year 2001: • Preliminary models and results. • One article in international scientific publication. • Presentation at one international conference. • One seminar in the Food 21 series.		**Results year 2001:** • One article submitted to the Journal of Industrial Ecology. • Data for energy consumption for cooking.
Deliverables for year 2002: • Model and method to assess sustainability of the consumer related part of the food chain. • Two articles in international scientific publications. • Presentation at one international conference.		**Results year 2002:**

FC3

Project	**Environmental systems analysis of Combined Food Chains.** (Collaboration with the project "Environmental aspects of food production" in the Consumer/Farmer sub-program).
Project leader	Dr Ulf Sonesson, SIK
Collaborating scientists	Dr Johanna Thuresson, SIK
Project deliverables for the total project	• Models describing resource consumption and environmental impact of entire food chains from farm gate to consumer plate (including detailed consumer models). • Results on sustainability characteristics of the chains.

Deliverables for year 2001: • The project will be run during year 3 and 4 of Phase 2.	**Results year 2001:**
Deliverables for year 2002: • The project will be run during year 3 and 4 of Phase 2.	**Results year 2002:**
Deliverables for year 2003: • Models describing resource consumption and environmental impact and results on sustainability characteristics of entire food chains from farm gate to consumer plate.	**Results year 2003 :**

2.3 Synthesis Themes

As a part of the overall synthesis work for the whole food chain (Section 1.4) partial synthesis themes are also posed to deal with specific sustainable issues or with the purpose to integrate research results within individual FOOD 21 sub-programs. In the case of animal production the synthesis has from the very start closely been integrated with the research projects.

FOOD 21 Research Themes

SG 4 Crop production

Project	**Integrated nutrient management in sustainable cropping systems**
Project leader	Docent Håkan Marstorp, SLU
Collaborating scientists	Docent Ingrid Öborn, Prof. Lars Bergström
Project deliverables for the total project	• The outcome of two workshops will be published as scientific articles including results from Food 21 projects as well as reviews in a special issue of an international journal. Well-established scientists within the different areas of nutrient management will be invited to the workshops together with Food 21 scientist. • On the basis of the workshops a problem/solution oriented information material will be produced in collaboration between scientist and stakeholders.

Deliverables for year 2002: • An international workshop. • First drafts of scientific articles. • Outline of the information material.	**Results year 2002:**

2.4 Program Budget

	MISTRA Funded							Sektor
	Budget	Payment	Budget	Budget	Budget	Reser-	Total	funding*
	2001	2001	2002	2003	2004	vation		2001-2004
Program management	2 925 000	2 663 194	2 975 000	3 000 000	3 025 000	822 337	12 485 531	
Communication	700 000	585 000	615 000	600 000	1 000 000		2 800 000	1 000 000
Internal education	300 000	100 000	200 000	200 000			500 000	
Synthesis (incl Food Chain 21)	4 970 000	2 470 870	4 963 000	3 823 130	2 958 000		14 215 000	
Forskningsprojekt								
Crop production	2 459 000	2 231 500	3 293 000	2 135 500	560 000		8 220 000	1 600 000
Animal production	2 228 000	2 078 000	2 347 000	936 000	719 000		6 080 000	
Product quality	2 393 000	1 849 000	2 206 000	528 975	8 000	29 025	4 621 000	
Consumer/Farmer	1 972 000	1 685 000	1 688 000	814 000	566 000	1 647 000	6 400 000	
Systems analysis & economics	1 368 000	1 368 000	750 000	1 766 000	1 766 000		5 650 000	742 000
SUMMA	**19 315 000**	**15 030 564**	**19 037 000**	**13 803 605**	**10 602 000**	**2 498 362**	**60 971 531**	**3 342 000**
* Sector funding at program level; 1 000 000 SEK in kind from LRF, 2 342 000 SEK from SLF and SLU, 6 658 000 SEK								
to be funded according to the MISTRA decision								

Budget 2002	PLG	Commu-nication	Internal education	Synthesis	Crop production	Animal production	Product quality	Consumer Farmer	System analysis & econ.	TOTAL
MISTRA funded	**SEK**	**SEK**	**SEK**	**SEK**	**SEK**	**SEK**	**SEK**	**SEK**	**SEK**	**SEK**
Senior researcher	1 810 000			1 940 000	862 000	195 000	175 000	50 000		5 032 000
PhD students				369 000	994 000	1 222 000	489 000	872 000	540 000	4 486 000
Technician etc						138 000	445 000	260 000		843 000
External costs	270 000	395 000	60 000	1 540 000		40 000	130 000			2 435 000
Consumables, travel etc	200 000	220 000	140 000	275 000	760 000	245 000	433 000	120 000	19 000	2 412 000
Office costs	330 000			218 000		120 000	203 000	181 000	84 000	1 136 000
Overhead costs	360 000			621 000	311 000	344 000	261 000	201 000	107 000	2 205 000
Depreciation	5 000				366 000	43 000	70 000	4 000		488 000
TOTAL MISTRA	**2 975 000**	**615 000**	**200 000**	**4 963 000**	**3 293 000**	**2 347 000**	**2 206 000**	**1 688 000**	**750 000**	**19 037 000**