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Proceedings Vegineco-workshop

20-21 June 2001, Amsterdam

VEGINECO Project Report No. 6

The Netherlands Italy Spain Switzerland

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J.J. de Haan & A. Garcia Diaz (eds.)

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1 Introduction

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This report covers the results and presentations of a workshop called "Potential and significance of integrated and organic vegetable production in Europe". This two-day workshop marked the completion of Vegineco, a four-year EU shared cost project on the development of integrated and organic farming systems for vegetable production. The workshop summarised the project results and offered a platform for discussing the potential and significance of integrated and organic farming systems for the EU, national governments and the market. Special attention was given to the certification and labelling of integrated and organic products in relation to market and government demands.

The content of these proceedings follows the logical line that was imbedded in the workshop.

First, the results of the Vegineco project are presented. These results indicate the potential performance of integrated and organic vegetable farming systems under different social-economic, soil and climatic conditions: Emilia-Romagna in Italy, the Valencia region in Spain, the Southwestern clay region of the Netherlands and Switzerland. This potential performance is based on four years of optimising the key farming methods in order to meet the set of demands that represent important economic and ecological values.

The Potential Performance of systems is one thing, but does this also cover the demands and ambitions of the different stakeholders, such as governments, retailers and consumers and how can this performance be communicated to these stakeholders? In Europe, market organisations, retailers and governments are increasingly transforming their ambitions (for environment, nature, product quality, food safety and labour conditions) into demands relating to production methods and products. They do so by demanding "controlled" production (documentation), by imposing list of demands (EUREP-GAP), by introducing labels ("Integrated Production" in Switzerland, "Qualita Controllata" in Emilia Romagna) and by restrictive legislation. Two presentations give insight in the background and development of labels and guidelines. First, an overview is given of the history and the diversity of objectives and intentions of different labels and stipulations.

Secondly, a representative of the International Organisation for Biological and Integrated Control of Noxious Animals and Plants (IOBC) presents a view on the development of guidelines for integrated production in general an more specific for outdoor vegetables.

As stated above governments and retailers are increasing the demands on production and produce. As important stakeholders, they help determine the content of, at the very least, the "integrated production". On the other hand they are about the only parties that can appreciate financial implications of the extra efforts the growers need to make. They can generally do this by means of two distinctly different mechanisms: 1) increasing the prices of produce (market) and 2) imposing subsidies or tax benefits (government).

Three contributions open the discussion on bringing the added value to the market. The first focuses on a case study of organic farming from the point of view of a trade organisation for organic produce. In organic farming, EU-level harmonisation of labelling is established, higher prices are paid and financial support by governments is often received. The second case study comes from Switzerland where a system of remuneration (direct payments) for public services of agriculture is combined with sustainable production from an ecological point of view. The third case study comes from the Emilia-Romagna region, where the regional government is stimulating sustainable production via a combination of subsidies for transfer of knowledge on sustainable farming methods, direct payments for agri-environmental measures and label production. The question is if whether these situations are ideal. Also discussed is how integrated and organic agriculture can upgrade their label requirements to meet the new and changing demands.

These contributions are followed by a forum of representatives of different stakeholders, who express their view on the matter. Themes for the discussion include the EU Common Agricultural Policy, the determination of the content of integrated and organic production and viable and fruitful incentives.

In addition to the oral presentations and discussions in the workshop, several participants presented posters on related topics. The posters presented can be found at the back of these proceedings.

Part 1, VEGINECO project results

2 Vegineco, farming systems research in outdoor vegetables

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Shortcomings of outdoor vegetable production
Farmers are currently challenged by consumers and authorities to be the responsible manager of the rural area while producing high quality (even speciality) products. This affects the full depth and scale of the farm management.
Looking more specifically to vegetable farming the need for new farming systems is even more dominant. The farms that produce field grown vegetables are relatively small, mostly concentrated in certain regions (for practical market-oriented reasons) often highly specialised and characterised by the very intensive land use (all year round soil utilisation), generally a low mechanisation and high (external) labour demand per hectare. Vegetable growing is facing increasing agronomic, environmental and economical problems:

Agronomically
There is a high pressure of pest and diseases and at the same time there is a demand for a high (cosmetic) quality.

Environmentally
Emission of nutrients and pesticides to the environment are generally large.

Health and Well Being
Pesticide residues on the produce can be regularely found and working conditions for farm workers are far from optimal.

Ecologically
Nutrients and pesticides cause damage to non-target biota and fragile ecosystems. There is generally little space for nature and landscape elements.

Economically
Most farms have a low profitability and product prices are under pressure.
Consequently there is an urgent need for innovative, new farming systems that are multi-objective and integrate "new" objectives such as quality of produce and production methods, quality of the a-biotic environment, landscape and nature values and agronomic sustainability into the old objectives.

The EU Vegineco project

Vegineco: "Development of sustainable vegetable farming systems focusing on high quality production and minimum environmental impact."

The EU project Vegineco has been focussing on farming systems research to develop, test and evaluate prototypes of integrated and ecological outdoor vegetable farming systems in three important vegetable producing regions spread over Europe under different social/-economic, soil and climatic conditions. For this farming systems development a comprehensive methodology called 'prototyping', was used. This methodology is based on the work in the concerted action EU 93-96 (Vereijken). Four partners took part in this project:
- Netherlands, Applied Plant Research (PPO)
- Italy, Centre for Plant Research (CRPV)
- Spain, Institute for Agricultural Research (IVIA)
- Switzerland, Swiss Federal Research Station for Fruit-growing, Viticulture and Horticulture (FAW)

The next systems were tested (see also system description in Annex 1):
- Two integrated and one ecological experimental system of farming systems with arable and vegetable crops in the Southwest region of the Netherlands.
- One integrated system with vegetable crops for the industry, one integrated system with fresh market crops and one ecological system with fresh market crops in Emilia-Romagna in Italy.
- 5 integrated systems and one ecological system all with fresh market crops in the Valencia region in Spain.

Next to these experimental systems, in Switzerland 7 ecological and 7 integrated pilot farms have been compared and goal oriented improved.
By choosing characteristic "environments" for Europe like in this project the potential has been studied in a standardised way with a comprehensive set of parameters. Potential refers to the set of objectives and to the impediments and opportunities for the systems in the different regions.

Innovation of agriculture
Innovation of agriculture is a continuous process of creating or utilising chances and opportunities, counteracting threats and solving problems. At present a complex of problems is destabilising agriculture and threatening the sustainability. However, simultaneously opportunities are offered to revitalise agriculture by seeking links with the urban population by offering scarce products and functions as agro-tourism, recreation possibilities, diversified landscape etc. Therefore, innovation of agriculture is at the moment synonymous to finding integral, coherent solutions while integrating different objectives and functions.
Innovation can be stimulated by:
1. the total complex of policy regulatory packages,
2. technological developments or
3. more social action at the basic farming community level.

Policy packages offer an excellent opportunity to create incentives for change and to facilitate this change. Socially based solutions refer to farming communities elaborating common objectives and plans and operating as a group in the communication with the so called “stake-holders” in the region. This community forming and communication process can be stimulated and facilitated by social scientist and extensionists Technological developments are necessary to enable innovation. These technological solutions can be divided in three levels:

1. system innovations,
2. process integrated solutions and
3. end of pipe solutions.

It is obvious that end of pipe solutions are often developed on an ad hoc basis to alleviate the negative effects of farming. More sustainable farming systems have to be based on system innovation and process integrated solutions. Novel systems are based on strategic overall concepts that constitute and enhance system innovation and on integrated technology based on agro-ecological principles, agronomy and biological, physical and chemical methods. In essence these novel systems are low input-high output systems that will have to be more sustainable in ecological agronomical, economical and social terms. Such, integral new farming systems are at the moment represented by two, different, approaches namely integrated and ecological farming. Integrated production under label has been introduced in the recent past for a number of products in a number of European regions and ecological production labels are harmonised on the European level. In spite of this, the potential of these systems is much larger than the present practice. In vegetable farming a systematic and standardised evaluation of the potential of both systems is lacking as is a comparison based on a standardised set of parameters.
Innovation is always a process of design, testing and improving (see Figure 2.1) based on comprehensive objectives. This innovation process can be facilitated and stimulated by all the mentioned approaches. In many projects all over the world this is attempted in a rather top-down approach. As initial step this might be appropriate. However when insufficient attention is given to interaction with the target group and their learning process, innovations are deemed to extinguish. On the other hand when successful, the initial linear innovation model (top-down) evolves into a circular, continuous innovation model, supported by the group. Prototyping is a method that structures the process of continuous innovation towards more sustainable farming systems.

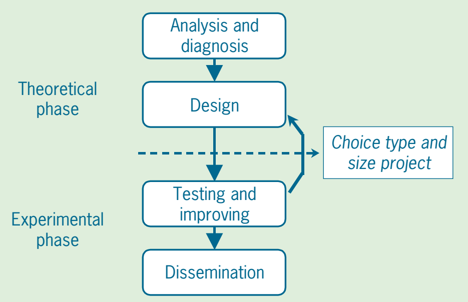

Figure 2.1 Prototyping methodology

Prototyping methodology (as used in Vegineco)
In the Vegineco project, a standardised methodology was used. This methodology is called prototyping and can be characterised as a synthetic research/development effort starting off with a profile of demands (objectives) in agronomic, environmental and economic terms for a more sustainable, future-oriented farming and ending with tested, ready for use prototypes, to be disseminated on a large scale. This methodology of analysing, designing, testing, improving and disseminating integrated and organic farming systems has been elaborated for arable farming in a four years European Union Concerted Action (Vereijken, 1994 and 1995). For vegetable farming however, this type of research is limited. It is a challenge and a necessity to transplant this methodology to vegetable production and start farming systems research to fully integrate all the different objectives and to be able to evaluate the full potential of the new systems. The methodology of prototyping is still young, dynamic and developing. However, it can be described as an innovation process in 4 steps (Figure 2.1).

Although presented as a linear top down process in figure 2.1, the different phases tend to overlap and circular processes are included (Figure 2.2 and 2.3). Especially when applying the methodology on pilot farms the dissemination phase and involvement of farmers and stakeholders already starts in the first phases.

The process of prototyping starts with a regionally based analysis and diagnosis phase of the following aspects: sectorial statistics, farm structure, agro-ecological state of the art, ecological/environmental impact, socio-economic situation, trends in structural changes and the present political conditions. Based on the analysis of the shortcomings of current farming and the perspectives in the future, a hierarchy of objectives for either an integrated (short-term alternative) or ecological (long-term alternative) farming systems has to be established. These rather abstract objectives are in the Vegineco prototyping practice

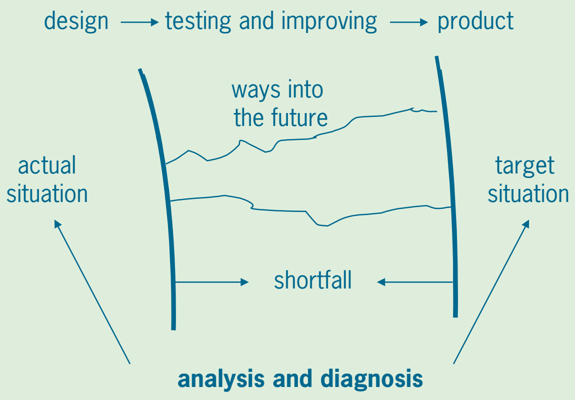

Figure 2.2 Continuous development to reach the target situation

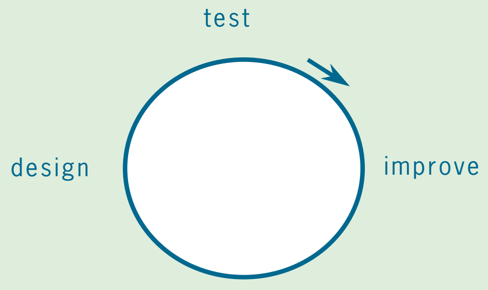

Figure 2.3 The circular process of designing testing and improving

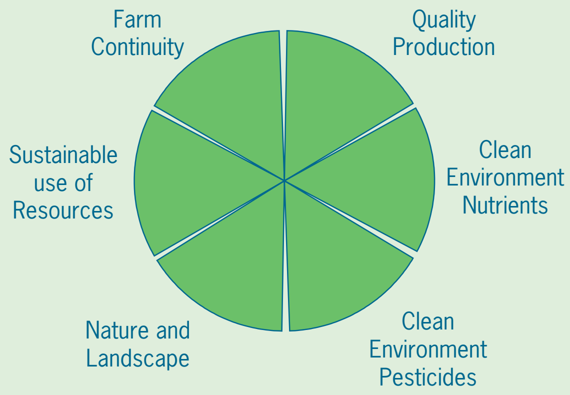

Figure 2.4 Major themes in the Vegineco project

translated in 5 directional themes: quality production, clean environment, attractive landscape and diversified nature, sustainable management of resources and farm continuity.

Each theme is concretised in a number of (farm level) parameters to be able to quantify the objectives of the theme. The main parameters used or developed in the Vegineco project can be found in Table 2.1. A brief description per parameter can be found in Annex 2. Each parameter is given a target value so that a well defined, documented and clear framework is elaborated to design, test and improve farming systems. The target levels are future oriented and are derived from legislation, scientific evidence or expert knowledge.

As next step, a suitable set of farming methods has to be designed. Methods here are defined as coherent strategies on the major aspects of farming, like crop rotation, nutrient management, crop protection and farm nature management. These methods mostly need further development in order to realise the related objectives. The results of the development of the methods in the Vegineco project are treated in depth in a correspondent method manual, which will be published as a product of the project.
The next step in the methodology is the design of a theoretical prototype in which parameters and methods are linked to each other as basis for a correct evaluation. This step is necessary to check the links between methods and parameters and as basic framework for interpretation of the results. The last part of the theoretical exercise ends with detailed cropping programmes. Adjustments

Table 2.1 Parameters used in the Vegineco project

Theme	Parameters
Quality production	Quantity of produce Quality of produce NO_3^- content (leafy vegetables)
Clean environment nutrients	Nitrogen (mineral) available reserves at the start of the leaching season Phosphorus and Potassium annual balance
Clean environment pesticides	Synthetic pesticide input (active ingredients) Pesticide input copper Potential emission to air, groundwater and soil of pesticide active ingredients
Nature and landscape	Surface ecological infrastructure Various other parameters quantifying landscape and nature (in development)
Sustainable use of resources	Phosphorus and potassium available soil reserves Organic matter annual balance Energy efficiency (in development)
Farm continuity	Net surplus or revenues per € 100 costs Hours hand weeding

might be necessary depending on actual crop, weather and soil conditions.
The next phase is testing and improving the designed farming system. Basis for a successful test-phase is the design of the farming system in time and space. This concerns not only the choice of a multi-functional crop rotation but also the agro-ecological identity of the farm. Testing implies that the shortfall between target and actual results will be analysed in terms of the methods linked to the parameters in question. The agronomic database and the qualitative observations during the growing season are indispensable for the analysis of the shortfall between actual and target results. In this phase, detailed knowledge is generated about the different production techniques, their compatibility with other farming methods, their effectivity in relation to the objectives and the (potential) conflicts with other methods and objectives. This information is directly used to improve the prototype. It increases the general knowledge of in- and output relations and enables to exchange production techniques in model studies when different balances of objectives are to be reached.
Testing on pilot farms also implies testing of the degree of manageability and acceptability of the newly developed methods.
The prototype will be improved by improving the set of methods in a targeted way, which implies to elaborate safe, efficient, acceptable and manageable integrated farming methods that can realise the target result. The prototypes will be improved from year to year. Any adjustment in the cropping programmes should avoid new conflicts between the objectives and needs therefore careful considerations.
The testing and improving continues until the objectives as quantified in a target level of the relevant parameters are reached. Primarily, agro-ecological objectives have to be realised. Economic objectives can be studied and optimised by model studies, involving different scales of farms. By these studies, it can become explicit what the consequences are for the needed farm structure when the agronomic and ecological objectives are fulfilled. This is a very important point of view for policy makers.
The required time to reach the objectives is dependent on the objectives, the specific character of the parameters (variability and response-time), the specific situation of the prototype and the extend to which production methods are already developed.
When the prototype shows stable results at the level of the targets set in the parameters, dissemination is the natural following step. The perspectives of new prototypes can only be evaluated in practice. Management is the key-factor for the success and feasibility of these new approaches. Therefore a first test of, the on experimental farms developed, region-specific prototype on a small number of pilot farms is considered to be an indispensable step before introducing new prototypes on a large scale into practice.

Vegineco results

The results of the Vegineco project provide a quantified level of the potential sustainability of the tested systems and indicate to what extent the described goals for sustainable production can be reached. Moreover the project provides the tested and improved instruments (farming methods) to realise these quantified levels of sustainability. The results and products of Vegineco can be summarised as:

- Tested and improved multi-objective farming methods concerning the key farm practices crop rotation, fertilisation and crop protection that enable integration of potentially conflicting objectives like economy and ecology. Next to these “old” practices new methods have been developed in the field of nature and landscape management (integrated in the farm practices).
- Novel approaches to pesticide use evaluation and pesticide selection, quality production of crops and energy input.
- Integration of the existing and partly newly developed international expertise elaborated it comprehensive, coherent farming methods manuals to be used by the farming industry, research, extension and education.
- A comprehensive and standardised comparison of ecological and integrated vegetable farming systems.

The next presentations will be focussed on the performance of the tested vegetable farming systems in different European regions. The methods and novel approaches used to realise this performance will not be mentioned in detail. The resulting methods are published in a final project report and a series of four method manuals on the key farm methods: crop rotation, nutrient management, crop protection and ecological infrastructure management.
The performance is presented in terms of the realised level of the parameters. This realisation is compared with the desired (target) levels of these parameters (Figure 2.5) and the remaining shortfall is commented. If possible, an additional comparison is made with the performance of the standard practice.

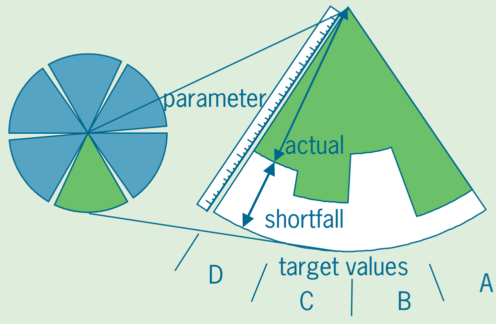

Figure 2.5 Schematic representation of realisation target and shortfall

3 Integrated vegetable farming systems: results and prospects

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Introduction

"Integrated Production (Integrated farming) is a farming system that produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming. Emphasis is put on a holistic systems approach involving the entire farm as a basic unit, on the central role of agro-ecosystems, on balanced nutrient cycles, and on the welfare of all species in animal husbandry. The preservation and improvement of soil fertility and of a diversified environment are essential components. Biological, technical and chemical methods are balance carefully taking into account the protection of the environment, profitability and social requirements."

The above definition of integrated farming was formulated by the International Organisation for Biological and Integrated Control of Noxious Animals and Plants (IOBC). In the context of this definition, a series of integrated vegetable farming systems have been tested and characterised in terms of quantifying parameters related to the major objectives of integrated vegetable farming systems. The results of testing and improving these vegetable farming systems are presented in this paper. Unlike organic farming, these farming systems do not have to meet a set of integrated standards, except in Switzerland.
The results presented are from experimental farms in the Netherlands, Italy and Spain and from three pilot farms in Switzerland (Table 3.1). Descriptions of the systems are given in Annex 1. The performance of these systems under different socio-economic and ecological conditions has been compared with a set of target values and, where possible, with the average or conventional practice. The target values are a reflection of an ambitious vision of an all-round sustainable system (see also previous paper). All tested experimental systems used a 4-year rotation and the crop choice had been adapted to the specific regional conditions (Table 3.1).

Overview of results

The overall results of the integrated systems are summarised in Figure 3.1. The six segments of the circle represent the themes, each of which is subdivided into one or more parameters. The outside of the circle is an ambitious vision of an all-round sustainable system. The different grey areas show the percentages of farms that achieved 75%, 90% and 100% of the target.
Figure 3.1 indicates that the main shortfall is in the following parameters:

- Risks of nitrate leaching (segment 6).
- Risks of pesticide leaching to the groundwater (segment 10).
- Large reserves of the nutrients potassium and phosphorus in the soil (segment 13 and 14).
- Revenues per € 100 costs (segment 16).

In the following paragraphs, we will zoom in on the results per theme, beginning with the results on production and economic results (themes "quality production" and "farm continuity"). Next, nutrients (themes "sustainable use of resources" and "clean environment nutrients") are reviewed. Then, pesticide use is reviewed in the theme "clean environment pesticides". Finally, some conclusions and recommendations are presented. The "nature and landscape" theme has been ignored, as it is still being developed and had not been tested or refined during the project period in any of the countries.

Quality production and farm continuity

Quality production
Quality production is a yardstick of the agronomic and economic success. Therefore, the quality production of the systems was compared with the quality production under Good Agricultural Practice (GAP), i.e. the quantity and quality obtained with good crop management under

Table 3.1 Integrated systems in the Vegineco project

Country	System	Abbreviation	Main crops
Netherlands	Brussels Sprouts	NL INT1	Brussels sprouts, potatoes, fennel, celeriac
	Iceberg Lettuce	NL INT2	Iceberg lettuce, potatoes, fennel, cauliflower
Italy	Integrated Industry	I INT1	Tomato, melon, spinach, green beans
	Integrated Fresh Market	I INT2	Lettuce, strawberry, melon, celery, cauliflower
Spain	Pilar de Horada	ES INT1	Watermelon, celery, onion, lettuce, broccoli
	Benicarlo	ES INT2	Artichoke, tomato, watermelon, lettuce
	Paiporta	ES INT3	Artichoke, watermelon, cauliflower, onion
Switzerland	3 pilot farms	CH INT1 – CH INT3	Lettuce, cauliflower, carrots, leek, onions

optimal conditions. Average vegetable farming practice achieves about 80-90% of the GAP-production.
Figure 3.2 shows the yields of the partners in 2000 in comparison with the target (GAP) and the average of four years. The yields realised in the Vegineco systems are on average comparable to average practice.
The quality targets were based on the percentages of marketable first class produce and, in some cases, the percentages of marketable second class produce. All systems reached the quality targets.

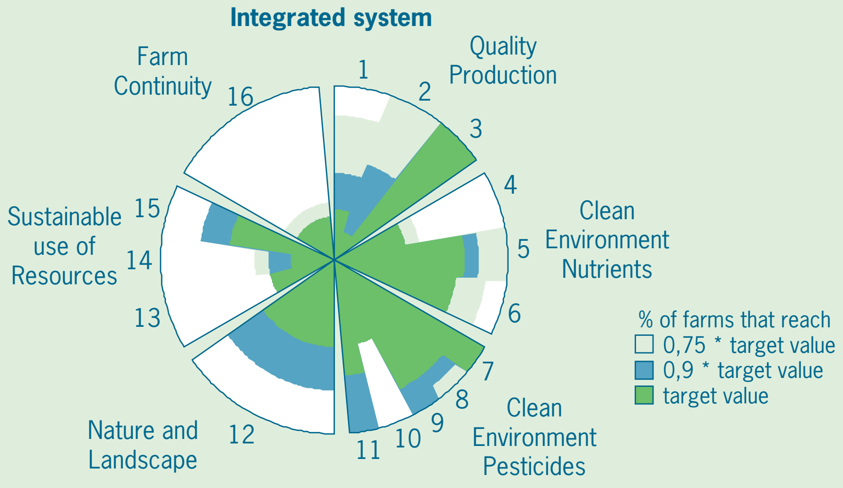

Figure 3.1 Overview of results of whole system: percentage of farms that achieved 75%, 90% or 100% of target value. Numbers depict parameters. See Annex 2 for explanations of numbers and parameters.

Farm continuity
Farm continuity was evaluated using net surplus, i.e. total revenue minus total expenditure. Revenue (price times marketed yield) fluctuated wildly over the years because of the variations in price. To evaluate the economic viability of the integrated systems, the results (considered as an average of several years) were compared with Good Agricultural Practice (GAP).

Table 3.2 shows the costs divided per category for an average of all integrated systems and an average based on GAP yields and conventional inputs (GAP reference). The costs of plants, fertilisers, pesticides represent the real market costs while the labour costs have been calculated based on the salary for an extra farm worker. In vegetable production, most of the expenditure is on labour (57%), with fertilisers and pesticides accounting for a small share (5% in total for integrated farming systems and 9% for the GAP references). Table 3.2 shows that total costs were lower in integrated systems compared to GAP, because of reductions in fertiliser and pesticide costs. The net surplus is comparable with GAP. Although the financial results are comparable, integrated farming is not attractive because the value of the crops and the risks of losses are high. Farmers are often

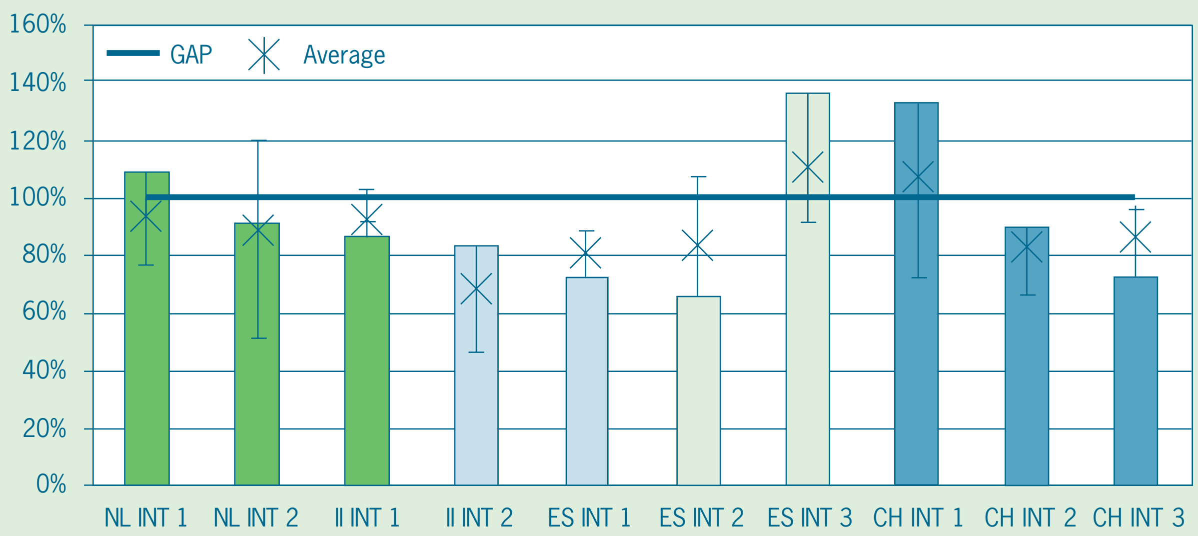

Figure 3.2 Quantity of production in the integrated systems compared to yields under Good Agricultural Practice. Bar depicts data of 2000 with minimums and maximums in the project period, the asterisk gives average values over the project period.

Table 3.2. Cost categories averaged over the integrated systems compared to the GAP reference

	Integrated systems		GAP reference	
	€ ha^{-1}	Cost %	€ ha^{-1}	Cost %
Plant material	2 212	16	2 059	14
Fertilisers	298	2	694	5
Pesticides	472	3	661	4
Labour	7 784	57	8 429	57
Other costs	2.887	21	2 937	20
Total expenditure	13 653	100	14 780	100
Total revenue	10 754		12 140	
Net surplus	-2 899		-2 640	

reluctant to risk extra labour or quality losses by reducing the relatively cheap inputs of fertilisers and pesticides. Figure 3.3 gives the income per € 100 costs. The graph shows that integrated farming as done in Vegineco gives results comparable with those of conventional farming: in most systems the income is about € 80 to € 90 per € 100 costs. This means that farmers in integrated systems work without good remuneration for their work and returns for their invested capital. In this situation, farmers are often reluctant to take many risks.

Conclusions on quality production and farm continuity
Summarising for quality production and farm continuity:

- On average, the quantity and quality aspects are comparable to average practice, as are net surplus and income per € 100 costs.
- Conventional and integrated vegetable farmers do not get a remuneration equal to what is normal for such a function.

Nutrients

Phosphorus and potassium available reserves
To minimise the use of phosphorus and potassium fertilisers, the fertilisation strategy is focused on keeping the phosphorus and potassium reserves (PAR and KAR) within a range that is considered to be environmentally acceptable and agronomically sufficient. Thus, if actual reserves exceed the target range, the inputs of phosphorus and potassium should be less than the output. If actual phosphorus and potassium reserves are within the target range, inputs should be equal to output.
Figure 3.4 shows the relative deviation of PAR and KAR by comparison with the target range. In many cases, P and K are higher than the desired range. The high levels of phosphorus have accumulated as a result of past fertilisation. This situation is very common in vegetable farming. It is necessary to reduce the reserves to avert the risk of leaching in the future. As shown in the circle diagram (Figure 3.1), the target values have not been reached for most systems. A time span of at least 10 years is necessary to reduce actual levels to target levels.

The results of the fertilisation management for phosphate are shown in Figure 3.5. The phosphate surplus realised is in line with the phosphate reserves. In the Italian Industry system project, the surplus was positive at the start of the project, because low PAR levels necessitated remedial fertilisation. In the Netherlands, compensation for unavoidable losses of 20 kg ha^{-1} caused the surplus.
Compared with references (conventional practice), the values of phosphate surplus were generally much lower in all integrated systems.
It is easy to reduce phosphate surpluses when mineral fertilisers can be applied as in integrated farming. When organic fertilisers are used to improve the soil organic matter content this can be

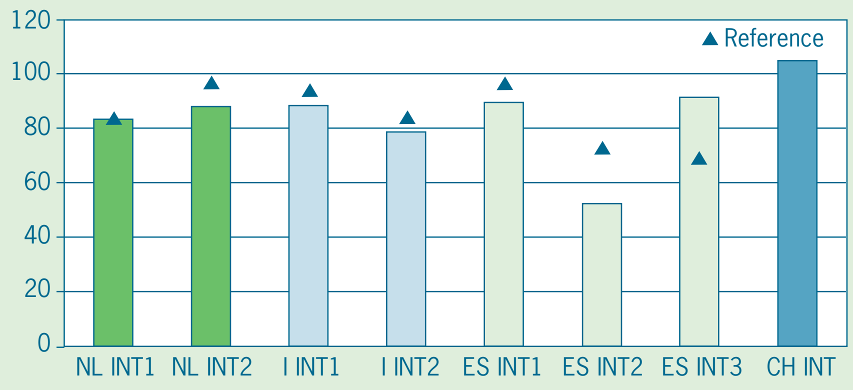

Figure 3.3 Income per € 100 costs

more difficult, as precise dosing of nutrients via organic fertilisers is impossible.

Nitrogen available reserves and nitrogen balance
The NAR (nitrogen available reserves) is the amount of mineral nitrogen in the soil before the start of the leaching season. NAR is an indicator of risk of nitrogen losses in soil and is strongly related to the risk of nitrate leaching to the groundwater in the system. The value of NAR depends on the fertiliser input, but also on the cropping sequence. Thus, some inefficient crops as lettuce give rise to high NAR, but other efficient crops such as cereal give a low NAR.
The target value for NAR is 70 kg ha^{-1} for clay soils and 45 kg ha^{-1} for sandy soils in the 0-100 cm soil layer. These target values are considered to be related to the 50 ppm of nitrate in groundwater in Switzerland, Italy and the Netherlands. However, the target value is site-specific and only valid in regions with a precipitation surplus of 300-400 mm. In Spain, with a precipitation surplus of only 128 mm, additional research is needed to set a target for this parameter. In Vegineco, target values were set at 70 kg ha^{-1} for clay soils and 45 kg ha^{-1} for sandy soils in all systems.
Figure 3.6 shows the average NAR realised in the different systems. Although in most systems the highest NAR levels were reduced during the project, problems remain in systems in Italy (I INT2) and Spain (all systems). For the NAR to be reduced further, the nitrogen fertilisation strategy will have to be improved. One possible improvement for Spain and Italy is to include the mineral nitrogen measured in the soil in the fertilisation strategy. This strategy should replace the current strategy, in which the nitrogen demand is based on a fixed figure per crop or a simplified nutrient balance.

Figure 3.7 shows the nitrogen surplus. What is most striking in this figure is the negative surplus for ES INT1, especially when compared with Figure 3.6. Despite the negative nitrogen balance, the nitrogen reserves in the soil are still very high. The nitrogen input in ES INT3 is another striking result shown in Figure 3.7. In this system, the input consists solely of nitrogen from irrigation water. The objective in this system is to reduce the amount of irrigation water needed, thereby also reducing nitrogen input.
In most cases, improvements have been implemented to reduce NAR and nitrogen surplus. In most cases, the nitrogen surplus in the integrated systems is less than in conventional systems. Some obstacles remain:

- in soils with a very high mineralisation rate, the NAR can be high, even if there is a low input of nitrogen,

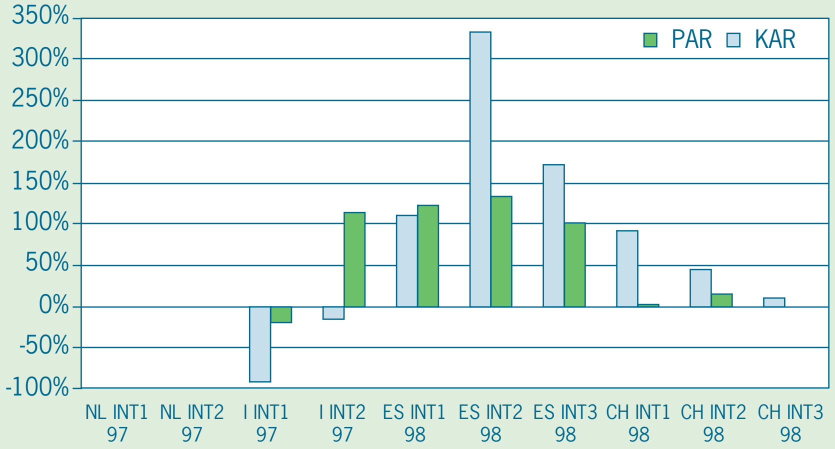

Figure 3.4 Deviation of PAR and KAR in percentages by comparison with the target range. Positive deviation means that levels of PAR and KAR are higher than target range; negative deviation means that levels are lower than target range. The numbers after the system codes, indicate year of measurement.

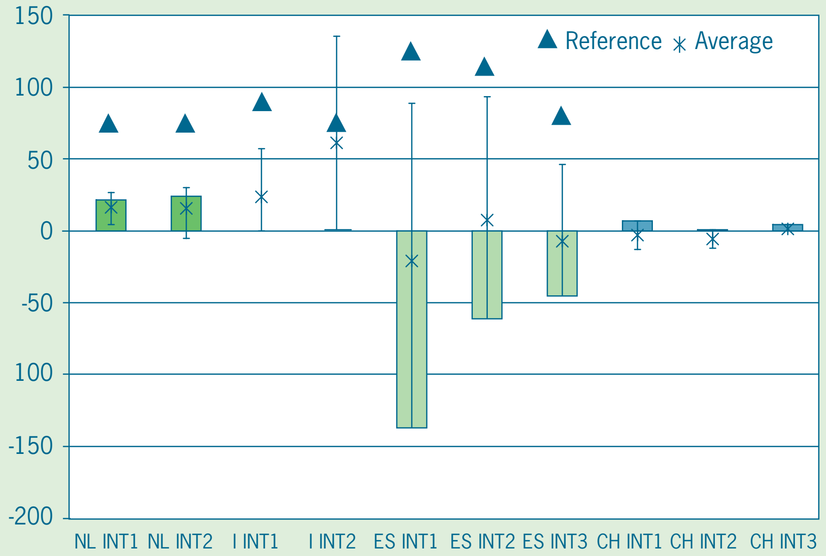

Figure 3.5 Phosphate balance (phosphate surplus) in kg ha^{-1}, reference gives the average practice in conventional systems

- many vegetable crops have a low nitrogen recovery and leave high nitrate levels behind after cultivation,
- when these inefficient crops are grown in autumn, often no catch crops can be cultivated to catch the remaining N, so the leaching potential is high.

Conclusions on nutrients
The risks of nitrogen leaching are still too high in the Spanish and Italian systems. The phosphate and potassium fertilisation strategies have been tested sufficiently and can be suggested to the farmers. Regarding nitrogen fertilisation, we need to find out more about the organic matter decomposition and the possibilities of reducing of NAR with the aid of catch crops. For Spain and Italy, it is necessary to define other nitrogen fertilisation strategies that are economically and ecologically sustainable.

Pesticide use, emission and damage
In integrated production, chemical pesticides are permitted and used intensively. However, to avoid ecological damage, it is necessary to minimise the use and emission of these pesticides and the damage resulting from them. In Vegineco, we have looked only at the input of active ingredient input (PESTAS) and the risk of emission of pesticides as ecological damage is difficult to quantify and is often only based on a few target species. It is possible that although a pesticide does not harm the target species, it does ecological damage to others.
Pesticide input was divided into input of synthetic pesticides, copper, sulphur and other pesticides (mainly Bacillus thuringiensis (B.t.). The risk of emission was calculated using the Environmental Exposure to Pesticides index (EEP), which takes emission to air, groundwater and soil into account. Pesticides were selected based on these emission calculations. Figure 3.8 shows the pesticides

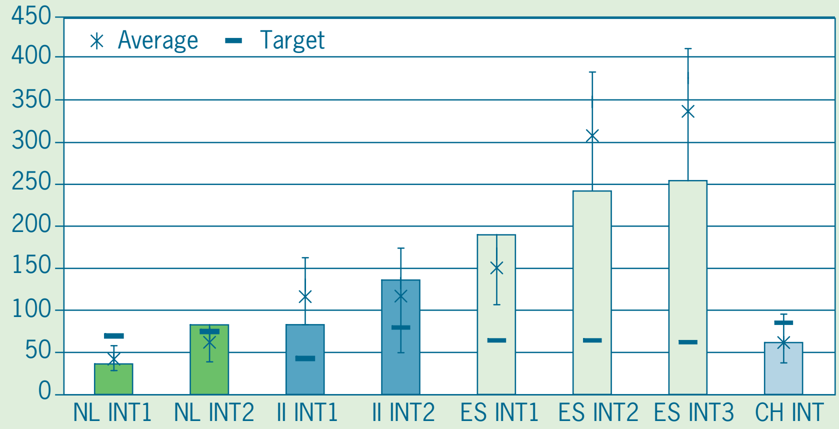

Figure 3.6 Nitrate Leaching Risks represented by the nitrogen available reserves (NAR) in kg ha^{-1}

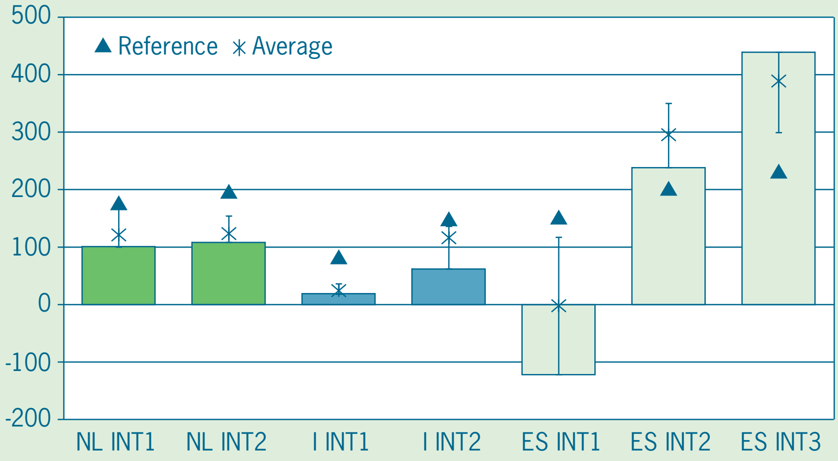

Figure 3.7 Nitrogen balance (nitrogen surplus) in kg ha^{-1}, reference gives the average practice in conventional systems

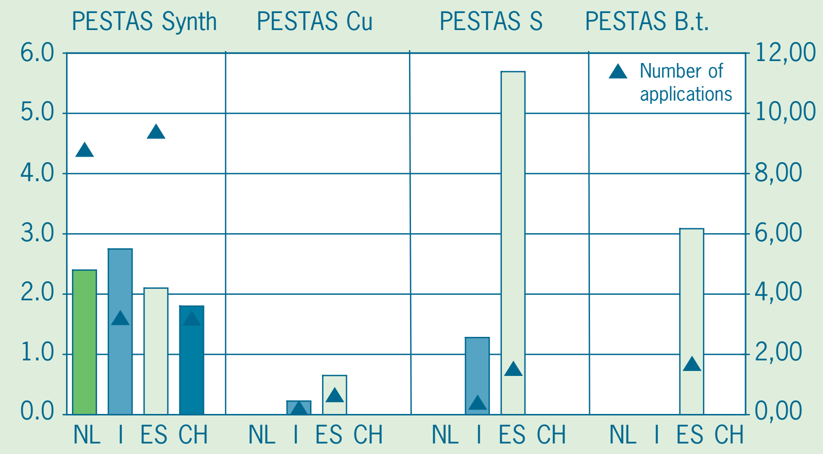

Figure 3.8 Pesticide input and number of applications divided into synthetic pesticides, copper, sulphur and other (B.t.)

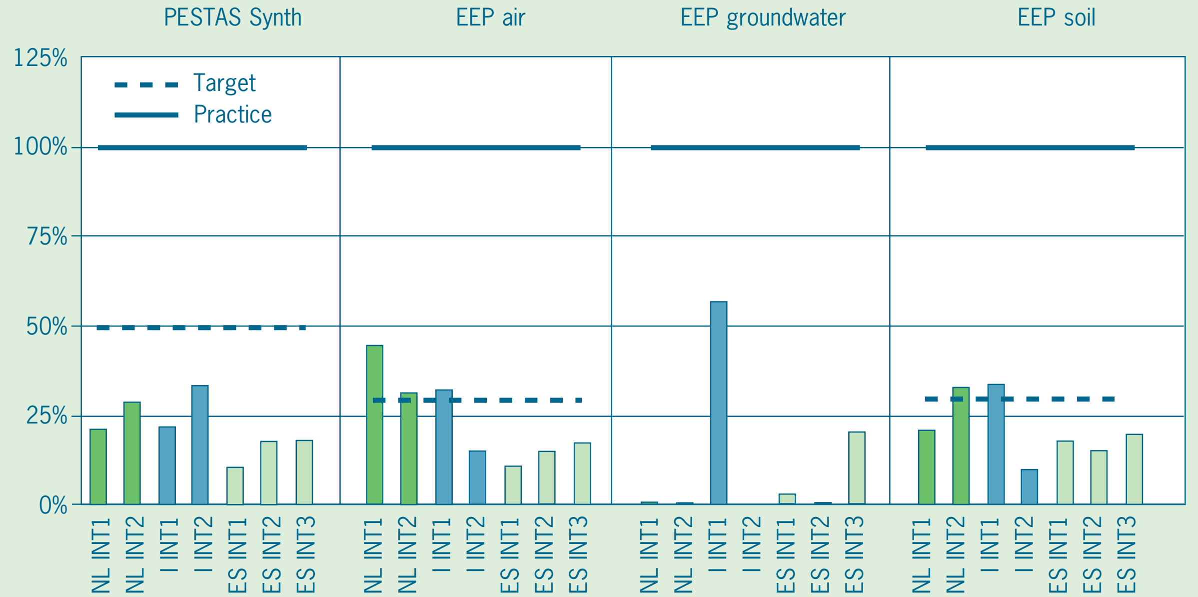

Figure 3.9 Relative realisation of input and emission in integrated systems. The level in practice is set at 100%; there is no reduction target for the EEP-groundwater, the target level has been derived from the EU drinking water directive (Figure 3.10).

used, divided into the four classes as defined above. The number of applications differs per system. However, the amount of synthetic pesticide used is more or less the same in all countries (2-2.5 kg ha^{-1}). Copper and sulphur are used in Spain, Italy and Switzerland, B.t. in Spain and Switzerland.

Figure 3.9 shows that the amount of pesticides and the emission risks in the systems have been lower than in conventional practice. The targeted reduction was fully attained for synthetic pesticides and almost attained for the emission to air and soil. The reduction in input of pesticides was obtained through:

- replacing herbicides by mechanical control,
- reducing the number of treatments through the use of damage thresholds, guided control, weather forecast systems and other techniques,
- reducing the dosage per application by optimising the timing of the treatment and in some cases by the use of improved spraying techniques.

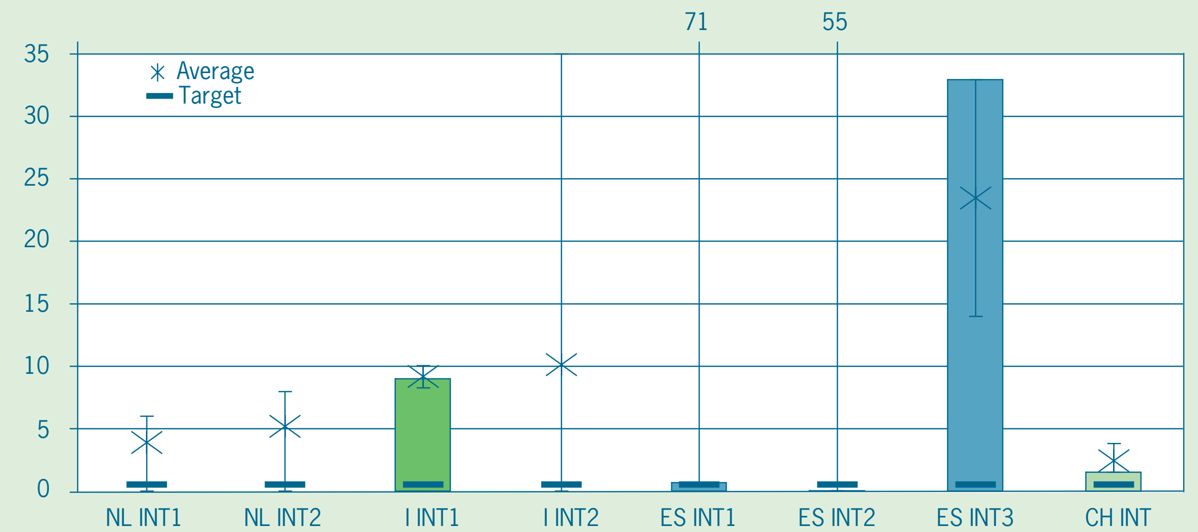

Figure 3.10 EEP-groundwater (ppm) for the integrated systems, target level is 0.5 ppm, derived from the EU guideline on drinking water

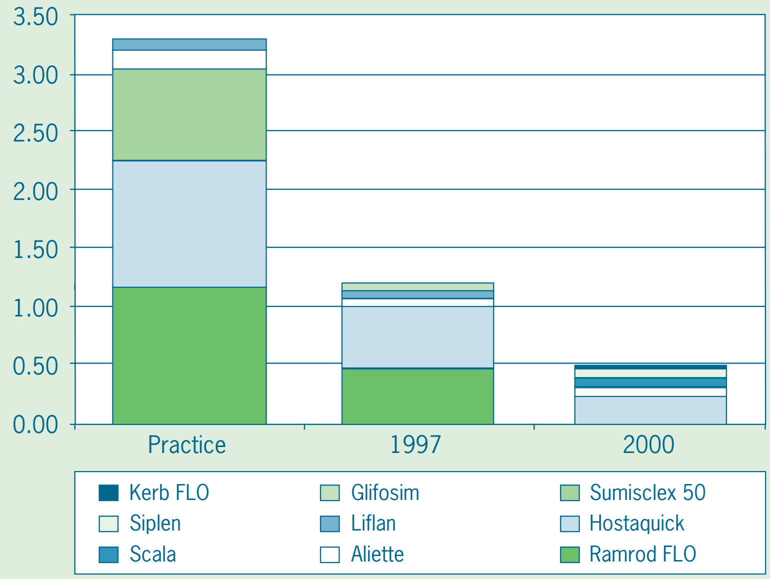

Figure 3.11 Example of the reduction in EEP air in the Integrated Fresh Market system (Italy). The figure depicts the contribution of different pesticides for average practice, the starting year of the project and the final year of the project. The reduction is about 70%.

There are currently no statutory requirements for the maximum permissible emission of pesticides to soil and air. Therefore, target levels were based on the reduction of emission compared to average practice. For the emission to groundwater (Figure 3.10), we used the EU guideline on pesticides in drinking water as a target value. For this parameter, there are still some problems in the Spanish system in Paiporta, in the Italian Integrated Industry system and in the Swiss integrated system:

- In ES INT3 the problem is caused by cyromazin (Trigard) in onion and chlorpyrifos-methyl (Reldan) in artichoke.
- In I INT1, the problem is due mainly to the herbicide lenacil employed in the Italian Industry system to control weeds in spinach.
- In Switzerland, chlorpyrifos-methyl (Reldan) is used in leek and cauliflower.

The emission risks are very dependent on the pesticide chosen. For example, Figure 3.11 depicts the improvement in the EEP for air obtained in I INT2 through a better choice of pesticides. Large reductions by comparison with practice were already achieved in the first year, and in subsequent years the results improved due to:

- the substitution of Butisan for Ramrod (also characterised by lower EEP for groundwater) and integration with mechanical weed control (ridging),
- fewer treatments with Hostaquik (better choice of treatment time),
- Sumisclex was replaced by Scala.

Of course, the choice of pesticide was also based on the emission to other compartments of the environment.

Conclusions on crop protection

The main conclusions for the “clean environment pesticides” theme are:

- large reduction in pesticide use and emission in all systems
- occasional negative effects on quality production,
- intensive input of knowledge is necessary for effective and environmentally friendly crop protection and
- great need for new alternative pesticides with low emission in all crops, or for extending the use of environmentally friendly pesticides to other crops (often those with a small area).

Conclusion

The objectives of this paper were to compare the results of the integrated systems with reference to target values and/or average practice. This comparison allows us to draw give some general conclusions:

- Integrated farming is able to reduce the emissions of nutrients and pesticides, safeguarding the quality production without influencing the net surplus (which is negative but comparable with practice).
- For specific crops or systems there are still shortfalls relating to nitrate leaching risks, pesticide emission and the availability of alternative systems and agents with low emission.

The main obstacles to improving the sustainability of vegetable farming are represented by:

- difficulties of cashing in on the added value of integrated farming,
- the low income for farmers (no investments in knowledge and hardware) and therefore risk avoidance,
- the high level of knowledge needed for integrated farming and
- the market demand for high cosmetic quality.

To promote integrated vegetable farming as designed and applied in the Vegineco project, governments, retailers and supermarket chains need to act together. Governments have to help farmers through economic incentives. Retailers and supermarket chains must differentiate the prices for produce from integrated production, not only for the consumers but also for the producers. At the end of four years’ activities, we may conclude that integrated farming is agronomically feasible but its valorisation depends on many factors outside the production field.

4 Organic vegetable farming systems: results and prospects

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Introduction
According to IFOAM (International Federation of Organic Agriculture Movements), organic agriculture includes all agricultural systems that promote the environmentally, socially and economically sound production of food and fibres (IFOAM, 2000). The term "organic" does not mean the type of inputs used, but indicates that the farm is considered as an organism, as was proposed by Steiner (1924). He considered all the components (soil minerals, organic matter, micro-organisms, insects, plants, animals and humans) as parts of an agro-ecosystem, which interact to give a coherent whole. In some countries, organic farming is known as biological or ecological agriculture. Thus, in the Vegineco project we use both terms interchangeably.
Although organic farming has been practised in some European countries since the beginning of the twentieth century, the official regulation governing organic crop production in the European Union was established by the EU Directive 91/2092.
The registered area of organic land in Western Europe has increased very rapidly in the last 10 years. By the end of 1998, it exceeded 2.8 million ha, and was almost 2% of the total utilisable agricultural area (Stockdale et al., 2001).
The basic characteristics of organic farming are the use of crop rotations, fertilisation with organic fertilisers, and crop protection with non-synthetic pesticides. The results presented here are from organic systems in the Netherlands, Italy, Spain and Switzerland.

Crops and rotations
The characteristics of the crop rotations used in the different systems are as follows:

- The system in the Netherlands was on the experimental field station of Westmaas, with a 6-year crop rotation, including arable crops and cereals. The system was converted to organic at the beginning of the project.
- The Italian system was on a pilot farm, and consisted of a 4-year crop rotation of vegetable crops for fresh market. The farm was converted to organic three years before the start of the project.
- The Spanish system, on an experimental field station at Paiporta, consisted of a 4-year crop rotation of vegetable crops for the fresh market. The system was converted to organic at the beginning of the project.
- For the Swiss partner, three organic pilot farms were used in two different areas (Zurich and Seeland), and for this work, only five vegetable crops were selected. The farms had switched to organic about five years before the start of the project.

More information on the systems can be found in annex 1. The crops grown on the different organic systems are shown in Table 4.1.

Results

Quality production
The quantity of produce (QNP) is calculated by dividing the realised marketable production by the production level according to good agricultural practices (GAP). The quality of production (QLP) is calculated by dividing the quality of marketable produce by the quality according to GAP. Figure 4.1 shows the QNP for the year 2000 and on average, per organic system. Figure 4.2 shows the equivalent data for QLP. These values indicate to what extent the system has attained the GAP level. The 2000 results show that in the Spanish, Swiss and Italian systems the target levels were (almost) reached for both parameters. The system in the Netherlands still has a shortfall in both parameters. The main reason for shortfall in QLP and QNP in the Dutch system was probably the crop protection strategy followed. As indicated in the paragraph on pesticides, no pesticides were used.

Farm continuity
Both parameters, net surplus and hand labour hours input, can be used as indicators of farm continuity.

Table 4.1 Types of crops grown in the different organic systems

Netherlands 6-year rotation	Italy 4-year rotation	Spain 4-year rotation	Switzerland 4/8-year rotation
Iceberg lettuce	Green beans	Artichoke	Head lettuce
Fennel	Fennel	Green bean	Cauliflower
Brussels sprouts	Melon	Onion	Carrots
Spring barley	Catch crop	Watermelon	Leek
Spring wheat	Strawberry	Cauliflower	Onions
Potatoes	Lettuce summer	Potatoes	
	Lettuce autumn	Fennel	
		Green manure	

Net surplus

The net surplus was calculated as the gross revenue minus total expenditure including labour, expressed in ha-1. The net surplus for the year 2000 is shown in Figure 4.3. These results indicate a positive net surplus in all systems. The high net surpluses obtained in the Spanish and Swiss systems are surprising. It is attributable to the higher price obtained by direct selling of the produce.

The prices of produce are normally a result of the demand/supply relation and they can be very variable, especially in organic farming. Therefore, a parameter such as the cost of produce per unit of weight could also be used, as a complementary parameter of the farm continuity in the organic systems.

Labour input

The input of labour hours is another important indicator of farm continuity. The results obtained (Figure 4.4) indicate a much lower value in the Dutch system than in the Italian and Spanish systems. In order to improve the viability of organic farming in Italy and Spain, new cropping management strategies must be developed to reduce labour.

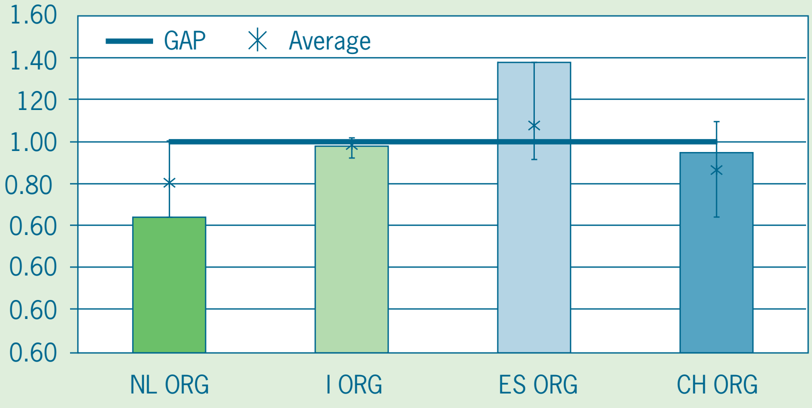

Figure 4.1 Quantity of production in organic systems relative: production compared to GAP organic

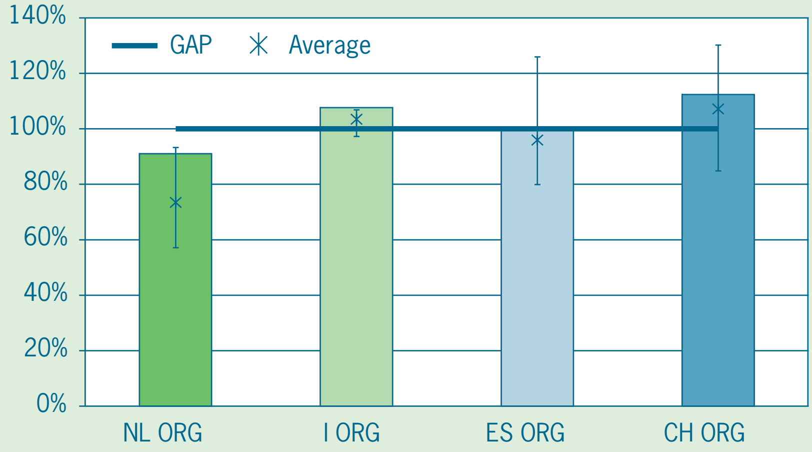

Figure 4.2. Quality of production in organic systems: relative quality compared to GAP organic

Clean environment nutrients and Sustainable use of resources

Phosphorus and potassium available reserve

To minimise the use of phosphorus and potassium fertilisers, the fertilisation strategy is focused on keeping the phosphorus and potassium reserves (PAR and KAR) within a range that is considered to be environmentally acceptable and agronomically sufficient. Thus, if actual reserves exceed the target range, the phosphorus and potassium inputs should be less than their output. If actual phospho-

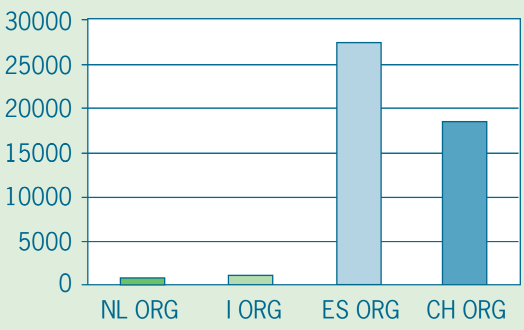

Figure 4.3 Net surplus per ha in the organic systems

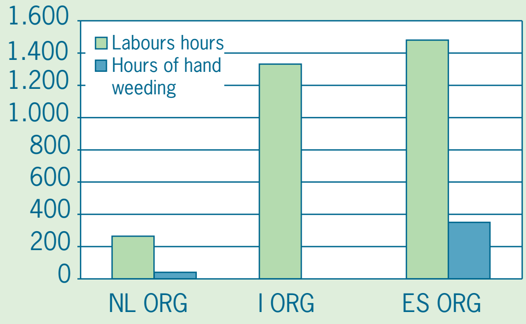

Figure 4.4 Input of labour: total labour hours and hours of hand weeding per organic system (hours ha-1)

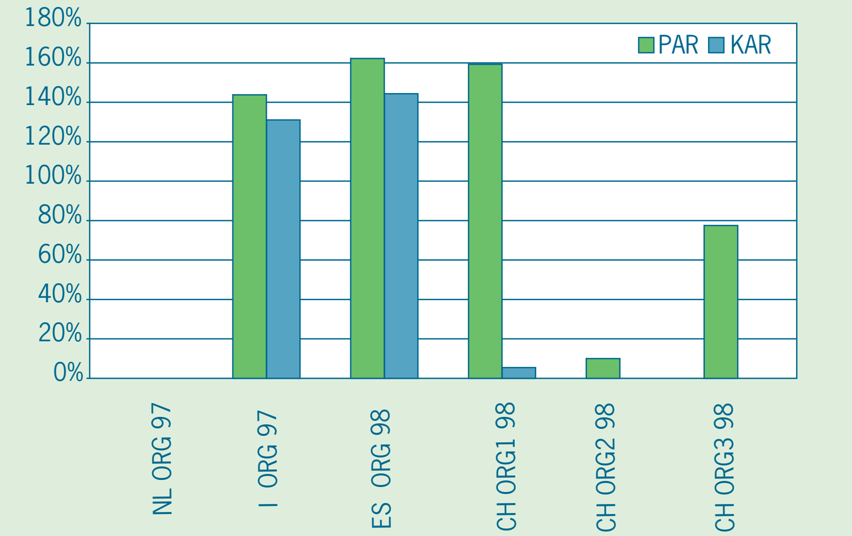

Figure 4.5 Phosphorus and potassium available reserves per organic system

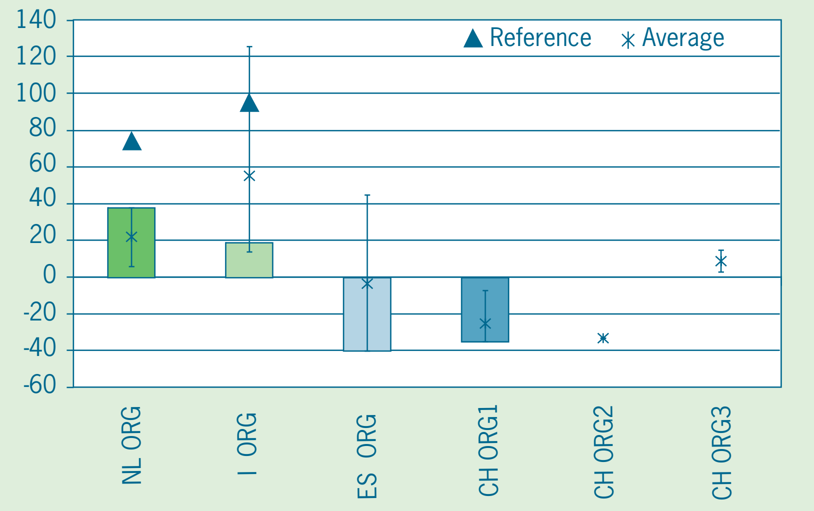

Figure 4.6 Phosphate surplus per organic system

rus and potassium reserves are within the target range, inputs should be equal to output.
Some results on the available reserves of phosphorus and potassium per organic system are shown in Figure 4.5, as percentage of the upper level of the target range. These PAR and KAR data indicate huge differences among systems, ranging from values higher than 100% (in the Spanish and Italian systems) to 0% (in the Dutch system). According to the fertilisation strategy followed, these differences of PAR and KAR should have influenced the nutrient input.

Phosphorus and potassium surplus

The results for the phosphorus and potassium surplus per organic system are shown in Figures 4.6 and 4.7. When using organic fertilisers (for instance manure and compost), it is difficult to achieve a good balance between the nitrogen requirements of the crop and the phosphorus and potassium requirements given the soil fertility. This is especially the case in systems with high levels of PAR and KAR.
The results for phosphorus and potassium surplus are in line with the strategy used, which gives rise to a sustainable situation. Systems with high reserves show a negative surplus (in Spain and CH ORG1). Systems with reserves within the desired range have small surpluses (compensating for unavoidable losses, as the case in the Netherlands) or zero surplus (in CH ORG2 and CH ORG3).
Comparing the phosphorus surplus realised in average practice with the systems in Italy and the Netherlands (Figure 4.6) shows a dramatic decrease in this parameter.

Nitrogen surplus and Nitrogen available reserves

The nitrogen surplus and nitrogen available reserves (NAR) per organic system are shown in Figures 4.8 and 4.9, respectively. Values for 2000 and average values are given. The nitrogen surplus has been calculated in the nitrogen balance as the difference between nitrogen input from all sources (organic manure, fixation, irrigation water and deposition) and nitrogen uptake by crops. The nitrogen surplus depends not only on the fertiliser input, but also on the cropping sequence, and can influence the NAR value.
The NAR is the amount of mineral nitrogen in the soil before the start of the leaching season. It is an indicator of risk of nitrogen losses in soil and is closely correlated with the risk of nitrate leaching to the groundwater in the system. The value of NAR depends not only on the fertiliser input, but also on the cropping sequence. Thus, some inefficient crops as lettuce give rise to high NAR, but other efficient crops such as cereal give a low NAR.
The target value for NAR is 70 kg ha^{-1} for clay soils and 45 kg ha^{-1} for sandy soils in the 0-100 cm soil layer. These target values are considered to be related to the 50 ppm of nitrate in groundwater in Switzerland, Italy and the Netherlands.

The nitrogen surplus is much higher in the Spanish system than in the other two systems (Italy and the Netherlands). The target NAR value was reached in the Netherlands and Switzerland but in the Spanish and Italian systems the NAR value is still problematic. Possible reasons for the shortfall in NAR and high nitrogen surpluses are:

- a high mineralisation rate of the organic nitrogen, quite common in the Mediterranean intensive vegetable production areas,
- in the Spanish system, the very high nitrate content in the irrigation water.

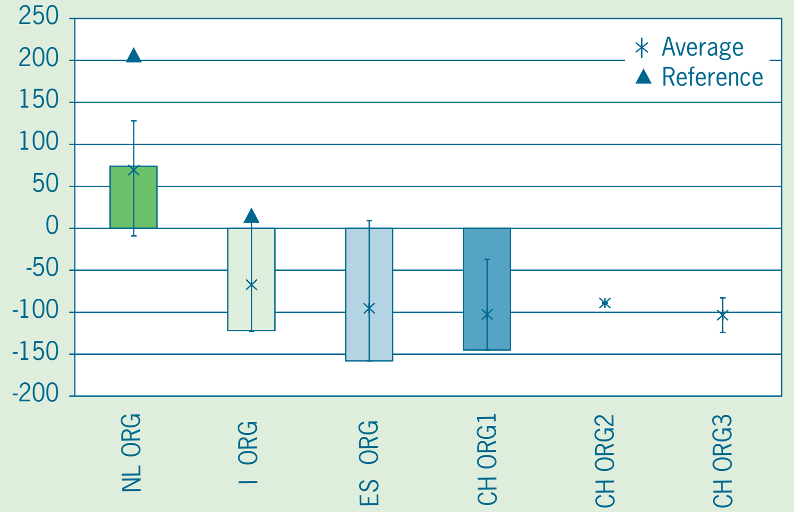

Figure 4.7 Potassium surplus per organic system (kg ha-1)

Clean Environment pesticides

A preventive or prophylactic strategy is the best choice for pest and disease control in organic systems, but in organic farming it is permitted to use some non-synthetic products (as bio-pesticides, Bacillus thuringiensis, copper and sulphur). The permitted bio-pesticides or natural pesticides include pyrethrum, rotenone and azadirachtine. Pyrethrum is derived from the leaves of a chrysanthemum species and can be used against sucking insects. Rotenone is extracted from the roots of certain legumes and is effective against various insects. Azadirachtine is obtained from various organs (leaves, fruits and seeds) of the Neem tree and can be used against a wide range of insect pests. Although of natural origin, these bio-pesticides have harmful side effects (e.g. on beneficial insects and fish). Therefore, their use should be restricted to certain cases.

Copper products are used to control certain diseases in vegetables. Concern is growing about the risk of copper accumulation in soils, because the average input is much higher than the crop off-take (0.5-1.0 kg ha-1 and year). High levels of this nutrient in the soil may have a negative impact on soil biological activity, plant growth, and human/animal health. Given that copper products are expected to be prohibited in organic farming after 1 January 2002, alternative strategies should be developed for controlling diseases in organic vegetables.

Bacillus thuringiensis (B.t.) is frequently used as a supposed method of “biological control”, because this soil bacterium produces a toxin that is toxic to many lepidopteran pests. Nevertheless, a widespread use of this microbial insecticide may cause problems, for instance of resistant larvae in the future.

Figure 4.10 shows the yearly input of pesticide active ingredients (kg ha-1) divided into synthetic, copper, sulphur and others (B.t.), obtained from the different organic systems. The results are consistent with the crop protection strategy used. Thus, in the Dutch system, there was no input of any pesticide. In the other systems, some permitted products such as bio-pesticides, copper, sulphur and B.t. were used.

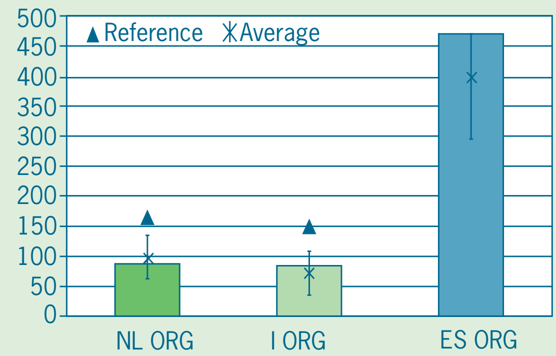

Figure 4.8 Nitrogen surplus per organic system (kg ha-1)

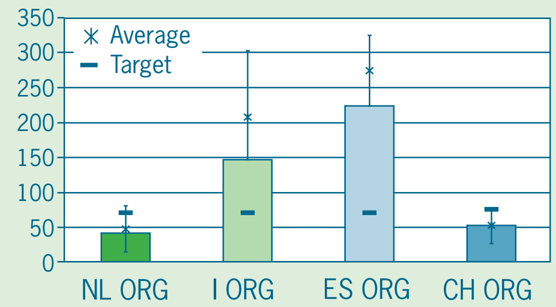

Figure 4.9 Nitrogen available reserve per organic system (kg ha-1)

The environmental impact of the pesticide inputs in these three organic systems was very low compared with the integrated or conventional practices. However in the future, it will be necessary to improve the crop protection

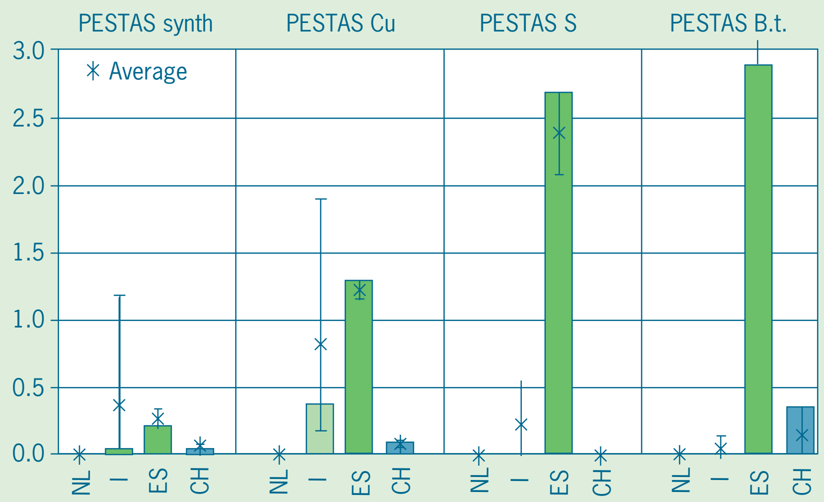

Figure 4.10 Pesticide input in the organic systems (kg ha-1)

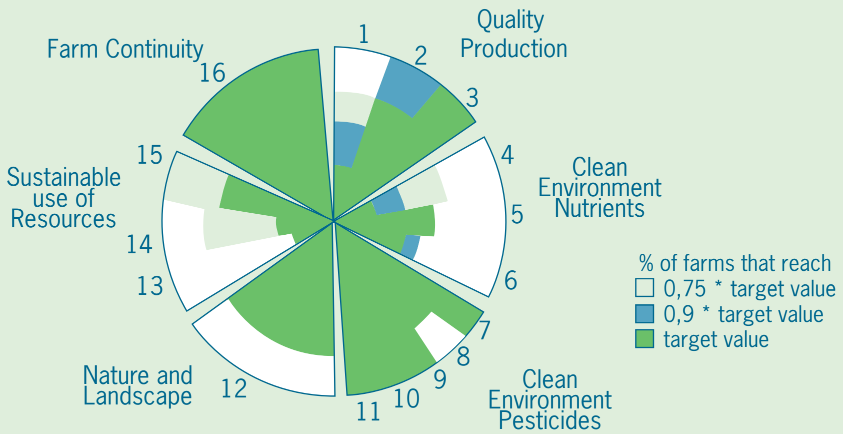

Figure 4.11 Overview of results for organic systems. Numbers depict parameters. See Annex 2 for explanations of numbers and parameters.

management in the organic systems, because of the known side effects of bio-pesticides and the new regulation applying to copper.

Results: overview of organic systems
The overall results for the organic systems are shown in Figure 4.11, which indicates the percentage of systems that achieved 75%, 90% or 100% of the target value of the parameters included in the different themes (see for explanation of the parameters annex 2). The results obtained indicate that the main shortfall is in the themes "environment nutrients" (phosphorus and potassium balance, and nitrogen reserves) and sustainable use of resources (especially phosphorus and potassium reserves).

Conclusions
From the results, the following conclusions can be drawn:
In most cases, the average yields were somewhat lower than the target, and the quality of produce was generally close to the target. However, there were large fluctuations between years. In all cases, nitrate content in produce reached the target.
The net surplus reached the target in all systems because of the high price level. Labour input in organic systems is still high and there is an urgent need to reduce this in future.
Nutrient management needs great improvement. Nitrogen losses should be reduced in Spain and Italy, and in all countries except the Netherlands the high reserves in the soil should be cut back.
Although target values were reached for pesticide use and emission, improved crop protection management should result in a reduction of the use of bio-pesticides and copper in the future, because of the risk of ecological damage by bio-pesticides.

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5 System comparison: organic versus integrated

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Introduction

This paper compares organic and integrated vegetable farming systems in Spain, Italy, the Netherlands and Switzerland. Unless stated otherwise, the data presented are for 2000. In some cases, these data are compared with average data for the entire project period, target values and/or reference data from average practice. The research in Spain, Italy and the Netherlands was done on experimental farms whereas in Switzerland it was done on integrated and organic pilot farms.
Integrated and organic vegetable farming is well established in Switzerland. Almost the whole vegetable area, including about 10% under organic farming, is cultivated in accordance with Swiss regulations for ecological production.
For this comparison, we selected comparable farms. Table 5.1 is an overview of the systems compared.

Firstly, an overview of the results for each country is given. Secondly, the results of some selected parameters are compared and finally an overall comparison is made and some conclusions are drawn.
Differences between organic and integrated farming
The most important difference between organic and integrated farming is the use of (or abstention from using) mineral fertiliser and synthetic pesticides. Closer examination, though, shows there are numerous exceptions to this rule of thumb, e.g. the use of copper as a fungicide in organic farming in some countries. Crop rotation is quite similar in the two systems, although rotations tend to be longer in organic farming.
Taking Switzerland as example, vegetable production is very heterogeneous and small-structured. This often makes it difficult to compare individual farms (Table 5.2). Integrated farms have a somewhat larger area for vegetable production than organic farms. The number of crops grown on the individual farm is very high in Switzerland in both systems, but even higher on organic farms than on integrated farms. Average manpower per hectare is high and slightly higher on the integrated pilot farms compared with the organic ones.

Differences between countries
Land use intensity varied from 1 cash crop per ha and year in the Netherlands – in Northern Europe – to more than 2 crops in Spain, in Southern Europe. This is due to different climatic conditions and a higher percentage of arable crops in the crop rotation of the Netherlands. Differences between integrated and organic systems within a country are of minor importance. Thus, intensive vegetable systems in Spain are compared to extensive vegetable systems in the Netherlands. This is an important difference to be taken into account for all results expressed per hectare (e.g. fertilisers or pesticides in kg ha^{-1}).

Comparison per country

Circle diagram
As explained in the previous contributions, 16 parameters were defined to evaluate the systems. These parameters are divided over 6 themes. In the circle diagram, the evaluation is visualised for all parameters and themes. Each parameter is a segment. If the target was achieved, the segment of the circle is coloured; shortfalls are blank. The parameters are listed in the appendix.

Netherlands
The systems are comparable in terms of the location and the crops grown. The crop rotation is six years in the organic system and 4 years in the integrated system.
- Crop quality and quantity did not reach the expected values in the organic system, due to pests and

Table 5.1 Integrated and organic farms used in the comparison

	Integrated	Organic	Main crops
Netherlands	NL INT1	NL ORG	Brussels sprouts, potatoes, fennel, celeriac
Italy	I INT2	I ORG	Lettuce, strawberry, melon, celery, cauliflower
Spain	ES INT3	ES ORG	Artichoke, watermelon, cauliflower, onion
Switzerland	CH INT1	CH ORG1	Lettuce, cauliflower, carrots, leek, onions

Table 5.2 Average vegetable area, number of crops and manpower per ha for the Swiss farms (range shown in brackets)

	Integrated farming	Organic farming
Vegetable area (ha)	14 (1-32)	8 (2-15)
Number of crops	39 (22-43)	41 (16-70)
Manpower ha^{-1}	1.3 (0.3-3.2)	1.6 (0.4-2.6)

diseases in Brussels sprouts, iceberg lettuce and potatoes.

- Phosphate and potassium balances were not in equilibrium in the year 2000, although they were in equilibrium over the whole project period.
- Farm viability is better for the organic system than for the integrated system.

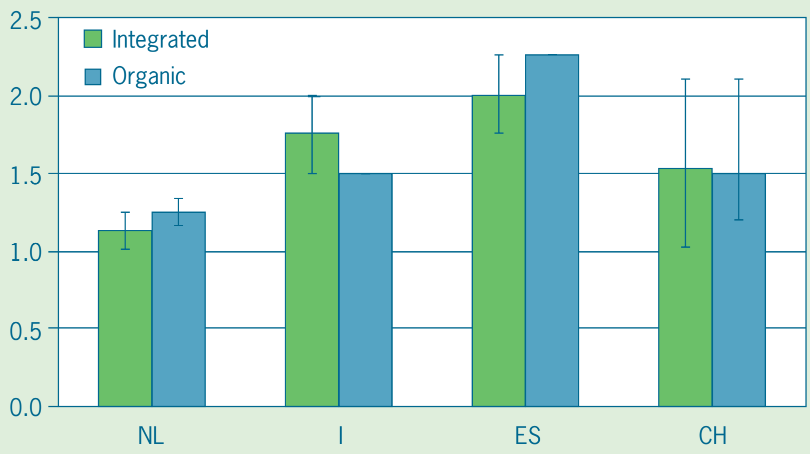

Figure 5.1 Land use intensity in partner countries: number of crops per ha per year

Italy

The organic and integrated systems in Italy have the same crops and length of crop rotation but represent different locations.

- In the organic system, the phosphate balance was too high, due to application of organic manure with a high phosphate content.
- In both systems, nitrogen reserves in autumn were too high.
- The organic system has high phosphate and potassium contents in the soil because of a high starting

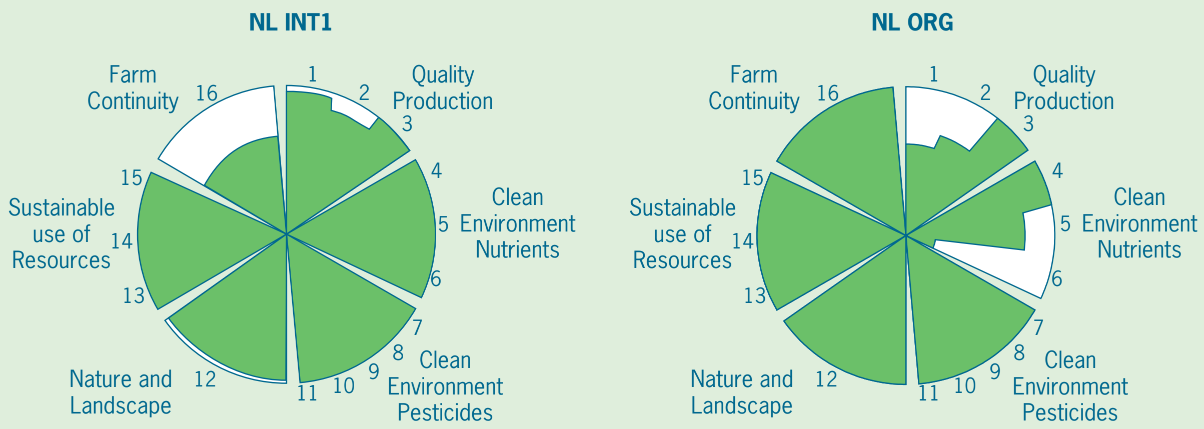

Figure 5.2 Results of NL INT1 and NL ORG, see Annex 2 for explanation

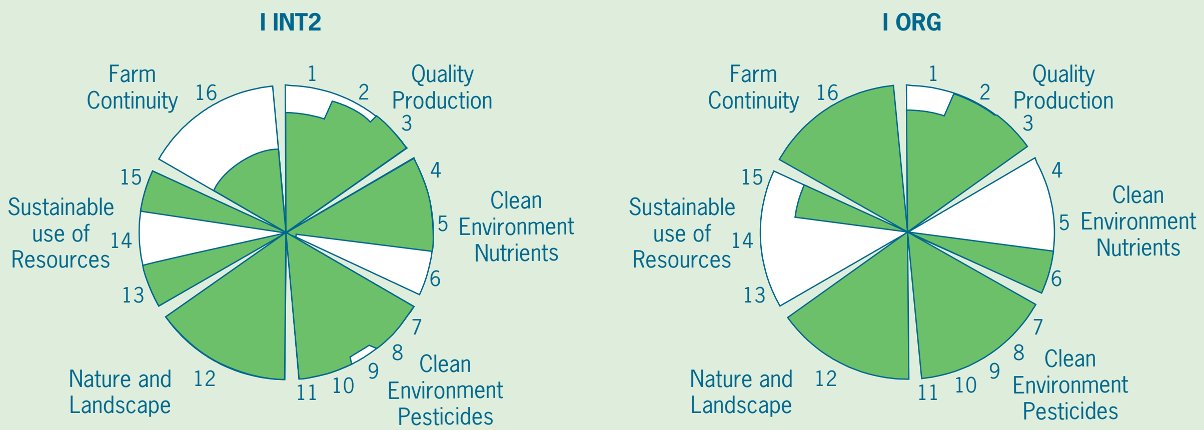

Figure 5.3 Results of I INT2 and I ORG, see Annex 2 for explanation

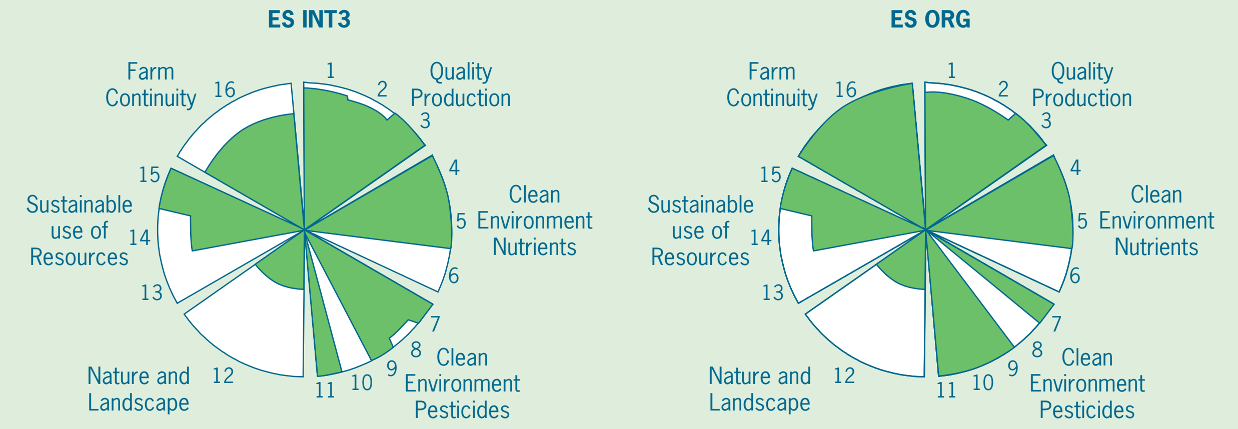

Figure 5.4 Results of ES INT3 and ES ORG, see Annex 2 for explanation

situation. The levels fell between 1998 and 2000: by 40% for phosphate and by 25% for potassium. The input of phosphate and potassium was minimised, nevertheless the phosphate balance was too high for the organic system.
- The organic system shows a better farm continuity than the integrated system.

Spain
The organic and integrated systems are comparable in terms of the crops grown and the length of the crop rotation. The points of note are:
- Nitrogen reserves in autumn are very high in both systems because of the high nitrogen content in the groundwater and irrigation water. In these systems, nitrogen is only supplied via irrigation water.
- The input of copper is particularly high in the organic system. Copper is used as biological fungicide in almost all crops in the organic system.
- Pesticide emission to the groundwater is very high in the integrated system because of the application of cyromazin (Trigard) in onion and chlorpyrifos-methyl (Reldan) in artichoke.
- In both systems the ecological infrastructure improved during the VEGINECO project, but did not reach the target because of the small area of the farms.
- Both the phosphate and potassium contents in the soil are too high because of a high starting situation. The levels decreased between 1998 and 2000: by 25% for phosphate and by 40-50% for potassium. The input of phosphate and potassium was minimised.
- The farm continuity was very high for the organic system, mainly because of on-farm sales, but was critical for the integrated farms.

Switzerland
The integrated and organic farms have the same locations and soils, but different crops.
- The quantity of production did not reach its target in the organic system.
- The pesticide input to control thrips in leek was too high in the integrated system; these applications were needed because of the stringent market requirements for cosmetic quality.

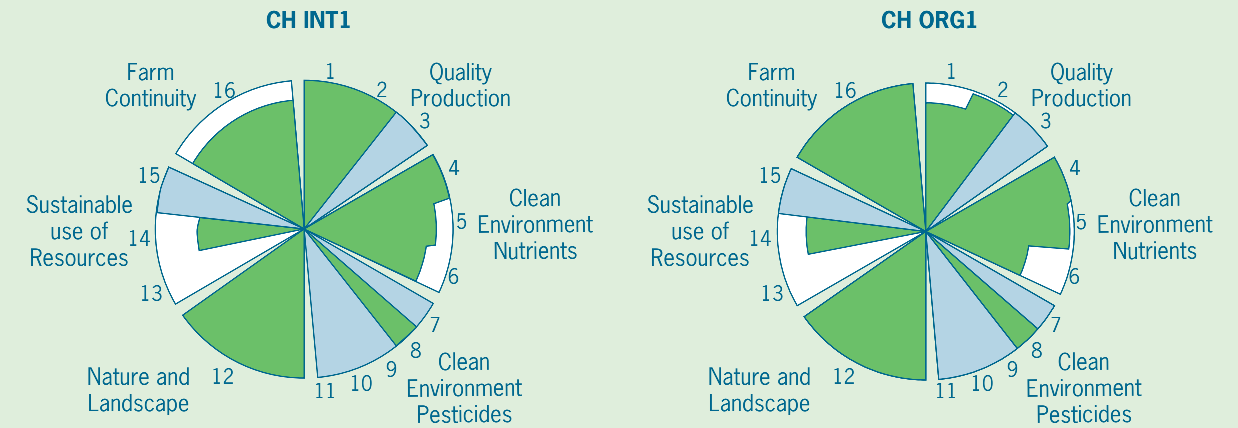

Figure 5.5 Results of CH INT1 and CH ORG1 (grey areas are not tested), see Annex 2 for explanation

- Lower product prices for the integrated system lead to sub-optimal farm continuity, whereas the organic farm reached the farm continuity target.

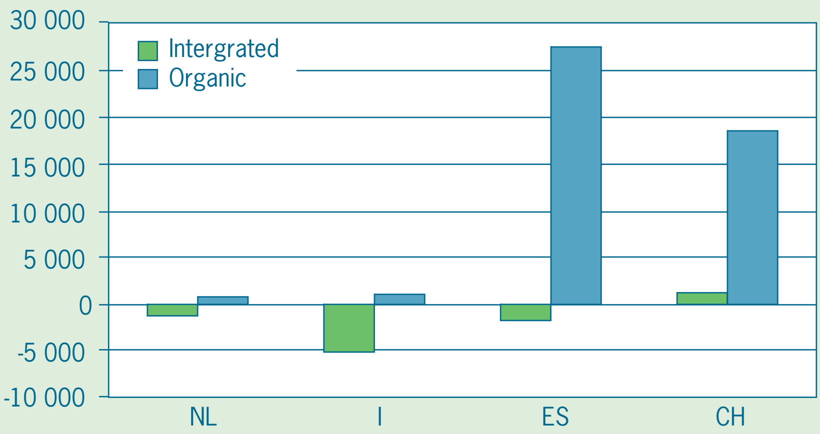

Figure 5.6 Net surplus (€ ha^{-1}) for integrated and organic systems

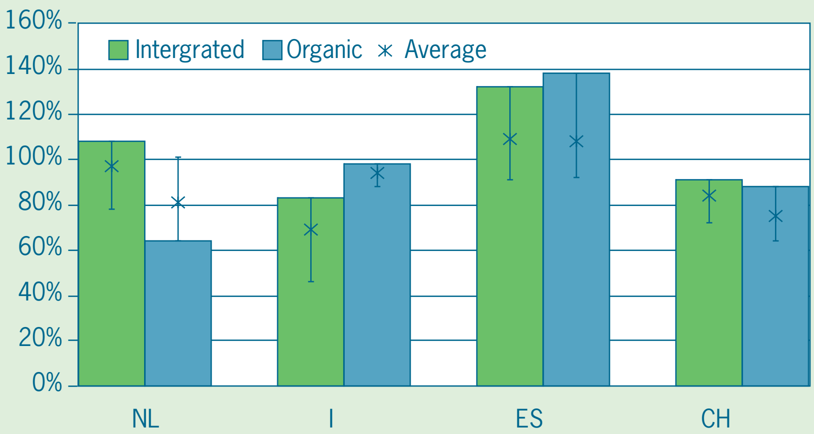

Figure 5.7 Integrated and organic yields relative to good regional yields

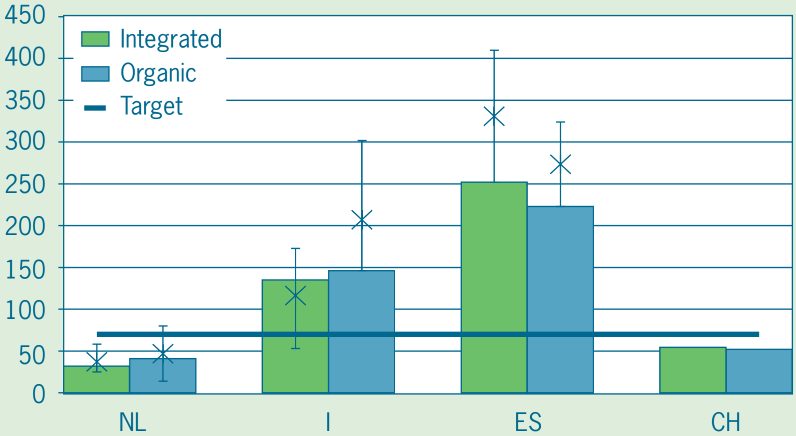

Figure 5.8 Reserves of available nitrogen in autumn (data from 2000, Switzerland from 1998) in kg ha^{-1}

Farm continuity

The applicability of the results on farm continuity (net surplus, Figure 5.6) is limited because the comparison involved different crops, sites, countries and prices.
The costs of organic farming in Switzerland were partly evaluated from costs for integrated systems. Despite these restrictions, it is obvious that in each country, organic farming compares favourably to integrated farming. The high net surplus in Spain and Switzerland is attributable to the high prices obtained for organic vegetables sold directly at the farm gate. In the other countries too, the good economic results are attributable to higher prices. The higher prices compensate for lower yields and the larger number of hours needed for manual labour.
The costs of hand weeding are double to four times more in the organic system and contribute substantially to the total expenditure. In farms with large fields, mechanical weeding may help slash the time needed for hand weeding. In the Netherlands, where fields are large, less than 10 hours ha^{-1} were needed in the integrated system and 40 hours ha^{-1} in the organic system. In Spain about 150 hours ha^{-1} were needed in the integrated system and about 350 hours ha^{-1} in the organic system. The different crops grown must be taken into account.

Quality production

The targets of product quantity were met in Spain, Italy and Switzerland with only minor differences between organic or integrated (Figure 5.7). In the Netherlands, the quantity of organic vegetables was low, because on the Dutch experimental farm no compromises were accepted in the application of pesticides. Figure 5.7 shows that it is difficult to produce organic vegetables of marketable quality without the use of harmful pesticides. Variations in yields were large.

Comparing the five most important field-grown vegetables in Switzerland (head lettuce, cauliflower, leek, carrot and onion) indicates an average variation between 1998, 1999 and 2000 of more than one third. The variations in organic farming were usually greater than those in integrated farming. Looking in detail at organic head lettuce on a specific farm in Switzerland, the yields in 1998 were good for the spring and summer crops (60 000 heads ha^{-1}). In 1999, the spring yield was zero because of hail, but the summer yield was very good (80 000 heads ha^{-1}). In 2000, the spring yield was good (60 000 heads ha^{-1}) but there were problems with bottom rot in the summer crop, giving a yield of only 20 000 heads ha^{-1}. Of course, weather problems, pests and diseases can occur on organic as well as on integrated farms. In integrated production, however, the farmer has more options available to react to problems with pests and diseases. Though the yields in organic systems are often lower than those in integrated systems, they may be higher or the same as those in integrated systems, as occurred in Switzerland for head lettuce, cauliflower and leek. These crops showed slightly higher yields in the organic system. On the other hand, carrot and onion yields were substantially lower.

Comparing the yield of fennel, potato and lettuce in Holland and Spain shows that fennel is an "easy" crop. There was no difference in yield between the organic and integrated systems. However, there is an important difference between the countries (20 tons in the Netherlands and 30 tons in Spain) probably because of growing conditions (light, temperature, rainfall etc.). Potato and lettuce are clearly more difficult crops. Substantially lower yields, up to 50% less than integrated, were obtained in the organic system. This was particularly the case for potato in the Netherlands, where no copper fungicides were applied against Phytophthera.

Clean environment nutrients

Nitrogen available reserves in autumn

The target value for the nitrogen available reserves in autumn is set at 70 kg N ha^{-1}. In Spain and Italy, the nitrogen available reserves were much higher than this in both the integrated and the organic systems. In Spain and Italy, there was great variation in the nitrogen available reserves in integrated or organic systems. There was much less variation between different systems and years in Switzerland and the Netherlands, presumably due to lower mineralisation rates and smaller surpluses of nitrogen.

In spite of the decrease in nitrogen input in the Spanish systems in recent years, a too high value of nitrogen in autumn was measured in the year 2000, as shown in Figure 5.8. Further improvements are needed in nitrogen fertiliser management to reduce the risk of leaching,

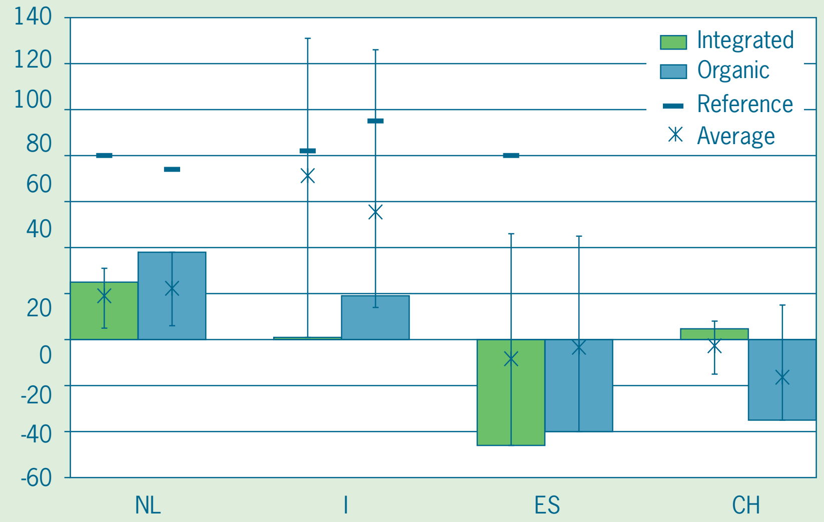

Figure 5.9 Phosphorus surplus in kg ha^{-1} for organic and integrated systems, reference is the average phosphorus balance in practice

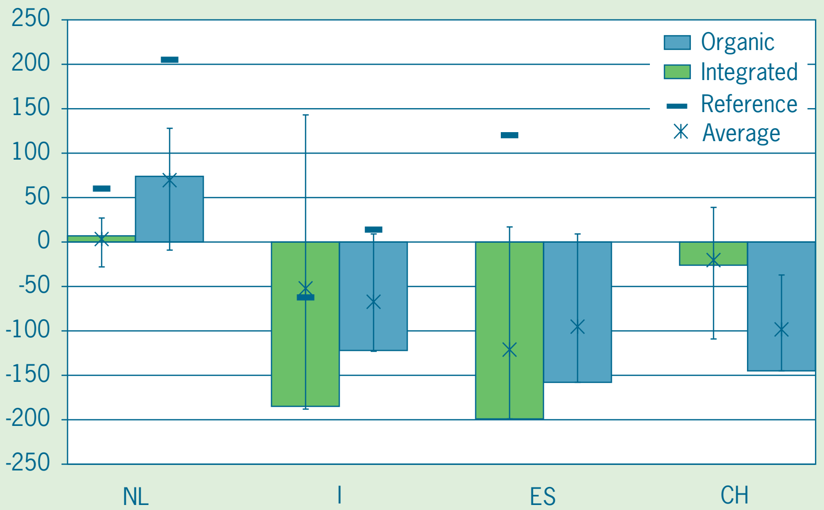

Figure 5.10 Potassium surplus in kg ha^{-1} for organic and integrated systems, reference is the average potassium balance in practice

taking particular account of the high nitrate content of the irrigation water.
In Italy, high nitrogen values were caused mainly by the mineralisation of ploughed-in crop residues (organic system) or by a high fertiliser input (integrated system, celery). The situation could be improved by additional catch crops in the crop rotation.

Phosphorus balance
Figure 5.9 shows the phosphorous balance. In Italy and the Netherlands, there is some surplus of phosphorus, particularly in the organic systems. This is caused by the application of organic fertilisers containing high concentrations of phosphorus. In the Netherlands, a surplus of 20 kg ha^{-1} is tolerated because of compensation for unavoidable losses. Over the whole project period, in both systems the average surplus was almost equal to the tolerated loss. By contrast, organic systems in Spain and Switzerland showed negative figures, indicating that the output exceeded the input; these systems profit from the reserves accumulated in previous years. This is a desirable situation because these soils have too high phosphorus contents compared to what is environmentally and agronomically desirable. With the negative balance, the potential risk of phosphorus emission to the groundwater can be reduced. The “Reference” indicates the situation in practice: in most cases, input is much higher than the output.

Potassium balance
The crops in all systems except for the Netherlands take up potassium from the available reserves in the soil. As these reserves are very large, there will be no need to replenish the potassium reserves in the near future in both types of system. In the Netherlands, the reserves are within the target range and there is a surplus to account for unavoidable losses.

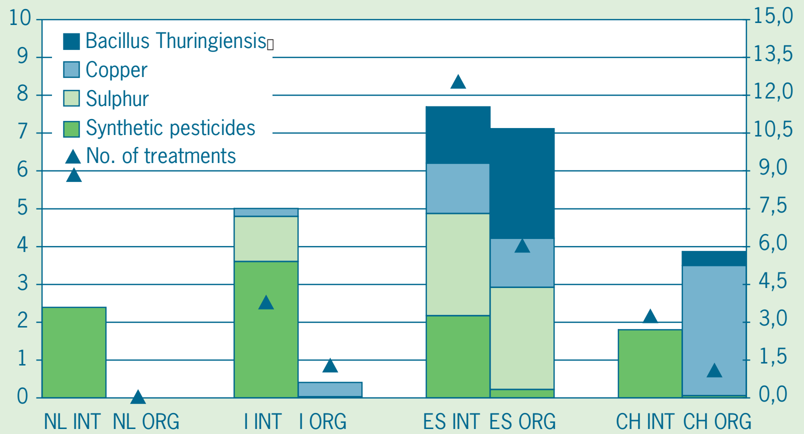

Figure 5.11 Pesticide use in integrated and organic systems in kg a.i. ha^{-1} (left axis) and in number of treatments (sum of all types of applications, right axis)

Clean environment pesticides
Figure 5.11 gives an overview of the pesticide use in organic and integrated systems. Pesticides have been divided into synthetic pesticides, copper, sulphur and other pesticides (mainly Bacillus thuringiensis, Bt.).
The synthetic pesticides use in all integrated systems is about 1.5 to 2.5 kg active ingredients ha^{-1} (Figure 5.11). Due to the intensive land use, the integrated system in Spain had the highest pesticide input at the start of the project. A high reduction was recorded in the course of the project, since organophosphates were replaced by synthetic pyrethroids; the so-called “natural” pyrethrins. Italy showed the highest input of all systems and countries in 2000.
Synthetic pesticides can be replaced by other classes of pesticides such as sulphur compounds, which were used intensively in integrated and organic Spanish systems, as well as in the Italian integrated system. Another possible substitute is copper application, as was done in Switzerland, Spain and Italy. Copper was used in organic farms to control harmful fungi like downy mildew in onion or lettuce.
No pesticides at all were used in the organic system in the Netherlands because of the assumption that all agents used as pesticide negatively affect the environment or human health. From the Swiss perspective, the presentation of pesticide input in kg active ingredients per ha has a limited value. Very active compounds like the synthetic pyrethroids are used in small amounts per ha but they can have serious side effects. Since every treatment has known or unknown negative side effects, the Swiss partner prefers to characterise the pesticide input (and the pesticide emission) by the number of treatments.

Comparison of integrated and organic systems
In Figure 5.12 the overall view of both systems are given in the circle diagram. In both types of system, there are shortfalls in the quantity production. The shortfalls are more pronounced in the integrated systems than in the organic ones.
In both types of system the nitrate content of the produce is low.
Most of the organic systems did not reach the clean environment nutrient targets. This shortfall is attributable to the intensity of the systems and the use of organic fertiliser as the only fertiliser.
When organic fertilisers are used, precision dosing of nutrient contents to meet the crop requirements is impossible.
For the clean environment pesticides theme, the organic systems score better than the integrated systems, mainly because synthetic pesticides are used minimally, or not at all. Only in the use of

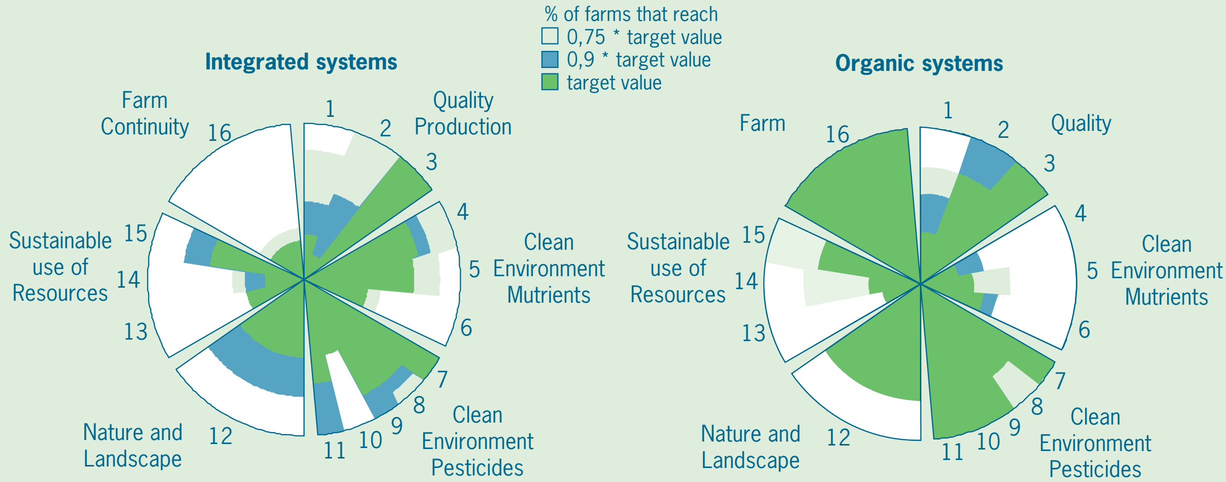

Figure 5.12 Comparison between integrated and organic systems: percentage of farms that reach 75%, 90% and 100% of target value

copper do the organic systems give a poorer result. In the integrated system, the emission of pesticides to the groundwater is still very large, because a few pesticides have a high potential to leach to groundwater.
In Italy and Spain the systems did not reach all the targets for nature and landscape, because of the small scale of the vegetable farms.

Conclusions

In this system comparison, the most striking difference is in the difference in revenue between organic and integrated systems. In all cases, revenue in the organic systems is equal to or more than the revenue in integrated farms. Occasionally, lower yields and more hours of hand weeding in the organic system are compensated for by higher prices.

The marketable quality of organic vegetables is gradually being adjusted to integrated standards because of pressure from wholesalers; this is a constraint to organic growers. The quality of organic products in the researched systems was comparable to quality of products from the integrated systems, except for the Dutch organic system, where no pesticides were used.
Impact on the environment (potential leaching of nutrients, pesticides) is influenced more by the site of the farm (climatic conditions, organic or mineral soil, main vegetable growing area or scattered farms) than by the production system itself (integrated or organic). Within a given site, optimised organic farming compares favourably in terms of harmful effects of pesticides on the environment (low input). In terms of nutrients, optimised integrated farming systems may have less harmful impact on the environment (better control of nutrient availability and nutrient supply).

Part 2, Certification: bringing the added value to markets and governments

6 Certification: bringing the added value to the market

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Introduction

More sustainable food production methods clearly provide an added value to society in comparison with traditional methods of farming. However, the question is: "value added to what?" In addition, other questions quickly arise as:

- what is the added value,
- how can it be expressed and made explicit,
- is this added value reliable,
- measurable and controllable,
- who is interested in this added value and
- is someone willing to pay for this added value to appreciate it in a way that contributes to the farm income and farm continuity?

In this contribution, recent developments in certification are analysed against a historical background. These developments will be related to organic and integrated food production.

Intensification, increasing problems and the reaction of stakeholders

Intensification, free market production, problems

Crop rotations and food production techniques have been intensified ever since the Second World War. Long and varied crop rotations often with perennial pastures of grass and clover were replaced for (short-term) economic reasons by short rotations of a small number of cash crops. Soil improvement together with high yielding, but often susceptible cultivars increased the yield potential dramatically. The high yield potential could only be realised over a strongly increased use of fertilisers and pesticides. This intensive, technology driven agriculture has very one-sided objectives (ensure basic income and sufficient supply of food, fodder and resources) and tries to realise them by relatively simple and one-sided agrochemical based methods (fertilisation and crop protection). An example is the use of pesticides. Current farming systems almost exclusively choose pesticides to correct the structural problems in farm management such as insufficient crop rotation, susceptible varieties and high nitrogen inputs. The one sided objectives and the one sided methods are the major cause of the complex of economic, environmental, agronomic and ecological problems that current agriculture got into.

The characteristics described above of current agriculture are typical for free market food production, which had for a long time almost no restrictions to the way in which food was produced.

The key problems of these type of farming systems are:

- the endangered quality of the *abiotic environment* mainly caused by the over-use of pesticides and fertilisers,
- the decline of *nature* (biodiversity) and *landscape* due to the "improvements" in farm structure and land management,
- the increasing *social costs* of agricultural production caused by pollution and overproduction,
- the *desertification* of rural areas, especially in the marginal (mountainous) areas in Europe due to the restricted *economic* perspectives,
- the ongoing pressure on the farmers' basic income levels and
- the increasing concern around *animal welfare* in modern production systems.

World-wide, especially since the end of the eighties, there has been a growing concern with respect to these adverse effects of agricultural production methods on the quality of the biotic and abiotic environment. There is a growing awareness of the complex interaction between agriculture and ecology and the environment. Questions have been raised concerning sustainability with respect to dependency on chemicals, the use of non-renewable resources and maintenance of soil fertility etc.

Reaction of society and governments

"Free" agricultural production lost much of its freedom in a relatively short time after the Second World War. The loss of freedom started more or less with the introduction of chemical inputs. Governments recognised that legislation was necessary in order to check the quality of these inputs and their effects on food quality and farm labourers' safety. In addition, agriculture would profit from an independent evaluation of the agricultural suitability of inputs and the accompanying instructions for use. Environmental concerns were introduced only later into the evaluation schemes. The first set of restrictions was directed to limit the types of products used. Since then, an ever-increasing number of issues are included in the evaluation schemes. Starting with Pesticide and Fertiliser Acts, this developed into pesticides and fertiliser policies. In first instance, the acts were directed to the allowance of the use of compounds; later, restrictions were made on the use of these compounds in the policies. In the policies concerning agriculture, agro-environmental issues were increasingly added to the agenda, followed by ecological issues such as quality of habitats, landscapes and nature (biodiversity). The EU introduced a pricing policy to safeguard the supply of inexpensive food and to maintain farming activities on a large scale (maintaining competitiveness in world markets with price interventions). Gradually, this agricultural policy had to shift to quota systems to restrict overproduction of certain commodities. In the seventies and eighties, the pricing policy became too costly and, in some ways, counterproductive and irrational. As a result, the policy shifted from price-based to land-based subsidies. Farmers were still supported; however, incentives that had caused overproduction were abandoned. Even schemes were introduced for setting aside land. The EU took the policy to the next level when the concept of reciprocity was introduced in an attempt to restrict adverse effects and stimulate agro-environmental protection. It is known as the "cross compliance approach" - if we pay, we will want the desired result - a suitable concept to help move agriculture in the "preferred" direction.

Government policies typically address public concerns, which are not safeguarded by individual or corporate interests. This takes place at every level because every level of government authority under the EU adds or implements general policies. An increasing number of restrictions, rules and regulations are superimposed on agricultural production, influencing its development. All issues stated are translated into policies, region specific implementation plans, rules, regulations and stimulation packages. All of these developments add up to, what we will call here: different "packages of demand". These packages are always related to methods of production, and differ depending on the authority and implementation incentives from EU, national, regional or even municipal levels. These packages contain restrictions, which are intended to direct agriculture towards more ecologically and environmentally sound production methods. As a result, these packages contribute to the biotic quality of rural landscapes and safeguard to a certain extend environmental quality.

In this respect, Good Agricultural Practice (GAP) is seen by many as a concept that constitutes the use of up-to-date farming technologies that can fulfil the current requirements of governments and society. GAP constitutes a basic level of technology applicable for everyone. In the context of the EU, 62 regions have defined their region-specific levels of GAP. The definition of GAP varies between regions, which partly is inevitable and partly offers the space for different interpretations of the concept.

Reaction of traders, consumer demands

Traders and retailers have increased their requirements as well, reflecting their market position and consumer concerns, as they perceive them. In first instance, they were concerned about (mainly external) quality. Later, in the nineties, this expanded to issues of food safety and sustainable production. It seems, after analysing their position, that traders and retailers have two main concerns: 1) maintaining and increasing consumer confidence and 2) avoiding liability claims The first is concerned with quality assurance, food safety and the sustainability aspects of farming enterprises in their socio-economic context. The second is mainly concerned with food safety. The concerns about the way in which commodities are produced range from environmental impact to ethical questions. Multinationals are studying these issues at this time. How these concerns are translated into guidelines and restrictions differs considerably. EUREP, the European conglomerate of retailers in fresh produce, is one of the first European organisations that attempted to follow a comprehensive, thematic approach to farming activities. Their approach is defined in production guidelines. The EUREP actions are discussed later in this article.

Research community divided

The research community has responded rather slowly to the increasing number of agricultural problems. The first group to notice these problems were the entomologists that responded to Rachel Carson's "Silent Spring" (Carson, 1962). They started to develop alternative strategies for pest control: alternatives to an entirely chemical approach. This conceptually different way of working, known as IPM (Integrated Pest Management), developed and expanded into diseases and weeds, and then into all agricultural sectors. Due to the efforts of the IOBC community (International Organisation for Biological Control), IPM expanded into Integrated Production (see later in this article). However, political interests and the increasing focus on environmental and ecological questions were not broadly supported in the agricultural research community. It was the tireless efforts of the pioneers, which changed new approaches into workable strategies for farmers. The rest of the community received a great deal of criticism at the end of the eighties and during the nineties for their relative lack of contributions to solving urgent problems.

Integrated and Organic Farming

The concept of integrated farming was and is a research-based concept. The transformation into guidelines for farmers started end of the eighties in the German-speaking part of Western Europe; gradually moving into a restricted number of other geographical areas. During the nineties, some governments in Europe embraced the concept, for example, the German government with the Crop Protection Act and the Dutch government with the Agricultural and Crop Protection policy.

Organic farming cannot be considered as a reaction to agricultural intensification. It originated, at the end of the nineteenth and beginning of the twentieth century, based on the initiatives of individuals and small groups, who were looking for alternative ways of agriculture. However, it appeared increasingly to be a radically different approach as the intensification of conventional agriculture increased. Now, it is in fact a distinctly separate form of food production with a reasonably, well-defined "package of demands", that is certified and labelled as organic production.

Image, blends and trademarks: jungle of claims

In addition to the developments mentioned above, based on concern for food quality and sustainability issues, a large number of trademarks, blends, and appellation contrôlee concepts (guaranteed origin and quality) have been developed that address issues such as image, quality origin and regional-context, which appeal to consumers' desire for authenticity.

All labels and trademarks, no matter what their origin and whether or not they have an official status, need certification schemes to prove their claims. However, all schemes together are resulting in a jungle of claims with little possibility for consumers to grasp the content of these claims. In this respect, action of governments is needed seriously to uphold a minimum standard of requirements and when possible, to reinforce the requirements by incentives or subsidies. All the other claims, requirements and labels are then above a basic governmental level.

Justification of production and certification

Scope of "packages of demand": license to produce and license to deliver

Farmers should at least act in accordance with the law. Farmers can, however, increase their income or acquire a better position in the market by meeting the standards in the "packages of demands" defined by governments or markets.

These packages are defined in the changing coalitions between different partners in the field: society, markets, research, government and farmers/producers organisations. These packages have different contents and procedures, consisting of either prescriptions or guidelines with rules concerning what is allowed and what is not allowed, and they eventually lead to certification. This means in the current terminology that the farmer/producer has to have a license to produce (government or society, prerequisites and boundaries), and the license to deliver (from the markets) (Table 6.1). These packages may vary considerably in content due to the objectives and ambitions of the coalition. They can be production or chain-oriented and address different issues, such as the production process (minimise side effects of potentially polluting inputs), the handling and packaging (quality assurance systems), labour conditions, and handling of waste.

Figure 6.1 presents the issues related to primary production and Figure 6.2 illustrates the varying scope of the packages of demands and the different levels of ambitions.

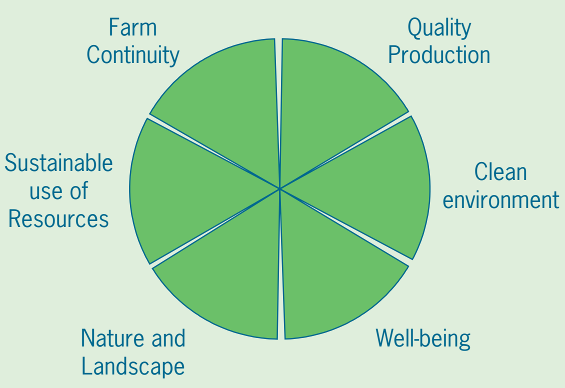

Figure 6.1 Issues related to primary production

Certification and related problems

All of these packages have to be certified so it is important to define certification first.

- Certification = acknowledgement by a certifying body that a product, service, person or system meets the published set of requirements.
- Certification scheme = set of requirements for client and certifying body.
- Accreditation = acknowledgement as certifying body.

In this sense, these packages of demands are certification schemes. They are public. An independent organisation carries out the audits to check if the production is done according to the regulations. This independent organisation is authorised in most countries by an accreditation board. Key issues in certification schemes related to the primary production are the means of production and the cultural practices such as the use of pesticides and fertilisers, seeds, plants and the quality of the equipment (precision and potential losses). In addition, the first regulations on biodiversity and wildlife habitat management can be found in new schemes. The documentation of all farm data is essential in these schemes. In all schemes, the basis for pesticide use is the legal framework. Additional demands focus on additional protection of the environment

Table 6.1 License to produce and license to deliver

	License to produce	License to deliver
Actors	Society, governments	Private enterprises, retailers
Type of Concern	Public concerns	Corporate concerns
Issues	Environment, nature and landscape, biodiversity	Consumer confidence, liability
Focused on	Abiotic quality, restricting side effects, increasing natureand landscape values	Quality assurance systems, procedures, tracking and tracing, EUREPO-GAP
Incentives	Financial support (subsidies) or Judicial enforcement (Laws, rules, regulations)	License to deliver, seldom financial bonuses
Control	Judicial, certification schemes	Audits, certification schemes, corporate enforcement

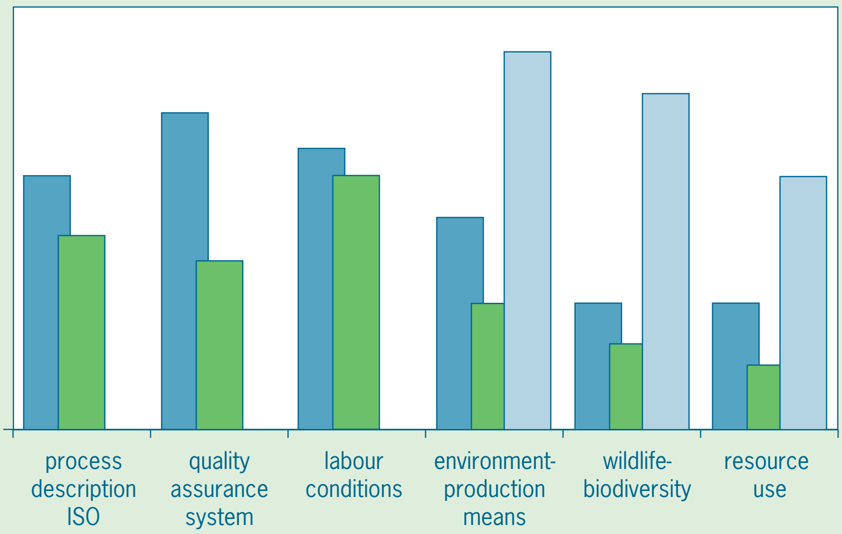

Figure 6.2 Examples of varying scope and ambition levels of various packages of demand (each colour represents a different package)

and/or the workers or beneficial organisms. In terms of agricultural practices, the schemes focus on Good Agricultural Practice or on methods beyond that. Concerning fertilisation, the additional requirements mostly focus on balances of input and output of P and K and adjusting N-fertilisation to the needs of crops and site-specific conditions. There are also many different types of certification. For example, the ISO-standards mainly indicate the necessity to document all practices and to carry out the actual documented practices. In other words, to make production processes clear and verifiable, for many customers a very handy tool. This indicates that not all certification schemes refer to changed or improved procedures in production or processing.

The monitoring and evaluation cycle

Finding ways to evaluate whether the certification schemes lead to the intended goals is the most critical problem in certification. The assumption is that the certification schemes are intended to help farmers reach certain objectives. Assuming that this is the case, the intentions and the objectives must be explicit and specified first. Then, these objectives have to be translated into guidelines and prescriptions. Especially the latter should form a certifiable set.

The problem is often that the objectives are output-oriented, referring to the status of, for example, the environmental quality. Usually, these types of parameters are not easy to access, due to the costs or the involved labour. Therefore, the regulations tend to focus on the production process and the way in which things are done, assuming that this will deliver the desired result. Specifically with the research-based concepts of integrated production (see following paragraph), the guidelines often prescribe the way to handle the production. This ensures that advanced agro-technology is used. However, in order to achieve the desired results, this is a questionable approach. It is possible to state that the methods used to achieve the objectives are not relevant, as long as they are achieved. More positively formulated, the question is whether it is wise to limit farmers in their resources to deal with the problems and the objectives.

Therefore, the first part of the certification cycle is to analyse the objectives and explicitly clarify them. The second step is to exam certifiable approaches that ensure the objectives are met as closely as possible. This is often a labour-intensive task because the existing databases and expertise must be interpreted.

The next task is to demonstrate and/or monitor in practice whether the intended (output-oriented) results have been acquired by the certification scheme and its prescriptions. This is often a weakness in the certification schemes.

It might involve measurements in practice or calculations derived from the collected data. Designing and carrying out a workable and reliable set of parameters and a monitoring system is a difficult task. The monitor (the total package of the monitoring system) should demonstrate the advantages of certified production compared to uncertified production. In addition, the monitor can pinpoint the weaknesses of the certification scheme: those aspects of the scheme that do not meet the targets. Additional adjustments of these aspects are necessary. This may require additional research to develop new techniques.

Main production directions for sustainable production, critical reflection

Three major directions in farming can be distinguished: conventional, integrated and organic. These are explained in detail below and the following questions are answered: what is their position in the development, how do they relate to these issues of certification and what is the added value to the market. Conventional is defined as world market-oriented agriculture within legal boundaries.

Organic production

Organic farming originated from the initiative of individuals or small groups to find new alternatives in agriculture. Organic farming has always been accompanied by strong philosophical visions. In spite of many differences, a broad consensus has been established concerning the intentions of organic agriculture. This is documented in the “basic standards for organic production and processing" as formulated by the "International Federation of Organic Agricultural Movements" (IFOAM Basel 2000, www.ifoam.org). The standards can be summarised as follows:

- Production systems should:
  1. deliver high quality production (quantity and quality),
  2. be compatible with and/or optimise/enhance natural biological cycles and biodiversity, maintain and increase soil fertility,
  3. support genetic diversity within the production systems and the surroundings including protection of plant and wildlife habitats,
  4. minimise use of non-renewable resources and minimise losses from the ecosystem and
  5. balance animal and plant production and respect animal species integrity.
- The organic food chain should be:
  1. free of genetic modified organisms, using renewable resources, producing fully biodegradable products and
  2. socially just and ecologically responsible.

Regarding the general intentions and objectives, the following key issues often appear in books/presentations and discussions:

- respect and responsibility for the biosphere (social and ecological impact) and
- respect for and safeguarding of the integrity of humans, plants, animals and even landscapes, environment friendly, sustainable, natural and healthy.

This describes what is called "the level of intentions in organic farming". The intentions are ambitious, however, often rather vague conceptual targets. Intentions have to be implemented and the first step is to define guidelines and global search directions. World-wide, organic farming is defined in terms of qualitative or semi-quantitative production guidelines addressing:

- the input of production means,
- management of animals and soil, the use of technology in processing and breeding (additives, GMOs) and
- general guidelines for appropriate crop rotation.

These guidelines are translated into controllable prescriptions a set of rules. The resulting certification scheme transforms organic farming into a controlled production system. The products are certified, identified by labels, controlled by certified organisations and harmonised (minimum production requirements) in the EU by the EU regulations 2092/91 and 1804/1999 for respectively plant and animal production. National certificate holders can add requirements or restrictions to the European regulations. Thereby, the requirements on organic production may vary per country (for example, pesticides). Guidelines, rules and prescriptions (the certification scheme) may be updated from time to time.

Critical reflection

Guidelines and regulations can be weak derivatives of the intentions. Moreover, they are usually focused on the "how" (input and means) and not on the "outcome". In other words, the certification scheme is input-oriented. This might be the reason that the current guidelines are, in general, not sufficient to safeguard the acquisition of the underlying intentions. Consider, for example, the "hard" environmental targets. It is absolutely not certain and documented that the current approaches can meet these targets. This is even more vague for issues such as natural, sustainable, safe and healthy because many aspects of these issues have not yet been implemented. In summary: the regulations are weakly related to the intentions because the intentions are insufficiently or not yet translated into quantifiable parameters and insufficiently implemented into guidelines and regulations. Moreover, most worrying is that the speed of development is too slow, given the ongoing developments in society and the markets (see below). It is questionable whether the organic movement is keeping up with the speed of developments in the markets. Is organic farming meeting the intentions, is it monitored?

Ongoing and shifting perspectives

Governments see farming increasingly as a social activity and farmers as managers of "public" green spaces. Mono-productive agriculture will evolve into multi-functional agriculture with production as only one (however still the most important) of the economic carriers of farm continuity. Fulfilling the requirements of governments and societies gives farmers a "license to produce". In recent years, a number of Northwest European governments embraced organic farming as the most promising production system for multi-functional agriculture: as a means to meet their targets. Moreover, issues such as sustainability and biodiversity are in the centre of the scientific debate and great efforts are being made to define these terms.
On the other hand, the markets predominantly represented by the European retailers, also increasingly demand more from farmers. For conventional farming, this was defined for the first time in the EUREP-GAP guidelines for the European retailers (www.eurep.org). It is logical that organic produce will be checked against these guidelines as well. Moreover, there are already a number of European retailers that have higher demands to organic produce than what is defined in the label requirements in the countries of origin. The "license to deliver" will only be presented when these requirements are met. Organic farming has the potential to be the pioneer, the front-runner of agriculture delivering high quality produce and services to society. To fulfil this potential in a sustainable manner, the following steps have to be taken:

1. the intentions have to be transformed in quantifiable and measurable parameters and target values,
2. translated into technical guidelines and
3. at the same time, it has to be proven that organic farming can meet the targets by using regular monitoring programmes.

Only in this way, organic farming can give the depth and content to its own intentions and survive the embrace of society. Immediate action is needed to keep the social "license to produce" and the markets "license to deliver" in the future. In fact, constant action is needed to stay ahead. Therefore, the organic farming movement should increase its sensitivity to the earlier mentioned developments, start the discussion internally and externally, and work closely together with the research community to explore new concepts.

Integrated production

Integrated production is a production method that arose from the efforts of the research community, is an addition to the legal restrictions, and requires more advanced agro-ecology in order to meet ambitious targets and to achieve more sustainable farming systems. The development of integrated production started in the sixties as a response to the biological problems caused by overuse of DDT (Rachel Carson, Silent Spring). Finding crop protection control strategies that were based on the use of different technologies and minimised chemical inputs was at the heart of this Integrated Pest Management approach. The concept expanded into the full range of crop protection and related agronomical questions. Then this transformed into the concept of Integrated farming systems when broader interests were taken into account. The International Organisation for Biological Control stimulated this by offering a platform for the development of these ideas. European co-operation in the design and development of Integrated and Organic Arable farming Systems (I/O AFS) started in the early eighties, inspired by the promising initial results of two European experimental farms in this area (Nagele, the Netherlands and Lautenbach, Germany). Research leaders from institutes in four European countries (Germany, the Netherlands, United Kingdom and France) met within the framework of an IOBC study group, convened by Vereijken (Vereijken et al, 1986). This group evolved into an IOBC working group as this type of research expanded to more countries and research teams. At annual meetings, the group exchanged experiences (Vereijken and Royle, 1989).
In the following years, it became clear that this young agronomic discipline of Farming Systems Research needed an extra impulse to substantiate the research rationale. It was necessary to assemble interested researchers and to draw upon the pioneers' experience to develop a research methodology. The opportunity to achieve this was offered by an European Concerted Acton (AIR 3 CT 920755, "Research Network for EU and Associated Countries on Integrated and Ecological Arable Farming Systems") that focused from 1993-1996 on the methodology of farming systems research (co-ordinated by Vereijken). The concerted action resulted in four progress reports and a manual, respectively dealing with designing, testing, improving and disseminating new farming systems (Vereijken, 1994, 1995, 1996, 1998, 1999). The Farming Systems Research methodology developed was called prototyping.
This farming systems research started in arable farming on experimental farms and broadened to pilot farm approaches to develop interactively integrated and organic farming systems on practical farms. The first efforts in vegetable growing originated from the beginning of the nineties (Sukkel et al., 2000), leading to an European shared cost project with teams from the Netherlands, Switzerland, Italy and Spain (VEGINECO, FAIR 3 CT 96-2056). These proceedings are part of the latter mentioned project's closing workshop.
In a number of European countries or regions, either governments, traders or retailers and farmers' organisations in changing coalitions took up this research-based concept as a useful concept for policy or label development. Retailers and farmers organisations took the concept onboard, for example, in fruit production in Southern Germany and Switzerland. For vegetables, the concept was used to develop "Integrierte production" in Switzerland or "Qualita Controlata" in Emilio Romagna, Italy. However, the number of regions and type of products is, on a European scale, very limited.

Critical reflection on current status

Integrated production is an approach that is different over Europe. There are large differences in the scope of topics involved in the recommendations or in the certification schemes. Consequently, the significance of the approaches may vary considerably. Significance refers to the scope of the objectives and the extent that these objectives are achieved. It implies that a set of objectives is specified, unfortunately. This is not often the case. There is a vague plan, however not concretised, since often the approach itself is already considered beneficial enough to a large number of issues.
In the market, there is a real danger of over-differentiation of integrated production programmes and labels. How can retailers distinguish, how can consumers be expected to make a well-motivated choice? Integrated production is not a protected trademark, which means abuse can take place.
The IOBC organisation shares these concerns. They publish guidelines for integrated production for different agricultural farming systems. These are intended to be used as a base line, a framework from where interested coalitions can refer to design an integrated production approach and corresponding certification schemes (IOBC, 1999).
However, for integrated production, more or less the same criticism is applicable as for organic production: are the targets well defined? Are certification schemes effective in meeting the targets? Are the results monitored?

EUREP-GAP

The EUro-REtailer Produce working group (EUREP) has representatives from all of the major partners in the European retail market. Inspired by existing efforts and standards all over Europe, including the examples of integrated production; they formulated EUREP-GAP 2000 as a basic standard for production and as minimum requirements to acquire the license to deliver (1997). It concerns an international commitment to GAP for fresh fruits and vegetables. The German institution, EHI, well known for the ISO-concepts, acts as the secretary' office. The intention is to commit growers more and more to the following issues:

- to maintain consumer's confidence,
- to minimise negative impact on the environment,
- to protect nature and wildlife,
- to reduce use of agro-chemicals,
- to improve efficient use of natural resources and
- to ensure responsible attitudes towards workers' health, safety, welfare and training.

The EUREP guidelines consider a wide range of issues, ranging from input-oriented regulations to farm management issues such as waste treatment and labour management. The initiative started in 1997 and the first draft guidelines were published in 2000. EUREP-GAP intends to incorporate integrated production concepts in their approach. The schemes are to be extended and sharpened over the years.

One of the problems related to EUREP-GAP is that GAP is defined separately for 62 regions in Europe. Therefore, fulfilling the GAP part of the schemes can have completely different meanings throughout Europe. Of course in some ways, this can be a reflection of the specific regional conditions. However, in a number of other aspects, it reflects different views of problems in the different regions.

Outlook: perspectives and constraints

Agriculture is in a transition process to multifunctional agriculture with farmers as the keepers of the green rural areas and delivering high quality products and services to society. They produce in a more sustainable way, safeguarding the quality of the environment while restoring and maintaining wildlife habitats and landscape. Many more aspects may be added. The requirements are high and the collective concerns at stake are important. However, all these different requirements, "demands", are leading to a jungle of "demand packages", rules, regulations and a forest of labels, brands and certified products. Still, from an agronomic point of view, two major conceptual well-developed production directions can be distinguished: integrated and organic production. The latter has the advantage of being well organised, having the same minimum label requirements throughout Europe, and delivering certified products under a label to a niche market.

Is there an added value to these two types of farming? The answer is, in spite of all the indicated shortcomings, clearly yes. It has added value concerning a large number of issues related to sustainability and the desired transition process of agriculture. This added value, however, has to be verifiable and controllable as explained above in detail.

Can this added value be cashed in on? Who are the interested parties? As far as we can see, there are two parties with major concerns in this added value being produced: the market organisations and the governments. Organic production has found a niche market with higher prices. The added value mainly comes directly from the market. Governments are subsidising the transition process to organic farming and, in many cases, they consider offering farmers additional advantages to use organic production. The legal boundaries are often a bottleneck in this respect.

Integrated production has not found a niche market yet. Until now, it seems that retailers use integrated production as a marketing concept, giving farmers the license to deliver rather then providing them with extra income. Governments are considering all types of direct and indirect (tax benefits) payments to support farmers for performing above the GAP levels. In principle, this seems possible and an appropriate way of moving agriculture in the desired direction. In practice, massive problems are encountered in legislation. However, payments have to be justified and, therefore, "certification" schemes are necessary.

Markets are going to take responsibility only for issues that are directly related to their two main concerns: their image and their potential liability. Some issues might even be too complicated, such as assuring that their suppliers' safeguard groundwater quality. Governments will always have more extensive concerns than that of the markets. The governments will have to take their responsibility for maintaining their policies. In spite of current discussions concerning how governments should withdraw from active interference and leave many issues to the so much anticipated mechanism of the free markets.

In some cases, governments and markets have matching requirements, as is the case in Switzerland. In this case, the reward comes from the government in the form of direct payments. In the Netherlands, the same type of approach is being implemented. An approach towards the certification of all farms is being developed as a basis for supporting measures and as a mean of improving the implementation of agri-environmental policies. Integrated production seems to be the "royal supplier" of the much-needed advanced agro-ecology.

In order to progress, a broad approach is needed towards agricultural production and clear and ambitious targets have to be set. The corresponding certification schemes have to be developed on a national or regional basis. Performance should be monitored. Close co-operation with the research community is needed to ensure the continuous and relevant development of agro-ecology. Farming systems research such as in this Vegineco project, however difficult as it might be, is an indispensable tool.

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7 The IOBC position with respect to integrated vegetable production

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Labels are no guarantee for high food quality
The press release on this page of the IOBC Commission on IP Guidelines and Endorsement might help to clarify the present complex and highly confusing situation on the market.
The different qualities of agricultural products put on the market can be visualised as the position of a given product in a quality pyramid (Figure 7.1).

Various rules have been established to separate bad food from food, meeting at least a minimum quality standard (usually meeting rules of Good Agricultural Practice GAP). An example is the document published recently as EUREP-GAP (www.eurep.org), which defines minimum production standards. However, it is evident that in the lowest price segments the food cannot meet the quality requirements for premium food as outlined in the IOBC press release. Cheap food is purchased on the market under lowest price conditions putting severe restrictions on the producers with respect to production costs and procedures. Internal food quality, ethical and social quality aspects are often grossly ignored in order to produce in these highly competitive conditions. The many different kinds of shortcuts taken in production and processing have resulted in regular front-page reports of food scandals.

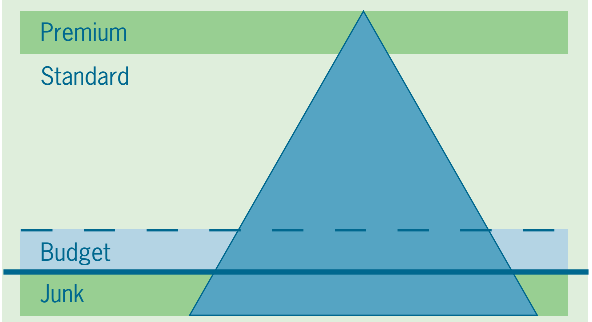

Figure 7.1 Quality pyramid of agricultural products

IOBC Commission in Integrated Production Guidelines & Endorsement
Press Release (18 April 2001)

Sustainable Agriculture today: IOBC endorsement procedure shows its teeth
IOBC (International Organisation for Biological and Integrated Control) founded in 1956 and establishing internationally accepted concepts and standards for integrated production since 1976 has once more taken the necessary steps to clarify and demonstrate its position with respect to the current situation in the food sector. Taking note of the wide-spread irritation of the consumers' community by increasing evidence and reported cases of bad quality and production procedures of our food, IOBC maintains and re-emphasises its traditional position that food has to provide more than mere good external quality and cheap price.
Whereas in most cases market takes care of the external quality of agricultural products, sustainable production systems endorsed by IOBC must consider as well 4 additional but for the consumers largely invisible quality traits of production, processing procedures and working conditions that provide the essential components of the overall quality of food and fibre:

- Internal product quality (chemical, physical, organoleptic).
- Ecological quality of production and processing.
- Ethical quality of production, processing and conduct of people involved.

Socio-economic quality of production, processing and working conditions of people involved.
Based on these considerations the "IOBC Commission of IP-Guidelines and Endorsement" has redefined on March 31, 2001 its "Admission Criteria for IP-Organisations seeking IOBC Endorsement". All relevant IOBC documents concerning Integrated Production (e.g. Concepts and General Technical Guidelines; Crop specific Guidelines for the Integrated Production of pome fruits, stone fruits, soft fruits, grapes and arable crops; most recent admission criteria) can be obtained directly on internet from the website of the IOBC Commission (www.admin.ch/sar/faw/iobc.html) or from its secretariat located at the Swiss Federal Research Station, CH-8820 Wädenswil, Switzerland (E.F. Boller).
International acceptance within and outside Europe of IOBC concepts and standards is not only documented by the recent establishment of French national IP-guidelines for viticulture according to IOBC but also by the first IOBC endorsement of an IP-grape-growers' association in North America (LIVE, Oregon, April 9, 2001. Growing interest in the modern IOBC approach also identified in Eastern Europe and in more remote geographic areas such as Latin America, Australia and New Zealand confirms that IOBC standards continue to provide important land-marks.

In the premium sector we find usually organic food that not only rests on a long tradition of high standard procedures but has also been subjected to strict regulation from governmental agencies. Thus it enjoys widespread consumer confidence and its market share is growing. The situation in other types of sustainable and ecologically sound production, such as Integrated Production, is more complex. The absence of international governmental agreement and regulation of key quality traits in this production sector to date has meant that national markets host a multitude of brands and labels that cannot be easily classified according to their intrinsic quality. The few brands whose production and processing procedures are known at all (in most cases these procedures cannot be seen from existing label descriptions and manufacturer's statements) could be positioned in any part of the quality pyramid. This situation is confusing for the discerning consumer and is also a major stumbling block for the development and commercialisation of alternatives to organic brands in the premium food sector.

In this context it is not surprising that the IOBC concept for Integrated Production with a clear hierarchy of basic objectives and principles, technical guidelines addressing aspects of organisation, inspection and key agronomic baselines, detailed crop-specific guidelines and, last but not least, international endorsement procedures for organisations operating according to IOBC standards, has found world-wide interest and acceptance. The fact that many national and regional stakeholders refer to the IOBC standards indicates the need for an international and independent reference of high scientific reputation. Even if we accept the fact that many producers' organisations seeking IOBC endorsement are strongly driven by the desire to penetrate saturated markets with high quality brands, we cannot deny that accepting the demanding admission criteria of IOBC is a big step forward in the development of high quality products in the upper segment of the quality pyramid.

IOBC's position in the vegetable sector

The participation of IOBC in this VEGINECO workshop demonstrates the great interest of our organisation in the final results, conclusions and recommendations of this international project. In 2000, the IOBC Commission received a mandate from the IOBC Executive Committee to initiate the preparation of IP guidelines for field-grown vegetables, but postponed the task, pending the outcome of the VEGINECO project. So far, IOBC has established crop-specific guidelines, has opened endorsement procedures for pome fruits, stone fruits, grapes, soft fruits and arable crops, and preparations for citrus and olives are at an advanced stage. At first sight, the obvious lagging-behind of vegetables is surprising, since the public is aware that vegetables are healthy and that vegetables have long been marketed with IP labels.

Why has IOBC delayed preparing guidelines for this important sector? The reasons are manifold: as outlined by various speakers at this workshop, vegetable production is a unique case amongst agricultural crops. I would like to go further than that by saying that in my personal

Table 7.1 The Evolution of Plant Protection Methodes (IOBC 1977, modified 1998)

1. Blind chemical control (Lutte chimique aveugle)	General, schematic and routine applications of the most potent pesticides; Advice from industry
2. Chemical control based on advice (Lutte chimique conseillée)	Application of a usually broad spectrum of pesticides after consultation with an official advisory service
3. Specific control (Lutte dirigée) *Transitory phase*	Introduction of the concept of the “economic threshold levels”; Application of pesticides with no negative side-effects; Protection of beneficial organisms
4. Integrated plant protection* (Protection intégrée) *Dynamic phase*	Similar to specific control, but also includes: • Integration of biological and biotechnical methods and methods of good agricultural practice; • Chemical control strongly regulated
5. Integrated agricultural production* (Production agricole intégrée) *Open dynamic phase, further development possible in the whole world*	Similar to integrated plant protection, but also includes Observance, integration and exploitation of all positive factors in the agro-ecosystem according to ecological principles

*) In the original table step 4 was separated clearly from step 5 by a solid line. We have replaced it by a broken line to indicate that in the modern concept integrated plant protection is removed from its isolation and put into the context of all farm operations.

assessment of the situation, vegetable growers face the accumulated problems of most other crops combined:

- they have to produce vegetables of the highest external quality, which are usually not processed but eaten fresh as fruits, leaves, stems, or roots. Damage to the crop, even when slight and cosmetic, is rarely tolerated,
- they have to produce in a highly competitive environment,
- they have invested a large amount of capital per unit area, and their success or failure depends on many critical environmental and economic factors,
- they work in annual crops with rapid turnover on the individual plots and cannot profit from ecologically important regulating factors to the same extent as growers operating in orchards, vineyards or field crops destined for industrial processing.

Given this situation, vegetable growing cannot easily satisfy all basic principles of IP as defined by IOBC. A prominent example is the aspect of plant protection. Whereas the modern concept of plant protection in the context of sustainable agriculture can be applied to most crops, in vegetable production it meets with restrictions. Examples of these include the application of the chronological sequence of indirect (= preventive) plant protection, followed by applying decision-making tools (i.e. monitoring, economic thresholds, forecasting) leading finally to direct plant protection (= control). A basic document on the evolution of plant protection, published in 1977 by IOBC, might help to clarify this point (Table 7.1).

Under most conditions, integrated vegetable production operates according to the 2nd step of evolution i.e. "chemical control based on advice". Although the scientific community has made a major effort to elaborate the essential elements of step 3, i.e. economic thresholds and protection of natural antagonists by application of selective pesticides, it is evident that the market requirement of highest external quality (and hence in practice, zero tolerance of damage from arthropod pests) does not allow these components of Integrated Plant Protection methods to be applied fully. This might also explain the certain reluctance in the vegetable trade to have international IP guidelines drawn up and applied.

This situation triggered considerable debate on whether IP in vegetable production is possible without violating the basic principles defined by IOBC. Given that for years vegetables have found their place on the market in the IP brand segments, it can be argued that an IOBC IP guideline for field-grown vegetables could and should be prepared that considers these restriction, outlines the present state of affairs and further indicates a set of recommended avenues for future improvements.

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8 Where ecology meets economics

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Rising consumer awareness

There have been several crises in European agriculture in recent years. This year, food and mouth disease has ravaged the United Kingdom. In previous years there were outbreaks of other diseases, such as BSE (mad cow disease) and swine fever. In all cases, these crises have resulted in a sharp fall in meat consumption. Crop cultivation has also had its share of problems and debate, e.g. on the dangers of GMOs (genetically modified organisms) and on levels of chemical residues in produce. All these crises have been publicly debated, making consumers more aware of the problems in food quality and how food is produced. For instance, the discussion on GMOs in the United Kingdom in the beginning of 1999 led to a ban on all genetically modified ingredients in the own-brand products of several supermarket chains and food producers.

Politicians are also taking up these problems and are trying to resolve problems by introducing regulations, e.g. on the prevention of the spread of disease and on pesticide use. And governments are formulating policy on more sustainable agriculture. In most cases, these policies are stimulating organic agriculture. The best example of politics paying more attention to organic production is from Germany, where the Renate Kunast was appointed minister of agriculture after her predecessor had to resign in the German BSE crisis. In April 2001 she set the target that by 2010 20% of German farms would be organic, and stated that "Klasse statt Masse" (product quality is more important than product quantity). She also renamed her ministry "Consumer protection, food and agriculture", placing the consumer first and relegating agriculture to third place. In other countries too, initiatives were taken to stimulate organic production more. In most EU countries, subsidies for organic farming and other forms of state support are available.

In general, interest in organic production and organic produced products is increasing, as organic production is seen as one of the ways (if not the way) to solve problems in agriculture.

Why consumers buy organic products

In spite of the developments outlined above, not all consumers are buying organic products. The consumers who do buy organic can be characterised as trendsetters who are well educated, live in urban areas and have a moderate income. They are between 20 and 50 years old and often live in families with young children.

The main reason for consumers to buy organically produced products is concern for health. A second reason is derived from the first one: the concern for food production practices (use of GMOs, pesticide residues on produce, use of hormones or fear of BSE). Other, less important reasons are environmental awareness, and flavour. Consumers are also buying more organic products because for several years these products have been more readily available and their quality and variety has improved greatly. Organic products are no longer sold exclusively in health food outlets. Supermarkets are increasingly selling organic products, as shown in the next sections.

Where organic consumers shop

In the last ten years, the organic market has grown enormously. In 2000, organic retail sales were eight times those of 1990 and more than double those of 1995 were (Table 8.1). The organic market will continue its rapid growth if the expected growth in area of organic production continues.

The original sales channels of organic products were the health stores. Farmers' markets and home delivery also had a market share. It is only relatively recently that supermarkets have started to sell organic products, and their share is growing. However, differences between countries are large, as can be seen in Figure 8.1. In the United Kingdom, two-thirds of sales are in supermarkets, compared with less than one-third in Germany. The prognosis for 2010 is that the German supermarkets will gain somewhat less than half of the market share (Schrot & Korn), with other parties losing much of their market share. Organic buyers can be divided into three groups: the first group, the "dark green organic buyers" buy most of their goods organic. The group is small but accounts for over half the sales of organic products. The second group of "mid green organic buyers" buy a small part of their goods organic. The group is larger but its market share is only a third. The third group, of "pale green organic buyers", accounts for three-quarters of the buyers but they buy only occasionally, so have only a small market share (Table 8.2).

Table 8.1 Organic retail sales in 106 US$

	1990	1995	2000
Europe	1.5	5	12
USA	1.2	4	10
World-wide	3.5	11	27

Table 8.2 Buyer groups versus market share. See text for explanation of buyer groups

	% buyers	% market share
Dark green	7	55
Mid green	18	34
Pale green	75	11

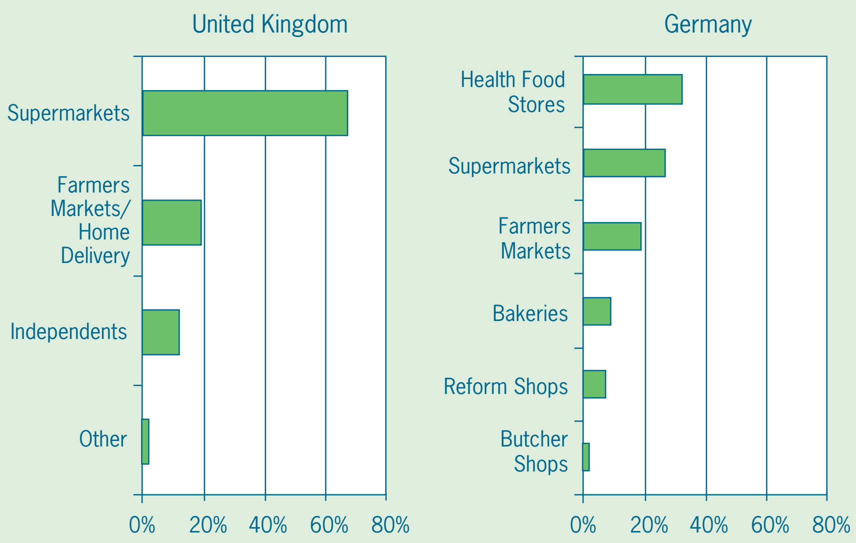

Figure 8.1 Organic products sold per sales channel in the United Kingdom (left) and Germany (right) (source FAS)

Future growth potential

In the next 10 years, biological production is expected to grow greatly – not least because of the high target of a 10-20% increase by 2010, set by politicians. This cannot be achieved by solely by political support (incentives and subsidies). More consumers need to be convinced to buy organic products. This can be achieved if the premium for such products is lower than the premium for conventional products. When the prices of organic and non-organic are comparable, almost everyone will buy organic products. When prices are double those for conventional products, only 6.5% of consumers will buy organic. For organic production to achieve a share of at least 10% of the total agricultural sales, the premium for organic products should be no more than 40 - 50%. For organic production to achieve at least 20%, the premium should be no more than 30% (Source Dr U. Hamm).
The threats and opportunities other than price development are indicated in Table 8.3.

Research

Research is needed in organic agriculture in order to ensure a good quality product. This research should be done from a holistic perspective and not be focused solely on narrowly defined problems. For instance, research should not focus on finding a pesticide for a certain disease, but instead should first analyse how and why this disease occurs. Only then should the best solution to combat the disease be looked for. This entails more than looking at pesticides: seed quality, crop rotation, fertilisation and cultivation measures can all play a role. Organic agriculture functions in a very complex system. To define the production problems and achieve proper solutions, the entire system needs to be analysed.

Standards

To gain and keep consumer confidence, farmers and other parties should use the organic standards and regulations honestly. If farmers repeatedly flout the regulations or push them to their limits, these standards and regulations will lose their strength. There need to be regular checks and controls. Failure to do this properly will lead to scandals being exposed by the media and will undermine consumer confidence in organic production.

Markets

Control is not reserved for control organisations only. Market parties can also play a role in the control of producers. Such control can be achieved almost automatically by ensuring there are close contacts throughout the production chain: between producers and traders, among traders, and between traders and consumers. Close contacts clearly have more advantages than control. Ultimately, they can lead to supply chain management: the co-operation in the production chain that serves the consumer optimally and reduces total costs as much as possible. A far-reaching example is given in the next section.

"Nature & More" quality protocol

The "Nature & More" quality protocol is a supply chain management system being developed for organic production, to ensure the quality of products. The mission of the protocol is to "Engage all parties involved in the supply chain in a dialogue around organic farming quality, social values and food quality. This is done by supporting organic

Table 8.3 Threats and opportunities in organic production

	Threats	Opportunities
Research & Development	Reductionism	Holism
Standards	Dilution	Integrity
Markets	Anonymity	Supply Chain Management

research and development; encouraging highest standards and providing transparency throughout food supply chain."
In addition to common rules and regulations, extra requirements have been set up on the following themes:

1. Farming quality: in addition to EU regulation 2092/91, extra conditions have been set for soil management (use of compost), crop management and biodiversity and landscape.
2. Social conditions: extra requirements have been set for individual working conditions, corporate development and societal contexts. These regulations augment regulations of the ILO (International Labour Organisation) and SA 8000 (certification for social accountability of companies for aspects such as child labour, working conditions, discrimination and free association).
3. Product quality: in addition to common commercial standards, extra requirements have been set for product quality, on the absence of residues, physiological compounds, sensoric compounds (flavour) and on vitality.

Producers do not have to fulfil all requirements, but they are assigned a score for every theme. These scores are printed on the product packaging. This gives consumers a quick overview of the conditions under which the product was produced. Consumers can get more detailed information from the code printed on the product packaging, by looking up the code details on the "Nature & More" internet site (www.natureandmore.com). An example of the information on the product package is given in Figure 8.2.

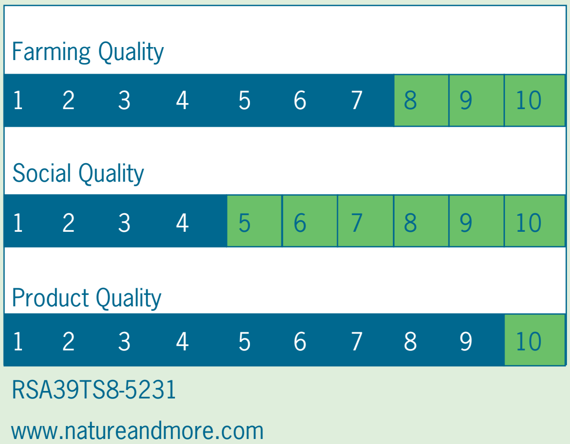

Figure 8.2 Product information on the organic product package with information on the quality of the production conditions

9 Implementation of integrated production, a case study from Switzerland

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Introduction
Although part of Europe, Switzerland is not part of the European Union. Therefore, the agricultural policy in Switzerland has developed separate from the Common Agricultural policy of the EU. This makes this Swiss agricultural policy an interesting case to study. An important element of the Swiss agricultural policy is the recognition that agriculture provides common services that should be rewarded. A system of direct payments has been developed to remunerate farmers for these public services.

Use of agricultural land in Switzerland
The total area of agricultural land in Switzerland is farmed by around 73 000 enterprises (Table 9.1).

Table 9.1 Agricultural land in Switzerland (1999)

Agricultural land in hectares	1999
Arable land	293 949
Sown pasture	115 933
Natural meadows and pastureland (excluding summer grazing)	626 799
Vineyards	12 921
Orchards	7 786
Other areas	14 511
Total	**1 071 899**

Around 2 300 enterprises occupy an area of approximately 11 000 hectares and grow over 100 different varieties of vegetables.

The development of the direct payments system
The Swiss system of direct payments was introduced in two stages. The first stage of the agricultural reform was implemented between 1993 and 1998 and focused on separating price policy from income policy. During this period, agricultural incomes fell by around 25% owing to lower prices. Approximately 14% was compensated for by improving direct payments.
In a referendum held in 1995 the Swiss electorate rejected the inclusion of a new article on agriculture in the constitution. One of the main reasons for this rejection was that the proposed new article did not stipulate that proof of the use of ecological production methods would be a prerequisite for receiving direct payments.
In 1996 a revised version of the article, this time stipulating that ecological proof must be forthcoming for direct payments to be awarded, was put before the voters and was accepted. Based on this constitutional article, new agricultural legislation was drawn up in 1998. The statutory orders issuing from this new law came into force in 1999. This marked the start of the second stage of the agricultural reform. The main thrust of this stage is the abolition of all price and outlet guarantees. The remaining system of state support for the market is less interventionist and is to be reduced by one-third within five years. At the same time, an ecological minimum standard (EMS) is required for all direct payments.

Today the direct payments serve principally to remunerate farmers for common services they provide, such as maintaining the natural heritage and looking after the countryside. Direct ecological payments form a major part of what is paid out and provide farmers with a strong incentive to use environmentally friendly cultivation methods, such as organic production or particularly animal-friendly livestock management systems.

Aims of the direct payments system
Direct payments are a crucial element in the new approach of agrarian policy. They allow price and income policy to be separated and, on the other hand, for farmers to be remunerated for common services expected by the population as a whole. A distinction is made between general payments and direct ecological payments (Figure 9.1).

From Federal Constitution Art. 104
1. The Confederation shall ensure that agriculture contributes substantially by way of a sustainable and market-oriented production:
   a. to the secure approvisionment of the population;
   b. to the conservation of national resources and the upkeep of rural scenery;
   c. to a decentralised inhabitation of the country
3. It shall conceive the measures in such a way that agriculture may fulfil its multiple functions. Its powers and tasks shall include the following in particular:
   a. It shall complement agricultural revenues by direct payments, to secure a fair and adequate remuneration for the services rendered, provided that compliance with ecological requirements is proven.
   b. It shall promote, by way of economic incentives, forms of production which are particularly close to nature and friendly to the environment and animals.

Remuneration for common services provided
The common services provided by farmers are remunerated through general direct payments. These include payments based on the size of the farm and those for animals that are fed raw fodder. The aim of these payments is to ensure that the entire cultivable area in

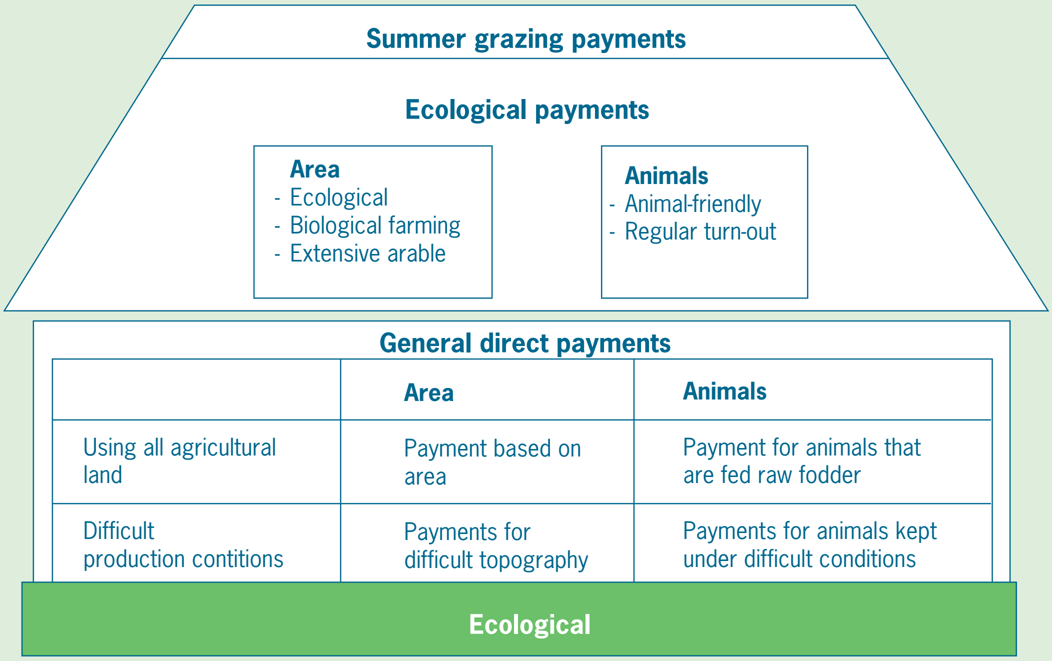

Figure 9.1 The aim of the direct payments system

Switzerland is indeed used for agriculture and maintained in a good state. In hilly and mountain zones farmers receive supplementary payments for difficult topography as well as for keeping animals under difficult conditions. This principle is intended to take into account the additional problems faced by farms in this type of terrain.

Payments for particular ecological services
Direct ecological payments are intended to give farmers the incentive to employ particular ecological production methods, which go beyond the ecological minimum standard. These include payments for maintaining the ecological balance, for extensive product of cereals and rape and for organic farming methods, as well as for animal-friendly methods of keeping farm livestock. These payments are aimed at maintaining and increasing biodiversity in agricultural areas, reducing excessive nitrate and phosphorus levels in the water and the amount of chemicals used, and improving the standard of livestock management.

Ecological proof
Since 1999 direct payments have been made only to farmers who provide proof that they are using ecological production methods. Any farmer who applies for direct payments must prove to the cantonal authorities that his entire enterprise meets the ecological requirements.
A certificate issued by an organisation approved by the cantonal authorities is sufficient proof. Ecological proof includes the following points:

Animal-friendly management of farm animals
The stipulations of the statutory order on animal protection must be respected. The onus of proof lies with the farmer, i.e. he must be able to show that the animal protection laws are respected on his farm.

Balanced use of fertilisers
In order to reduce the loss of nutrients to the environment and to achieve nutrient cycles that are as tight as possible, the amount of nitrogen and phosphorus used must be calculated according to the needs of the plants grown and the level of potential production. In this way excessive use of fertilisers can be avoided. A tolerance limit of 10% is applied.
Soil analyses from alternating sections of the farm must be carried out at least every ten years in order to determine the nutrient reserves in the soil and to adjust the amount of fertiliser used to ensure that the soil remains fertile.

Appropriate proportion of ecological compensation areas
At least 3.5% of special crops and 7% of the remaining productive area should be reserved for ecological compensation areas. Strips of at least 0.5 m must be left uncultivated along paths, rivers, hedges and wooded areas on riverbanks, as well as around ponds, coppices and forests.

Regular crop rotation
In order to maintain the fertility of the soil and good quality plants a crop rotation system must include at least four crops every year. In addition, on farms, which have over 3 hectares of open arable land, the law stipulates a maximum proportion of main crops on the arable land or

compulsory intervals in cultivation. The following regulations apply specifically to the production of vegetables:

- In the open, an interval of at least 24 months must be allowed for between two main crops of the same family. Main crops are defined as crops which remain in the soil for more than 12 weeks or several quick-growing crops of the same family planted in the same year. Winter spinach, winter lamb's lettuce and winter radicchio are not considered main crops.
- A crop rotation system must cover a period of at least 3 years.

Suitable soil protection
A soil protection index is laid down for each crop. In order to reduce soil erosion, depletion of nutrients and deposits of chemicals in the soil, each farm with over 3 hectares of arable land must achieve a minimum mean level of soil protection. In the case of arable farming, this level constitutes 50 points, for market gardening 30 points. Samples are taken every year on 15 November and 15 February (Table 9.2).

Table 9.2 Soil Protection Index

Winter crops	Points	
Winter cabbage varieties, Brussel sprouts	80	
Strawberries (annual)	60	
Winter spinach	60	
Leeks, Swiss chard	60	
Black salsify, parsnips	40	
Summer crops	**Points**	**Points**
Plants which cover the soil until	15th November	15th February
Intact root system of vegetables harvested	10	30
Revitalising plough-in crop sown before 31.8	80	100

Selection and targeted use of chemicals on plants
The aim here is to achieve high-quality production with the minimum use of pesticides. The following regulations apply

- Power take-off or self-driving equipment for plant protection must be tested at least every four years.
- Plants should be treated according to recognised guidelines for reducing negative impact on the environment. These guidelines are based on the principle of an economic damage threshold and give preference to organic or biotechnical methods of production.

Every year the federal research laboratories publish the Vegetable Handbook, which contains a list of the chemicals whose use is permitted for vegetable production and the areas in which they may be applied. The Handbook also provides information about the environmental impact of chemicals used, as well as damage thresholds.
The allocation of private labels is based on ecological proof. In some cases, the labels go beyond the requirements of federal laws on the use of fertilisers and plant protection. Today, market demand is almost exclusively for vegetables with an ecological label.

Funding the direct payments system
The Swiss parliament has approved funds for direct payments for the period 2000-2003 (Table 9.3).
The amounts approved for 2001 are presented in Table 9.4.

Table 9.3 Funds for direct payments (2000-2003) in million €

Payments for size of farm	3150
Payments for animals that are fed raw fodder	666
Payments for difficult topography	292
Payments for keeping animals under difficult conditions	696
Ecological payments	1000
Compensation aimed at preventing erosion and depletion of nutrients through water	150
Payments for summer grazing	234
Total (2000 – 2003)	**6188**

Table 9.4 Direct payments approved for 2001

	€ / hectare
Payments for size of farm	780
Supplement for arable land and perennial crops	260
Extensively used meadows: arable zone	937
Fallow land sown with rich mixture of nutrient plants (valley zone only)	1953
Organic production: special crops	651
Arable land	390
Green areas	65

Implementation and control
Responsibility for controlling the implementation of the direct payments system has been delegated to the cantonal authorities, which may use the services of external organisations, which can ensure that checks are carried out professionally and independently. The work of such organisations also has to be randomly checked from time to time. The controls carried out concern:

- all farms applying for direct payments for the first time,
- all farms which did not meet the requirements when checked the previous year and
- at least 30% of the remaining farms, chosen at random.

In 1999 around 30 000 farms, including 4 500 that use organic production methods, were checked by the cantonal authorities, or by organisations called in by them, to ensure that they met the ecological requirements.

Evaluation of agrarian policy
The developments, which have resulted from agrarian reforms, are continually evaluated. The following goals should be achieved by 2005:

General goal
95% of all farms fulfil the conditions of Integrated Production (ecological minimum requirements).

Specific goals (examples)
The progress made in ecological farming habits has been considerable. In 1999, around 95% of the agricultural land

Table 9.5 Examples of specific goals

Areas	Environmental goals	Agronomic goals
Biodiversity	No further reduction in biodiversity	At least 10% of agricultural land is to be reserved for use as ecological compensation areas
Nitrogen	Lower nitrogen content in the groundwater (- 5 mg l^{-1})	33% reduction of the N surplus
Phosphorus	50% reduction of P in lakes from agriculture	50% reduction of the P surplus

in Switzerland was used in line with ecological minimum standards (including organic production). It is estimated that in 2001 approximately 9% of the agricultural land in Switzerland will be used for organic production (Table 9.6).

- Around 9% of the land is reserved for ecological compensation areas.
- According to the N balance, the excess of N fell by 14% between 1990 and 1992. The N balance is the difference between the total amount of N applied to the soil (mineral fertilisers, waste fertilisers, manure, biological N fixation and deposits of airborne N) and the amount of N taken up from the soil through arable and fodder crops such as grass, hay and cereals.
- As far as the P balance is concerned, agriculture in Switzerland is considered as if it were one farm. Sources of additional P include imported fodder, mineral and waste fertilisers, imported seeds and deposits of airborne P. P is taken up in the form of nutrients for plants and animals and other products supplied by the farming industry. Between 1990 and 1992 excess P fell from almost 20 000 tonnes to around 9 500 tonnes. This can be explained by the drop in the use of P, mainly thanks to the reduced application of mineral fertilisers and the fact that less fodder was imported. At the same time, the amount of P taken up rose slightly.

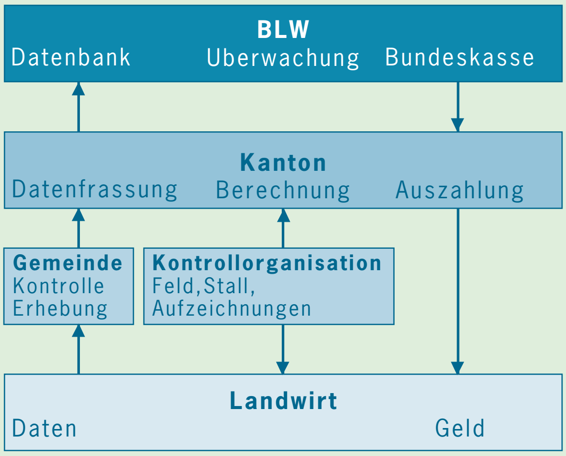

Figure 9.2 Responsibility for implementing the direct payments system

Between 1990 and 1998 the amount of chemicals used on plants fell by around 31%, from 2 300 tonnes to 1 600 tonnes of active substances. Over the same period, the total amount of the two most frequently used groups of products – fungicides and herbicides – showed a reduction of 25%. The most dramatic drop was seen in the use of growth regulators, which fell by 77%.

Table 9.6 Percentage of agricultural land used according to IP, ecological or biological (= organic) norms

	1993	1994	1995	1996	1997	1998	1999
IP/eco (excl. bio)	17.6	29.8	38.1	66.7	80.8	85.4	87.3
Bio (excl. eco)	1.9	2.1	3.0	5.6	6.9	7.4	7.6
Traditional methods	80.6	68.1	59.0	27.7	12.3	7.2	5.1

10 The stimulation of sustainable agriculture in Emilia-Romagna, Italy

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Abstract
In the 1970s the Emilia-Romagna Region in Italy started promoting sustainable agriculture by means of regional initiatives and the large-scale application of structural and rural development policies, most of which accompanied certain measures. Commercial promotion initiatives were developed by the introduction of an integrated label ("Qualita Controlata"). A further opportunity to accelerate the sustainable agriculture policy already promoted during the previous 10-15 years, especially in very intensive areas, by means of both integrated and biological production, was the application of Regulation (EU) 2078/92. The great majority of these initiatives have now been re-proposed in the Regional Rural Development Plan 2000-2006 approved according to Regulation (EU) 1257/99.

The agriculture of Emilia-Romagna
The Emilia-Romagna Region in Italy is one of the most important agricultural areas in Europe. It has 148 000 farms, of which about 70 000 have an economic dimension > 6 UED (i.e. Standard Gross Margin of € 5 000 per year). The Gross Output is about M€ 4 000 per year, split equally between crops and livestock farming. The total agro-industrial sector produces a Gross Output of M€ 10 500 per year and a Value Added of M€ 2 300, which is more than 1/6 of the total national agro-industrial production.
The total area under agriculture is about 1 250 000 ha. The most important crops are fruit (100 000 ha), grapes for wine (70 000 ha) and vegetables for both the fresh market and industrial processing (57 300 ha). Important arable crops are cereals, sugar beet and fodder crops - especially alfalfa. Agricultural development of the most valuable crops (fruit/vegetables and grapes) has followed an intensive model based on the small to medium-sized family farm. Arable crops are concentrated mainly on medium to large farms. The most important crop and livestock production is concentrated in flat or hilly areas renowned for viticulture and dairy farming.
In addition to the general economic crisis in agriculture due to over-production (especially for milk, grains and fruits), the most important structural problems remain the small average size of farms - only partially solved by producer organisations - and the farmers' age (65% of farmer are older than 54).
Intensive agriculture contributes to the environmental pollution of the Po river plain with nitrates (surface and groundwater) and pesticides (mainly in groundwater and sometimes in the form of residues on products). The less favourable areas for agriculture are concentrated in the mountains and in the humid lowland area in the Northwestern plain: these areas have been progressively abandoned during the last 40 years. This phenomenon has made hydraulic and soil management difficult and has aggravated the cumulative social problems for the remaining rural population.

The regional initiatives to promote sustainable agriculture
In order to apply the methods of integrated pest management and integrated production, the regional Government promoted several years of experimentation and organised a specific Regional Advisory Service for the adoption of integrated production methods. About 200 technicians employed by associations of producers assist the farms involved in the scheme. RER ("Regione Emilia Romagna") provides about 50% of the funds (in the early years it provided 80%). The EU funded training and some of the activities of the first years. The technicians are responsible for the application of regional guidelines for integrated production in the assisted farms, and for running training activities aimed to make the farms as self-sufficient as possible in integrated production (pest management, fertilisation, irrigation and the other main agronomic techniques).
Co-ordination, communication and training of advisors is organised by a special group of 12 technicians.
Communication activities involve weekly information bulletins, which are recorded on telephone answering machines and disseminated via local TV, newspaper and Internet.
The farms are visited once a week or more, depending on their degree of autonomy. All data on the methods applied are recorded. The methods applied to a sample (5%) of pilot farms, and the results, are recorded and processed by means of an information system. The same system distributes meteorological and weather forecasting data collected and processed by the Regional Meteorological Service (40 automatic stations).
Scientific support is provided by regional bodies (Regional Plant Protection Service, Regional Meteorological Service, etc.) and university and ministry institutes. The representatives of these bodies, and also of producers' organisations, decide on the Regional Integrated Production Guidelines. The regional agricultural development service is responsible for the scientific and technical co-ordination of the service as a whole.
A quality trademark has been introduced to promote the produce of farms practising integrated production. It is "QC" ("Qualità controllata", which means "checked quality"), and is available for producers' associations or single farms that agree to apply the official regional IP guidelines (also for post-harvest, storage, handling, quality standards, etc.) and to fulfil specific obligations, controls and sanctions. During 2000 a large proportion of the total regional integrated fruit production was commercialised under this label or under the Great Distribution Organisations (GDO) label connected with IP principles.

During the 1990s, organic agriculture was also promoted by the same advisory services and by specific research and development programmes.

Integrated production guidelines

The techniques applied have been defined following the principles of integrated production (IP) (IOBC, 1999)[1]. The structure of these guidelines include the following aspects: choice of planting site, cropping system, sowing/rotation, soil management, fertilisation, plant protection and weed control, ecological infrastructure, irrigation and harvest. To qualify for the regional QC label, the specific IP guidelines also include food chain aspects such as post-harvest treatments, storage/conservation, selection, quality index, packaging, commercialisation and own and external control procedures.

Integrated plant protection and weed control requires that treatments are demonstrated to be justifiable. The justification may based on sampling for pests (economic thresholds are then applied), or on the prevalence of climatic conditions favourable for diseases (forecasting models are used, if possible). Timing of treatments is also based on forecasting models, if available. Biological and biotechnological methods are generally advised. The only pesticides permitted are those, whose active ingredients are on the permitted list: these active ingredients normally permit the optimal application of integrated control. In certain emergencies, the use of partially selective active ingredients is also permitted. Mechanical control is generally advised for controlling weeds. The use of glyphosate (and also of gluphosinate-ammonium and gluphosinate-trimesio) is permitted as a basic product.

Concerning fertilisation, a standardised soil analysis is required every 5 years, in order to apply a balanced fertilisation programme calculated according to technical guidelines. These technical guidelines are revised annually on the basis of experimental results. This programme relates the soil fertility to crop quality, pest management and environmental protection. Both organic and synthetic fertilisers are permitted. Where available, maps of soil fertility are used instead of soil analysis.

A maximum has been set for the input of nutrients given in one application. Normally if more than 60 kg ha^{-1} is needed, nitrogen fertilisers have to be split into two or more applications in order to increase the nitrogen use efficiency (NUE) and reduce leaching. It is forbidden to apply mineral nitrogen in periods when plant uptake is very low or on very wet soils.

As far as the other agronomic techniques are concerned (i.e. rotation, irrigation, cultivar choice, planting system), a list of requirements is given, to avoid environmental risks and promote the use of improved integrated methods.

Guidelines for organic production

To obtain direct help from Regulation (EU) 2078/92 the farms have to fully respect Regulation (EU) 2092/91 and its updates, and adopt ecological infrastructure measures (hedges, woody elements etc.) on a minimum of 5% of the area in flat areas, 10% in hilly areas and 15% in mountain areas. In the case of a farm being converted from integrated to organic, a 5-year period is permitted.

Agro-environmental measures under Regulation (EU) 2078/92

Under Regulation (EU) 2078/92, several measures to protect the environment and to maintain the countryside based on activities of the advisory service have been activated, with contracts of 5 or 20 years involving direct payment to farmers. The areas for application of these measures were defined as flat, hilly or mountainous. Another zoning, in this case transverse, is into ordinary and preferential areas. The preferential areas were defined as more sensitive environmental areas (e.g. protection of rivers, lakes and channels, risk to potable groundwater, parks and surrounding areas). In these areas, the support has normally been 20% higher compared to ordinary areas. Table 10.1 lists the actions proposed and applied. Table 10.2 indicates the total financial support distributed. The areas involved are 59% of the flat areas (43% preferential and 16% ordinary), 20% of the hilly areas (15% ordinary

Table 10.1 Agro-environmental actions of the regional agro-environmental programme under Regulation (EU) 2078/92

Actions related to agronomic techniques and production	
A1	Integrated agriculture
A2	Organic agriculture
B2	Permanent herbaceous crops in flat and hilly areas
B3	Permanent green cover and low input techniques in fruit orchards and vineyards in hilly and mountainous areas
D4	Cover crops
Actions related to environmental techniques	
D1	Re-naturalisation or maintenance of natural agro-ecosystem elements and of landscape
D5	Local animal species at risk of dying out
E1	Management of extensive mountain pastures
E2	Care of abandoned copses in hilly and mountain areas
F1	Creation of environment for survival and reproduction of fauna and flora
F2	Creation of natural and semi-natural environments with ecological and landscape purposes
F3	Creation of environment for water system protection
G1	Creation of paths in parks and nature reserves
G2	Creation of infrastructure for public access to cultural and recreational activities in the natural surroundings of historical and architectural sites.

[1] *The text of the regional IP guidelines is available at http://www.regione.emilia-romagna.it/agricoltura/disciplinari/index.htm*

and 5% preferential) and 21% of the mountainous areas (18% ordinary and 3% preferential). Figure 10.1 illustrates how the areas are distributed between the actions applied, and shows the importance of the application of integrated and organic production systems.

In total, about 12 000 farms have been involved, with a total area of 165 000 ha (13.2% of the total regional agriculture area) and 10 500 head of livestock (cattle and pigs).
During the first years of application, the integrated agriculture action (A1) was applied on a small scale. This direct contribution to the farmers made them more responsible compared to the "assisted" previous condition. After this first period, growth increased appreciably (Figure 10.2).

Most of this area is in preferential areas, contributing importantly to environmental protection. The results in terms of reduction of pesticide and fertiliser use have been very good. Input has been reduced by between 25 and 50% and the remaining input has used products and techniques with less impact on people and the environment.
It is important to underline that the majority of the crops involved were intensive (e.g. fruit, vineyard, sugar beet). In some cases - e.g. fruit orchards - the increase was more than 25%. Mainly because of the rotation problem and, more in general, of the very high degree of agrochemical input, the vegetable crops were less involved. An exception is tomato for industrial processing (in this case, strongly positively correlated with the market demand for the IP product).

Figure 10.3 shows the trend in the area under organic agriculture. In this case, the absolute result is important, but there has been a shift toward extensive crops (e.g. fodder) and/or marginal areas. Involvement of vegetable crops has been negligible.

In both cases (A1 and A2 actions) any higher production costs were covered by the financial support (from € 110 to € 900 ha-1 year-1

Table 10.2 Support from Regulation (EU) 2078/92 during 93/94 – 97/98

Year	Support (M€)	%
1993/94	1.8	2
1994/95	11.0	9
1995/96	20.0	17
1996/97	27.0	23
1997/98	56.1	48
Total	**115.9**	**100**

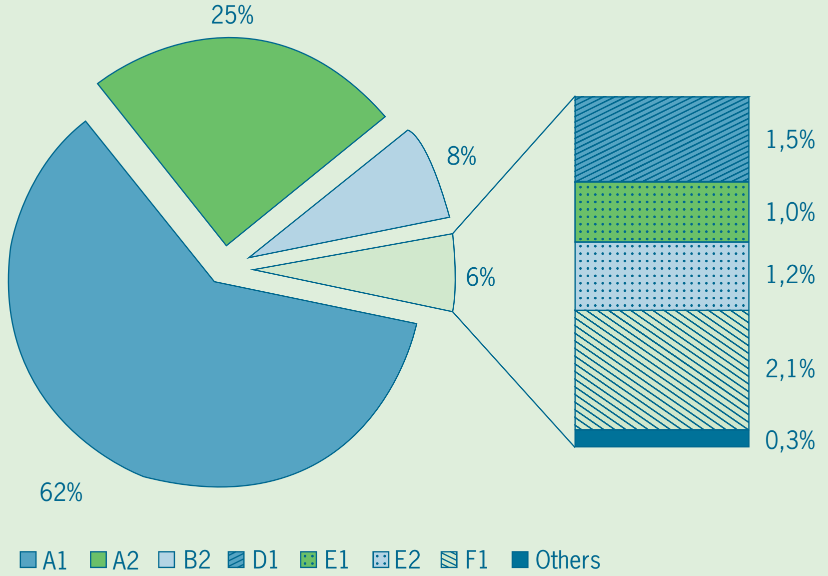

Figure 10.1 Pie chart of area subjected to actions in 1997/98

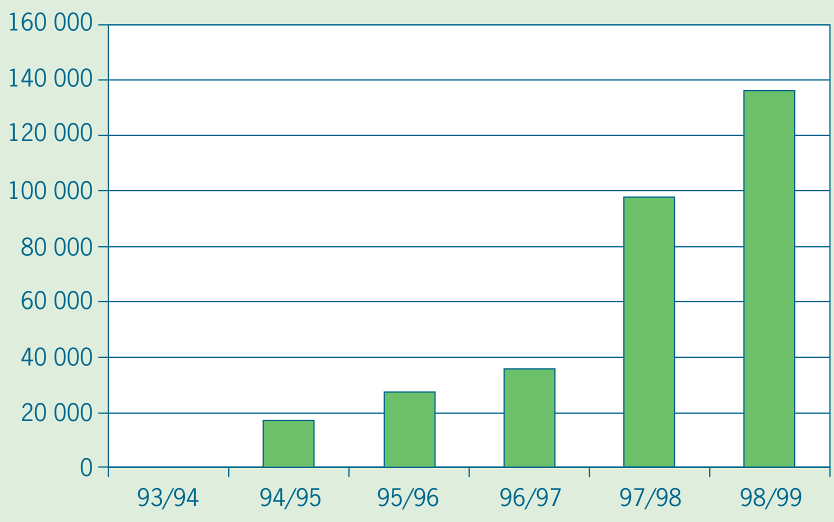

Figure 10.2 Area involved in A1 action period 93/94 – 98/99 in ha (integrated agriculture)

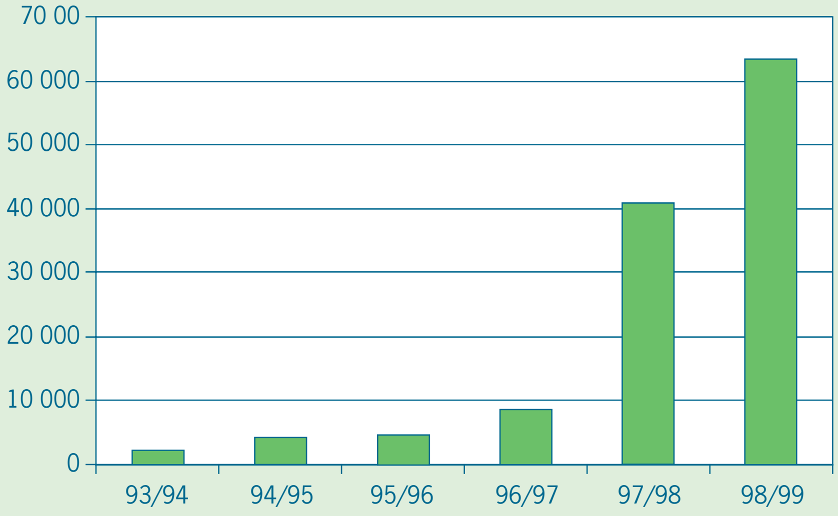

Figure 10.3 Area involved in A2 action period 93/94 – 98/99 in ha (organic agriculture)

It is important to note that the entire initiative has had a very important and positive impact on both a technical and a cultural level. For the first time since the beginning of "green revolution" the farmers have been recognised (and paid) as environmental tutors instead of polluters.
The great majority of these initiatives have now been re-proposed in the Regional Rural Development Plan 2000-2006 approved under Regulation EU 1257/99.

Conclusion and prospects

The Emilia-Romagna experience in the stimulation of IP and OP has demonstrated that in the medium to long term, the cost of direct support is very high. This cost is probably sustainable only for a conversion period for both IP and OP. In the case of OP, the market price for certain crops will probably not be sufficient to cover the production costs.
For both IP and OP it is strategically important to offer the possibility of support from the extension service Regulation EU 2200 = CMO fruit & vegetables). Together with the agro-environmental measures mentioned above, both systems should offer good prospects in terms of demand and price, due to the special demand from supermarkets after the recent food scandals (e.g. dioxin, BSE). A further opportunity in this direction could also come from a European endorsement for IP production, as was the case for organic production after 1992. Several initiatives (e.g. IOBC, Eurofru, EUREP) testify to this interest.

depending on crops and areas).
The most important results for the commercial promotion initiatives of IP production are the possibility of commercialisation into a protected "niche" with price and demand guaranteed (GDOs) and, in certain cases (e.g. strawberries), a 5-15% higher price.
On the other hand, the prices for organic produce are significantly higher for intensive crops and the lower yields are balanced by subsidies for extensive crops.
A further advantage for farms involved in these agro-environmental measures is the priority in ranking for investment in agricultural holdings for rural development actions.
D1 "Re-naturalisation or maintenance of natural agro-ecosystem elements and of landscape" was the most important of the environmental techniques D, E, F and G, which involved 51% of the resources for these actions. The D1 action was a mandatory complement of the organic agriculture measure (A2). In 1998 approximately 2400 ha of natural agro-ecosystem elements were involved in this measure.

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11 The view of the European Environmental Bureau on sustainable farming systems

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Introduction

The EEB is a European umbrella organisation of some 140 environmental organisations in all EU member states. One of its 8 permanent working groups focuses on agriculture policies. Mr Kuneman, employed at the Netherlands Society for Nature and Environment (Stichting Natuur en Milieu) chairs the Agriculture Working Group. The EEB will in the coming years focus mainly on the mid-term review of the EU agriculture policy in 2003, and the reform after that. The EEB co-operates closely with various other organisations on agriculture.

Objectives

The EEB wants to make agriculture sustainable. This means reducing its environmental impact such that there is no further decline of biodiversity, whilst maintaining viable rural communities. In practice this means, among others, reducing use of pesticides and loss of nutrients, closing mineral cycles and maintaining natural and landscape elements. The EEB favours organic agriculture as the most environmentally benign method of production.

Ways to get there

The best way to reach these objectives is to internalise externalities, i.e. to ensure that environmental pollution is included entirely in the end-price of produce, but also to fairly reward external benefits of farming like attractive landscapes. Steps towards this long-term aim are legislation (e.g. N-Directive) and levies on damaging impacts (e.g. leaching of nitrates) or on potentially damaging inputs (N-fertilisers). On the positive side, the EEB aims to green EU CAP subsidies, i.e. set environmental conditions to income support and gradually shift all support to payments for landscape and nature management. Farmers can be further helped by tax breaks and information. Consumers can be stimulated buying the right products via price incentives (e.g. differentiated VAT rates) and information (e.g. labelling, information campaigns).

In the short term (2003), the most important steps which can and must be made in EU agriculture policy are compulsory environmental conditions to all direct payments, earmarking of a larger share of EU subsidies for rural development and agri-environment measures.
The mid-term CAP review in 2003 should furthermore set the stage for fundamental reform in 2006. To that aim, a broad policy debate on that reform should be started now, involving all stakeholders. This debate should result in a reform-plan for 2006 and the years beyond.

Good agricultural practice

A crucial element in future EU agriculture policy is the definition of good agricultural practice (GAP). Currently GAP, defined on member state level, is the minimum level of performance, which a farmer must apply in order to receive agri-environment payments. In future GAP should become the benchmark for receiving any EU farm-subsidies. In that future situation, GAP should be more sharply defined. The definition is set at regional or national level. However, an EU-level framework for GAP is required to ensure environmental progress and a level playing field.

Thus, EU-policy will produce a generic EU-level benchmark, to be used in policy (threshold for subsidies). The same benchmark might also be used for certification in the processing and retail chain, or even as a consumer label. The possibilities for this depend on accuracy, transparency, and whether GAP can be translated into something understandable to the general public.

EEB position on GAP and labelling

The EEB thinks integrated crop/pest management should become the standard for conventional farming, i.e. integrated should soon be conventional. With the right information supplied to farmers, most if not all should be able to work according to ICM/IPM. If the bulk of the farmers apply IPM, this will provide large steps forward in reducing pesticide use and nutrient loss. Therefore, GAP should be set at this level. Integrated production must, however (1) be better internationally defined, (2) be set at acceptable levels of environmental performance and (3) be better monitored and enforced.

The EEB is very reluctant to introduce a “green” consumer label in addition to the organic label, as it is likely to confuse consumers and dilute the acclaim for organic. If, as the EEB hopes, conventional farming becomes equal to integrated farming, there is no need for such a label. In the transitional period towards that aim, the EEB does support introducing a label at this level for the processing and marketing chain.

12 Integrated Crop Management and the Common Agricultural Policy

B. Berger
DG ENV of the European Commission

This statement reflects the view of the author only and not necessarily the opinion of the European Commission or its services.

I am very interested in „Integrated Crop Management" and welcome that a project on that issue has been carried out under a FAIR contract, funded by the European Community.

On Community level, only one farming system has been defined by legislation, which is organic farming. In addition, the Rural Development Legislation, based on Council Regulations (EU) 1257/1999 and (EU) 1750/1999, define Good Farming Practice "…as the standard of farming which a reasonable farmer would follow in a region". "In any case, these standards shall entail compliance with general mandatory environmental requirements." In addition to these standards, Community legislation provides for some quality and designation aspects, such as the Regulation on Geographic Indication and Designation of Origin (EU) 2081/92, and for Protection of Traditional Speciality (EU) 2082/91. However, there is no harmonisation on Community level for Integrated Crop Management, although Integrated Crop Management is common in many Member States and also supported by Community funding via agri-environmental measures of the Rural Development Plans.

I consider it very interesting to see research studies on the environmental impact of Integrated Crop Management. Clear, scientifically proven benefits of this production system for the environment could feed into reflections on the review and reform of the Common Agricultural Policy in various ways. Divers questions will arise in this context and I am very happy to have the opportunity to discuss all these issues with you and profit from your expertise in the area of Integrated Crop Management.

Part 3, Poster abstracts

13 BIOM, a pilot farm network of organic farms in the Netherlands

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Keywords: pilot farms, prototyping

Introduction
Farming systems research into organic farming goes in the Netherlands back to the early eighties when the Development Farming Systems (DFS) project in Nagele was started. This was the national focal point for development and comparison of conventional, integrated and organic farming systems. The work extended over the last 20 years to a national network of experimental farms where 'prototype" systems of organic arable and outdoor horticulture systems are currently being developed. The methodical way to design, test, improve and disseminate region specific, more sustainable farming systems is called prototyping and was elaborated in an EU concerted action (see Vereijken, 1998). It can be characterised as a synthetic research/development effort. It starts off with a profile of demands (objectives) in agronomic, environmental and economic terms for a more sustainable, future-oriented farming and ends with tested, ready for use prototypes, to be disseminated on a large scale (Wijnands, 1998). Recently the work on experimental farms found it's logical progression in a national pilot farm network directed on Innovation and Conversion to Organic Farming (BIOM).

BIOM project
Objective of BIOM project (1998-2002) is to innovate and optimise organic farming in practice and to stimulate and facilitate the conversion to organic farming. BIOM works on four different levels: firstly a limited number of existing organic farms (25) are functioning as innovative pilot farms in close co-operation of farmers, extension service and research. Secondly, around 70 farms are guided in optimisation groups. Thirdly the in conversion interested farmers are technically prepared in 5 day courses. Finally, market- and farm economic perspective studies will contribute to overcome the existing lack of reliable economic information. Organic farms in the Netherlands grow arable crops in combination with vegetables. BIOM farms in grow over 80 different crops.
Based on an analysis of the current shortcomings in the practice of organic farming (BIOM farms) the needed innovation in organic farming is described in the following themes: Quality production (improve and stabilise production quantity and quality), Clean environment (nutrient losses, pesticide use), Attractive landscape and diversified nature (ecological infrastructure), Sustainable management of resources (soil fertility, energy, non renewable resources) and Farm continuity (income, labour input and organisation). These themes are the focal points and red thread in and throughout the project. In accordance with the prototyping methodology, the themes are quantified in a set of parameters with target values. The yearly improvement of the systems is then based on the yearly analysis of the shortfall between actual result and target result in terms of the methods used on the farm. Results are discussed with farmers, both on an individual basis and in their study groups. In this dialogue, we try to connect the more quantitative project approach with the experience of the farmers. Innovation is a difficult process of designing, testing and improving. In BIOM we try to go this road together with the farmers in a step by step approach.
A substantial effort is made in BIOM to communicate the results and experiences to different target groups (conventional farmers, policy and research). By the connection of the research team to the prototyping work on experimental farms, the research challenges are directly translated to and integrated in the research layout. By the close co-operation of research, extension and practice in BIOM, knowledge, expertise and innovations flows more easily between the groups. Moreover, a sharp and clear picture is emerging of the threats and opportunities for organic farming. Opportunities are used and threats counteracted and solved. BIOM therefore constitutes a national framework for a targeted development of organic farming.

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14 Prototyping on farm nature management

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Summary
Farmers in the Netherlands are increasingly involved in protection and development of nature on their farms. To support their efforts, specific nature plans for their farms are being developed. Unfortunately, most plans are developed within the borders of the farm only and do not consider the regional context. In this paper, a methodology is presented which makes it possible to analyse and evaluate the achievements of on farm nature management. The methodology provides tools for optimising on farm nature management with respect to the landscape, development policies and farm specific possibilities.

Key words: buffer zones, biodiversity, biotope, circuitry, connectivity, prototyping

Introduction
Over the last decades both quantity and quality of nature have dramatically decreased in The Netherlands. The landscape characteristics are becoming increasingly similar and the biodiversity is still decreasing (Maas, 1997). Intensification of agriculture and increasing urbanisation have resulted in the removal of natural elements from the landscape and a decrease in the quality of the remaining landscape elements. To improve the functioning of existing nature core areas, the Dutch Government has launched a national Nature Policy Plan (LNV, 1989). An important aspect of this plan is the establishment of an ecological network by formation of new corridors and nature development areas connecting the existing nature areas.
Farmers can play an important role in connecting nature core areas, enhancing the quality of the landscape and providing recreational possibilities. These activities may provide the farmers with a broader economic basis in the future than production of food alone. At present, most plans for the optimisation of natural elements on farms are developed within the borders of these farms and focus mainly on protection of natural elements. In fulfilling the demands of society, plans have to be developed for on farm nature management in which the regional context of the farm and the development policies for that specific area are taken into account. Ideally, these plans must evaluate the present situation, describe the desired situation and indicate the measures needed to realise this. To optimise on farm nature management, the prototyping methodology may be used (Vereijken 1997, Wijnands 1999). Prototyping is a methodology to design, test, improve and implement new farming systems. This paper explores the possibilities for using the method of prototyping in optimising on farm nature management.

Material and methods
The methodology of prototyping on farm nature management involves three steps:
1) analysis and diagnosis, 2) design and 3) testing and improving. These steps will be elucidated in the following sections.

Analysis and diagnosis
Regional landscape and policy
In The Netherlands, 17 million people live and work on a relative small area and consequently pressure on the available land is high. The main claims for land use are for housing, industry, transport, nature, recreation and food production. In order to harmonise this, rural development plans are designed for almost all areas on provincial and community levels. A thorough knowledge of these plans is necessary for determining development routes for individual farms.
Besides that, a thorough analysis of the existing landscape in which the farm functions is necessary. Existing biotopes (size, frequency, distribution, connectivity etc.) and present land use are described.
From these two types of analysis a target vision for the regional nature and landscape can be deduced.

Agro-ecological lay-out and management
A general picture of the agro-ecological layout of the farm

Table 14.1 Objectives and themes of research in relation to parameters

Objectives	Theme	Parameters
Nature and Landscape	Functioning of landscape Increasing potential biodiversity Agro-ecological lay-out	Percentage of woody elements Connectivity Circuitry Representative biotopes Maximum field width Buffering of landscape elements
Environment	Clean environment Preventing disturbance	
Welfare	Attractive landscape Recreation	Not yet developed

Table 14.2 Parameters and target values	
Nature and landscape	
PWE Percentage of Woody Elements	Percentage at farm level (scale 1:5000) = percentage at landscape level (scale 1:25000). At landscape level the presence of larger woody elements in 250/250 meter squares is scored, at farm level the presence of individual trees in 50/50 meter squares is scored. For the landscape level, maps around 1970 are used. If rural development plans for the area differ from the actual landscape, target values may be adjusted.
CoLE Connectivity Landscape Elements	Connectivity of landscape elements surrounding and on the farm > 30%.
CiLE Circuitry Landscape Elements	Circuitry of landscape elements surrounding and on the farm > 50%.
BTP Biotopes	50% of existing biotopes in the 6.25 km^2 surrounding of the farm must be present on the farm.
Environment	
BZI Buffer Zone Index	Length of buffer zones per length of ditches, watercourses or woody elements between 1 and 2. For elements at the border of the farm the index is 1, for internal elements the index is 2.
BZW Buffer Zone Width	The average width of the buffer zones = 4 m. For the calculation of this parameter buffer zones wider than 4 m are fixed at 4 m.
Agro-ecological layout	
EII Ecological Infrastructure Index	Percentage of the farm which is managed as a network of linear- and non linear biotopes for flora and fauna including buffer strips > 5%.
FSI Field Size Index	Width of the fields < 125 m. FSI =(Al * (Wl-125)/At) with Al the area of the farm with fields wider than 125 m, Wl the average width of that part of the farm and At the total area of the farm. Every 25 units corresponds with a 10% shortfall.
BTS Biotope Target Species	Number of target species present in a biotope. For each biotope 20 target species are chosen. These 20 species can be divided into 4 groups corresponding to a specific stage in the succession of the vegetation.

and the imposed management has to be constructed. Therefore, a spatial image of the farm and its close surroundings has to be drawn, indicating the production fields, the buildings, roads and the different landscape elements. This delivers information on the diversity and frequency of the different biotopes, the length of transition zones, the level of buffering of landscape elements, the connectivity of the ecological infrastructure etc. To complete the picture, the imposed management is described which enables the qualitative judgement on the chances of success for biotope-specific vegetation development. The complete overview of the existing agro-ecological layout is the basis for the next step in prototyping: the design.

Design

The design phase consists out of the following steps: 1) determine objectives; 2) to develop a suitable set of parameters and their target values; 3) development of methods to reach the target values; and 4) development of a theoretical prototype. This paper describes the first two steps in this process.

Objectives

The design phase starts with the elaboration of objectives for on-farm nature management (Table 14.1). The general objectives were derived from the functionality of nature and landscape both from an ecological, environmental and societal point of view. The specific objectives then detail these general aspects in more casual and operational criteria. These general and specific criteria have to be matched with a farm specific situation, e.g. adaptation to the specific position of an individual farm in the regional context and networks.

Parameters and target values

The specific objectives have to be translated into a suitable set of parameters to quantify them. The quantified objectives are used as the desired results for the evaluation of on farm nature management. In Table 14.2, parameters and their target values are presented which are used to evaluate on farm nature management. In evaluating the results of on farm nature management, emphasis is on the difference between the achieved results and the desired results (shortfall). The shortfalls for the different parameters are the basis for the design of the new prototype. A new prototype aims at fulfilling all target values.
The parameters proposed for linking the farm to the landscape (PWE, CoLE, CiLE and BTP, see Table 14.2) have recently been developed and have yet to prove their suitability in different landscapes. PWE was developed to provide a guideline as to how much woody elements on a farm reflect the landscape the farm is situated in. The same holds for BTP. CoLE and CiLE were derived from landscape ecology where connectivity and circuitry are used to describe the functioning of networks (Forman & Godron, 1986). In this methodology, they are used to involve farms in realising corridors and so connecting nature areas. The introduction of specific stepping stones on the farm may improve the connectivity and circuitry of existing networks. Moreover, when new landscape elements are introduced on a farm, the positioning has to be evaluated regarding the connectivity and circuitry in relation to existing networks.
BZI and BZW are based on pesticide drift reduction studies, which show that with 4 meter wide zones drift can be reduced to zero.
EII is the only parameter which is also used in the original prototyping methodology (Vereijken, 1997). FSI was developed to express what the possibility for stabilising the agro-ecosystem of the specific farm is. Expert judgement indicates that the optimal field size for predators to reach the centre of the field is 125 meter (Booij; pers. comm.)
For all parameters (except BTS), it is hypothesised that when the target values have been achieved, preconditions are present for a certain basic level of quality of the (agricultural) landscape. What the ultimate quality will be, depends largely on the management of the different elements. This can be evaluated with the BTS parameter. This parameter has so far only been developed for the management of dyke grassland vegetation (Sprangers & Arp, 1999). Similar methods for other biotopes are now being developed.

Testing and improving

In order to optimise and evaluate the methodology it has to be tested in different situations. Whether the proposed set of parameters is the proper set is subject to testing and improving. The relative value of the parameter is tested, e.g. how sensitive, how descriptive, how indicative is the parameter? What is the similarity with visual assessments? All the parameters as a whole should reflect the desired target image and objectives. The parameters PWE, CoLE, CiLE. BTP and BTS will have different target values in different regions and their validity has to be tested and improved in different landscapes and with different development policies. Therefore, testing and improving of the methodology has to be carried out with groups of pilot farms in different regions. For this purpose farmers have to be found who are interested in on farm nature management, who consider it important to develop this aspect for the continuation of their farm and who are able to communicate their experiences to other farmers.

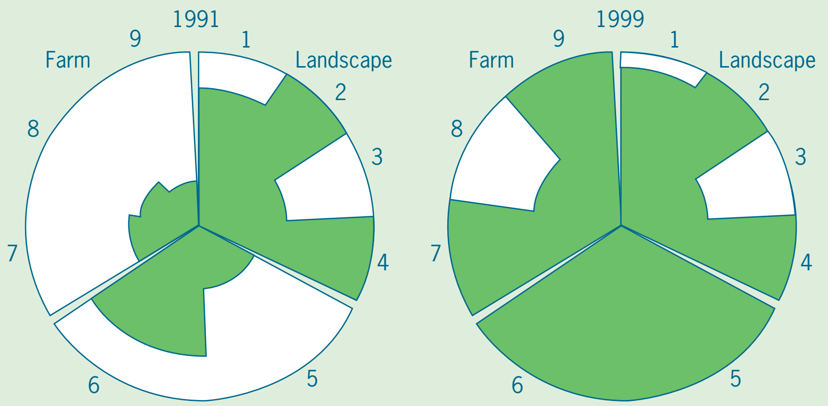

Fig. 14.1 Results of prototyping on farm nature management for an experimental farm in The Netherlands in 1991 and 1999. The outer sides of the circle represent the specific target values for each parameter. When a segment is filled the target value is reached. 1 PWE, 2 CoLE, 3 CiLE, 4 BTP. 5 BZI, 6 BZW, 7 EII, 8 FSI, 9 BTS. For explanation of the abbreviations used, see Table 14.2.

Results

To illustrate the methodology, the results of the prototyping methodology for one of our experimental farms are shown in Figure 14.1. In 1991 shortfalls were observed for all parameters except for CoLE and BTP. Through the continued process of testing and improving, in 1999 six target values were reached. For PWE, CiLE and FSI shortfalls were present. In the process the following actions were taken: 1) all ditches and woody elements were buffered with 4.5 m wide buffer zones; 2) ditch sides and buffer zones were cut twice a year and the hay was removed; 3) small bushes of Salix spp. were planted every 100 meter along the ditches; 4) through the arable fields grass strips were realised; and 5) new hedges were planted with native species.

Discussion

Prototyping on farm nature management provides a tool to analyse and evaluate the achievements of nature management on a farm. The data presented in Figure 14.1 show that with a relative small set of parameters insight can be gained in the main shortfalls of a farm with respect to nature and landscape, the environment and the agro-ecological layout. This provides the farmer or researcher with clues how to improve the functioning and the quality of the nature on the farm and the surrounding area. It is important to emphasise that the methodology presented evaluates whether the conditions are present for a basic level of quality of the (agricultural) landscape. The achieved quality depends largely on the management of the different elements.

Parameters for the evaluation of the latter will be developed in analogy with the BTS parameter (Table 13.2). The prototyping methodology for on farm nature management is still in an experimental phase and has to be improved in co-operation with pilot farms in different regions. For this purpose, we have recently started a project in which the methodology will be tested on 25 pilot farms in five different regions in The Netherlands. This project will be supported by our research on our experimental farms where we test and improve farming systems and where we focus on the relationship between functional biodiversity and stability of agro-ecosystems.

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15 The consumers faithfulness and competence in regard to organic products[1]

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Introduction
In this research work, we have examined the relation between the consumption of organic produce and consumer's competence on what organic agriculture and products stands for. At present, we notice an increased consumption of organic products in traditional groceries, constituted by the "new consumers". The "ancient consumers" often do their shopping in specialised (organic) shops.

Problem
The question is whether the consumer, in particular the "new consumers", upon which the growth in the market is based, will become "faithful consumers" of organic products, and what this is depending on.
We hypothesise that for the further development of the organic market, it is required that the "new consumers" not only become "faithful", but also competent on what organic agriculture stands for. If not so, the market will be fragile.

Method
The method chosen is based on the assumption that comparing two different situations results in a better understanding of each individual situation. Therefore, we have carried out 106 interviews (46 in France and 60 in Norway) with consumers, doing their shopping in traditional and specialised (organic) grocery shops.

Variables and their definitions
1. Degree of faithfulness: Percentage of organic consumption and duration of that behaviour.
2. Competence: Degree of knowledge about objectives, rules and regulations in organic agriculture.
3. Reason of product choice.
4. Culture: Impact of institutional factors (national culture, traditions and practices) on defining the national organic agriculture practice and consumers behaviour.
5. The social-demographic and economic impact on consumption behaviour.

Results
1. In France we found a trend with a larger degree of "ancient faithful" consumers of organic products than in Norway. We found also in both countries an increase of "new consumers" coming to traditional groceries buying organic products.
2. The most surprising result was that in France several "faithful consumers" had little competence in what organic agriculture stands for. In Norway, the situation seems to be rather the opposite. All the "ancient faithful" were competent and so were also a great number

Table 15.1 Marketing strategies to the different types of consumers

"Type of consumer"	Type of marketing	Solution
1. "New Norwegians non faithful"	Apprenticeship	Information by the media about the world economy and the ecology
2. "New French (buyer of organic meat)"	Apprenticeship	Information by the media, farmers and the specialised (organic) grocery shops about organic agriculture
3. "New Norwegians (not satisfied with today's offer)" 4. "New French (all organic products)" 5. "Ancient Norwegians (not satisfied with today's offer)"	Traditional	Improvement of the promotion, reduce prices, improve the quality of the products and brands
6. "Ancient French vegetarian (crisis-based)"	Apprenticeship	Information in specialised (organic) groceries about organic agriculture and the reason behind the crisis
7. "Ancient French (all products)" 8. "Ancient French vegetarian (health-based)"	Apprenticeship	Information in specialised (organic) groceries shops about organic agriculture

[1] *Original title: Fidélité et compétence des consommateurs vis à vis des produits biologiques – Une comparaison France – Norvège (Sogn, Persillet et Sylvander, in press). Publication is done in end of summer 2001.*

of the “non faithful consumers”.

3. In both countries, the major reason for product choice was the assumed health effect of organic produce[2].
4. In general French consumers seems to be more remote from the agricultural daily life than the Norwegian consumers. This might be related to the relatively short industrial history in Norway compared to France and that Norway until rather recently was a rural society.
5. Our final conclusion is that different “types” of consumers require different types of marketing strategies represented in Table 15.1.

Further research

Study the phenomenon of the marketing of apprenticeship in the two countries. We hypothesise that this type of marketing rather than the traditional marketing, might constitute new competencies among consumers based on what organic agriculture stands for. The traditional marketing focuses only to answer the preferences already exiting among consumers, which for example even might be based on incorrect knowledge about organic agriculture.

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[2] *This was when the consumers had to choose one alternative of several*

16 Switzerland as a partner in the EU project VEGINECO

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Introduction

What does VEGINECO mean?
VEGINECO is a four-year EU project supporting the development of sustainable farming systems for field grown vegetables. The participating countries are The Netherlands, Italy, Spain and Switzerland (Baumann et al., 1997).

The VEGINECO concept
Integrated and organic farming systems are described by means of standardised parameters (e.g., quality and quantity of produce, pesticide use, nutrient balances) from the following agricultural topics (Wijnands and Sukkel, 2000):

- production,
- soil fertility,
- environment,
- landscape.

National targets are assigned to the parameters and the realisation is monitored. If the objectives are missed, possible explanations are discussed and (at experimental farms) the cropping strategy is adapted correspondingly.

The Swiss approach
Integrated and organic farming are already well established in Switzerland. In 1999, 95.3% of the agricultural area was cultivated ecologically sound according to the Swiss regulation "Ökologischer Leistungsnachweis" including 7.3% of organic farming (Anonymous, 2000). Thus, the data for the VEGINECO project could be gathered at commercial pilot farms instead of experimental farms. 7 organic and 7 integrated farms took part in the project. Furthermore, farmers were asked about the technical problems in Swiss vegetable production (Figure 16.1; Kesper and Imhof, 1998). Integrated farmers were most concerned about pest control and organic farmers about weed control. Based on the details of this survey, separate research projects with orientation towards the special need of the Swiss farmers were initiated. Results of this work will be presented on further posters.

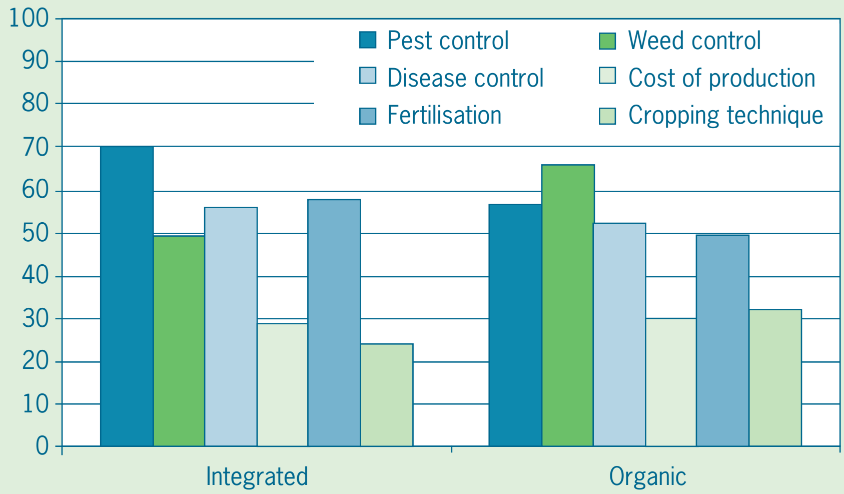

Figure 16.1 Assessment of six agricultural problem areas by the farmers of the 14 VEGINECO pilot farms (7 integrated and 7 organic farms). The individual scores (%) represent the importance of the subjects.

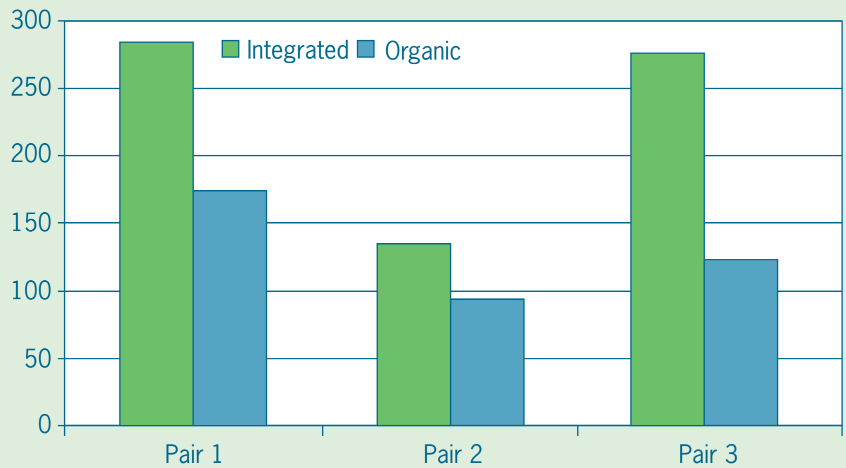

Figure 16.2 Nitrogen requirements (kg ha^{-1}) of selected vegetable farms in 1999

Characterisation of Swiss vegetable farms

Vegetable production in Switzerland is very heterogeneous and small-structured which often makes it difficult to compare individual farms. In order to show the differences and problems in integrated and organic production of field grown vegetables, three integrated and three organic farms were selected from the 14 VEGINECO pilot farms and combined in pairs. The first pair consisted of neighbouring farms from the canton Zurich which delivered their produce mainly to wholesale distributors (Migros, Coop), the second pair were French Swiss direct sellers and the third pair was made up of farms from the Seeland region with main delivery to wholesalers. Farms with integrated production had a larger nitrogen requirement than their organically producing partner farms (Figure 16.2). This is a typical result for the more intensive production at integrated farms. The direct sellers (pair 2) produced less intensive and had the lowest nitrogen requirement among the three pairs.

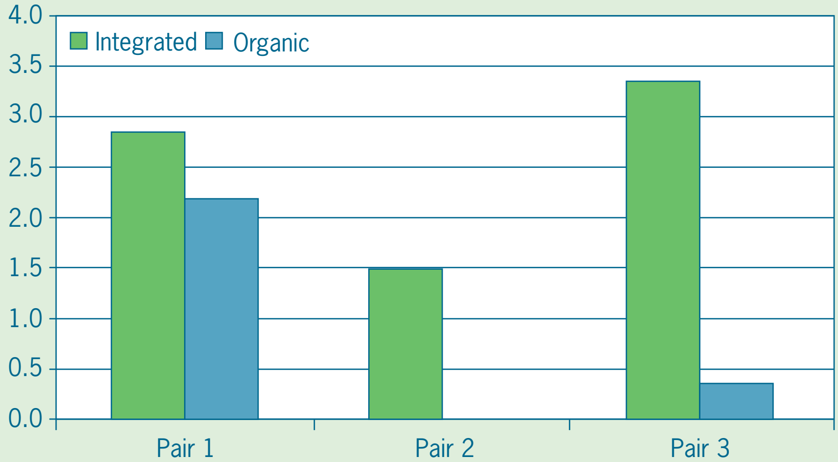

Figure 16.3 Intensity of pesticide usage in head lettuce crops 1998-2000 (average number of treatments per crop)

A similar situation was found regarding the use of pesticides. Head lettuce crops were more often treated at integrated farms than at organic farms (Figure 16.3). Direct sellers (pair 2) used less or no pesticides at all, which can be explained by reduced quality standards and, in this case, a lower pest and disease pressure.

In the final EU report, the VEGINECO parameters - grouped in the topics production, environment, soil fertility and landscape - are compared with their target values (EU FAIR 3CT96-2056). The realisation of the objectives is shown graphically for each selected vegetable farm by means of subdivided circles (Figure 16.4). Problem areas can be identified in this way and individual farms as well as the situation in the VEGINECO partner countries can be compared.

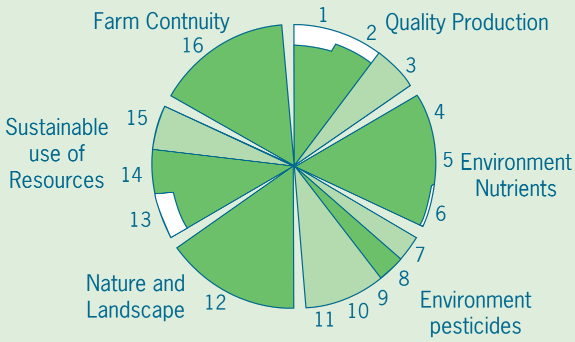

Figure 16.4 Realisation of the targets for the VEGINECO parameters 1-16 at a vegetable farm (example for demonstration purposes). The larger the dark green area of a segment, the better the realisation of the specific target value (light green area: parameter not tested).

Ecological compensation in Switzerland Inquiry and evaluation at Swiss pilot farms

Legislation in Switzerland

- Ecological compensation: the Swiss government supports farming systems, which comply with ecological requirements with direct payments.
- At least 3.5-7% of the farm surface has to be reserved for nature (3.5% for vegetable crops and 7% for arable crops).
- 17 types of ecological compensation have been described, e.g. extensive meadow or hedgerows.

Situation at Swiss pilot farms

- The percentage of ecological compensatory areas at integrated vegetable farms was 6-7%, which corresponded nearly to the average at Swiss farms (8-9%). Whereas the percentage at organic vegetable farms was much higher and came to 16-17%.
- The main type on the Swiss pilot farms was extensive meadow (Figure 16.5).

Evaluation of ecological compensation
Evaluation of extensive meadow at selected plots of 9 pilot farms

- Method:
  Key „Ökologische Qualität - Naturnahe Lebensräume selber einschätzen“ (Charollais et al. 1997), developed in Switzerland.
- Result:
  Most of the extensive meadows offered good conditions for flora and fauna, they can be optimised by adjusted cultivation.
  Biodiversity reached a medium-high value.

Evaluation of two pilot farms
with adjacent and non-adjacent fields

- Method:
  Key of VEGINECO, still testing (VEGINECO 2001),

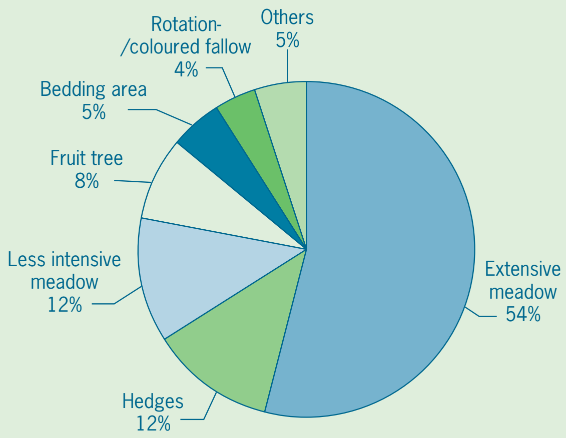

Figure 16.5 Distribution of the types of ecological compensation at Swiss pilot farms

developed in the Netherlands.

- Result:
  The farm with adjacent fields offered a good ecological infrastructure, field size and network of biotopes could be improved.
  The farm with non-adjacent fields offered a good ecological infrastructure as well. The parameter network of biotopes could not be evaluated because of the non-adjacent fields.

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17 Soil arthropod diversity in relation to weed diversity in agro-ecosystems

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Key words: Maize, olive-groves, Shannon index, soil arthropods, vineyards, weeds

Summary

Intensive agricultural production created undesirable environmental and social side-effects (Kromp and Steinberger, 1992). This study was conducted to investigate the possible effects of different farming systems (conventional and organic) on weed and soil arthropod diversity.

Soil arthropods and weed species were studied in agroecosystems located in northern Greece which consisted of: a) two organic and two conventional vineyards (vine-*Vitis vinifera* L.), b) two organic and two conventional olive-groves (olive tree-*Olea europaea* L.), and c) one organic maize field and one conventional maize field (maize-*Zea mays* L.). For weed sampling, each field was divided into five equal rectangles and one sample was obtained from each rectangle using a 30 x 30-cm quadrant in October 1999. Soil arthropods were sampled during the entire month of October 1999 with pitfall traps (Southwood, 1978). For both, weeds and soil arthropods, Shannon's diversity index H = - piln(pi) was calculated (Krebs, 1978).

Eighteen weed species (*Alyssum saxatile* L., *Amaranthus blitoides* S. Watson, *Amaranthus retroflexus* L., *Chenopodium album* L., *Cichorium intybus* L., *Convolvulus arvensis* L., *Cynodon dactylon* (L.) Pers., Cyperus rotundus L., *Echinochloa crus-gali* (L.) P. Beauv., *Medicago sativa* L., *Paspalum distichum* L., *Portulaca oleracea* L., *Settaria viridis* (L.) Beauv., *Sinapis arvensis* L., *Solanum nigrum* L., *Sorghum halepense* L., *Tribolus terrestis* L. and *Vicia* spp.) and 21 soil arthropod orders (3 Arachnidia, 2 Chilopoda, 2 Diplopoda, 1 Isopoda and 13 Insecta) were found in the studied fields. The highest number of soil arthropod orders (21) was recorded in the organic olive-groves while the lowest number (12) in the conventional maize. Soil arthropod orders found in the studied agroecosystems were similar to those found in most of the disturbed maquis and phrygana ecosystems of the Greek islands (Magioris, 1991; Marmari, 1991). Generally, soil arthropod taxa recorded in the conventional fields were similar to the numbers found in degraded natural ecosystems.

In conventional vineyards and in conventional and organic maize, weed diversity index had the lowest values. The highest diversity indices for soil arthropods were found in the organic vineyards and the lowest in conventional maize. Generally, a positive trend between diversity indices for weeds and soil arthropods was found. With respect to the relationship between plant and arthropod diversity Di Castri and Vitali-Di Castri (1981) and Brown and Southwood (1987) reported that vegetation cover and litter quality are the most important factors affecting soil arthropod diversity.

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18 Organic horticulture in Finland - problems and possibilities

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The growth of organic horticulture in Finland has been rapid, especially after joining the European Union in 1995. This increase cannot be considered to have been achieved by subsidising the farms. The main reason for the increase in vegetable and soft fruit production has been due to a rise in consumer demand.

Puutarhaliitto ry, The Central Organisation for Finnish Horticulture, prepared a developing strategy for the Finnish organic horticulture for the years 1999-2006. The problems and possibilities of organic horticulture were evaluated in this strategy.

Statistics: production area, subsidies and prices
The area of organic vegetables was 434 ha in 2000 (est.). This presents 5.2% of the whole vegetable area in Finland. The production area of berries was even higher, 664 ha. The subsidy for organic production in Finland was € 147 per ha during the conversion period and € 103 after that. The farm average price for organic vegetables has been 1.4-2 times higher than in conventional production.

Table 18.1 The most important vegetables

Vegetable	Organic area in 2000, ha	% of the whole production area
Onion	128	15
Carrot	80	5
Garden pea	55	2
Swede	21	6
White cabbage	20	3

Possibilities
- Geographical position North of the 60th latitude with cold winters helps to prevent many pest and disease outbreaks.
- Population density of 17 persons km^{-2} makes it easy to find suitable production areas for organic vegetables.
- Growing domestic markets. During the main yield season, imports to Finland from other production areas are relatively low while domestic products are available.

Main problems in production
Two types of farm
1. Vegetable farms already in organic production with an average vegetable production area of 2.0 ha $farm^{-1}$. Total farm size 27.7 ha.
   - Relatively high costs from manual weeding.
   - In small areas it is difficult to invest in machinery.
   - Problems with pest management, especially cabbage and carrot.
   - Lack of longer production chains.
2. Conventional vegetable farms with an average vegetable production area of 7.5 ha $farm^{-1}$. Total farm size 22.2 ha.
   - Transition period demands too high:
     - crop rotation requires more land,
     - disease and pest problems prevent converting into organic production,
     - no suitable marketing channels for organic products.
   - Lack of good production models:
     - specialised advisory services are hard to reach, partly due to long distances,
     - farmers' attitude that organic production is only meant for small scale farms; there are not enough large scale model farms,
     - larger contract processors are not ready to handle organic products,
     - farmers are content with conventional farming, as long as they are able to manage it; the subsidy for organic farming is not tempting enough,
     - there are still a lot of unanswered questions, e.g. the list of allowed plant protection substrates in the production of organic farming.

Challenges for organic vegetable production
1. How to get conventional vegetable growers interested in organic production?
2. To develop advisory services for special plant growers.
3. To continue the farm research projects to get practical information on the fertilising and plant protection questions.
4. To prepare to use of organic seeds before the year 2004.
5. To maintain the quality and safety of the products, when the production area increases.
6. To develop contract production of organic vegetables for the processing industry.

19 PCBT starts experimental farm for organic farming

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Introduction

As in other European countries, organic farming is encouraged strongly in Belgium. The government, the market and society are asking for more organic production. However, farmers have many questions. Many of them are related to cultivation practices and farm-management in organic farming.

In Belgium, up to now there was only little structural research to answer these questions. With the financial support of the province of West-Flanders, PCBT (Interprovincial Research Centre for Organic Farming) could start in April 2001 with the conversion of an experimental farm to organic farming.

Presentation of the farm

- Located in the West of Belgium, near the coast and the French frontier.
- Located beside the POVLT (Provincial Research and Advisory Centre for Agriculture and Horticulture), so that a good equipped research-accommodation is available.
- 10 ha, all around the farm, divided over 3 parcels.
- Soil sand-loam.
- Till now, the farm was a conventional, mixed farm. with a little cattle, arable crops and vegetables.
- In conversion since 1 April 2001.

Objectives

2001 is the starting year and the first year of conversion. Research is mainly focussed on mechanical weed control. The intention is to focus on the development of a sustainable organic farming system, as it is designed by Pieter Vereyken (PAV, NL, 1994-1998) and elaborated by Frank Wijnands (PPO, NL)

Rotation : vegetables, arable crops, green-manures.

- Nature elements will be developed (moist pasture in a lower corner of the field, hedges and tree rows of regional origin such as pollard-willow).
- Technical items (variety-choice, fertilisation, cultivation practices) have to be treated to answer the lacks in the farming system and practice.
- Corresponding to the local conditions and opportunities and in concert with the local (organic) farmers. Collaboration and exchange of information between the experimental pilotfarm and practice have to guarantee the development of organic agriculture towards more sustainable agriculture.

20 Comparison integrated and organic strawberry production

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In the Southeast region of the Netherlands, several types of experimental vegetable farming systems are tested. The next table shows and compares the first year cultivation results of strawberries in two different systems.

System	Organic, Fresh market vegetable system	Integrated Specialised strawberry farming system
Location	Meterik, sandy soil	Meterik, sandy soil
Rotation	1. Leek 2. Green beans – tagetes 3. Strawberry 4. Triticale + clover 5. Lettuce – Chinese cabbage 6. Chinese cabbage lettuce	1. strawberry early + catch crop 2. cereal or other rest crop 3. strawberry plant production 4. catch crop + strawberry late 5. cereal or other rest crop 6. strawberry summer + catch crop
Variety Plant date	Elsanta 14-8-00	Elsanta 14-4-01
Fertilisation	Green manure (tagetes) Liquid cow manure (spring) 20 ton N 90 kg ha^{-1}, P_2O_5 18 kg ha^{-1}, K_2O 112 kg ha^{-1}	Fertirrigation N 50 kg ha^{-1}, K_2O 30 kg ha^{-1}, no P because of high levels of soil phosphate reserves
Crop protection diseases	No treatments	*Botrytis cinerea* • pyrimethanil (Scala) 0,6 kg ha^{-1} and • tolylfluanide (Eupareen) 0,57 kg ha^{-1}
Crop protection pests	Trips • *Amblyseius cucumeris (200 m^{-2})* • *Hypoaspis aculeifer (70 m^{-2})*	Trips and *Anthonomus rubi* • deltamethrin (Decis) 0,00075 kg a.i ha^{-1}
Crop protection weeds	• Finger weeder – 3 applications 2000 • Hoeing 1 application early spring 2001 • Plastic soil cover and straw mulch 2001 • Hand weeding 60 hours ha^{-1}	Plastic soil cover and straw mulch No input of herbicides or hand weeding
Yields 2001	16 ton ha^{-1}	23 ton ha^{-1}

VEGINECO publication list

VEGINECO project reports

1. VEGINECO Final Report
W. Sukkel and A. Garcia (Eds.)
VEGINECO Report 1. 2002. Applied Plant Research. Lelystad.

2. Manual on Prototyping Methodology and Multifunctional Crop Rotation
J.J. de Haan and A. Garcia (Eds.)
VEGINECO Report 2. 2002. Applied Plant Research. Lelystad.

3. Integrated and Ecological Nutrient Management
J.J. de Haan (Ed.)
VEGINECO Report 3. 2002. Applied Plant Research. Lelystad.

4. Integrated and Ecological Crop Protection
W. Sukkel and A. Garcia (Eds.)
VEGINECO Report 4. 2002. Applied Plant Research. Lelystad.

5. Ecological Infrastructure Management
G.K. Hopster and A.J. Visser (Eds.)
VEGINECO Report 5. 2002. Applied Plant Research. Lelystad.

6. Proceedings of the VEGINECO workshop, 20-21 June 2001, Amsterdam
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Other project-wide VEGINECO publications

Wijnands, F.G. and W. Sukkel.
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In addition, every partner has published many publications in national and regional agricultural journals. For a complete overview, contact the concerning partner.

Annex 1. Short description of the systems

Southwest region of the Netherlands

Regional Context

In the Netherlands, approximately 70 000 hectares of more than 50 different types of vegetables are grown (including onion and peas). The farms are be divided in two groups: 1) the very specialised, small farms that grow mainly fresh market vegetables (19 000 ha, 4 200 farms, average size 4.5 ha) and 2) the larger farms with arable activities (more industrial processing crops, 25 000 hectares of vegetables, 4 900 farms, 25-75 hectares per farm). Arable farms are increasingly including vegetables in their crop rotations. In addition, farm size and specialisation is growing and land lease and exchange is becoming more important. The most important crops in terms of area and financial turnover are onions, carrots, chicory, leek, asparagus, Brussels sprouts, cauliflower, cabbage, lettuce, beans and peas.

Site information

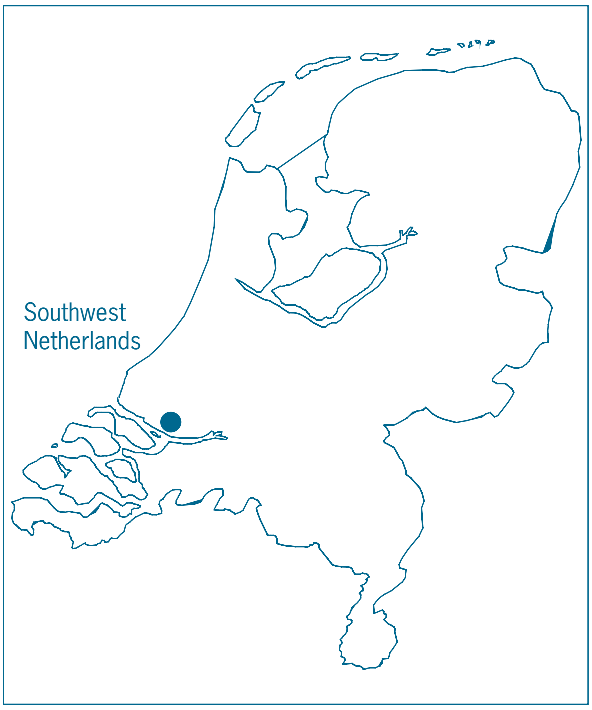
Soil characteristics	Integrated	Organic
main soil type	marine clay	marine clay
clay (%)	33	33
organic matter (%)	2.4	2.2
pH (KCl)	7.5	7.2

Climatic information	
annual average precipitation	760 mm
annual average sunshine	1 450 hours
annual average radiation	380 kJ cm^{-2}
annual average temperature	9.9 °C
average latitude	51 °N.
average altitude	0.8 m above sea level

Tested systems

In the Netherlands, two integrated and one organic systems were tested on an experimental location in the Southwest region of the Netherlands. A combination of vegetables and arable crops were chosen in all systems, this represented the developments in the region. The labour demand differed between the two integrated systems. The system with Brussels sprouts as the main crop was designed as a labour extensive system. The other system, with iceberg lettuce as main crop, was designed as labour intensive.

Location



Rotations

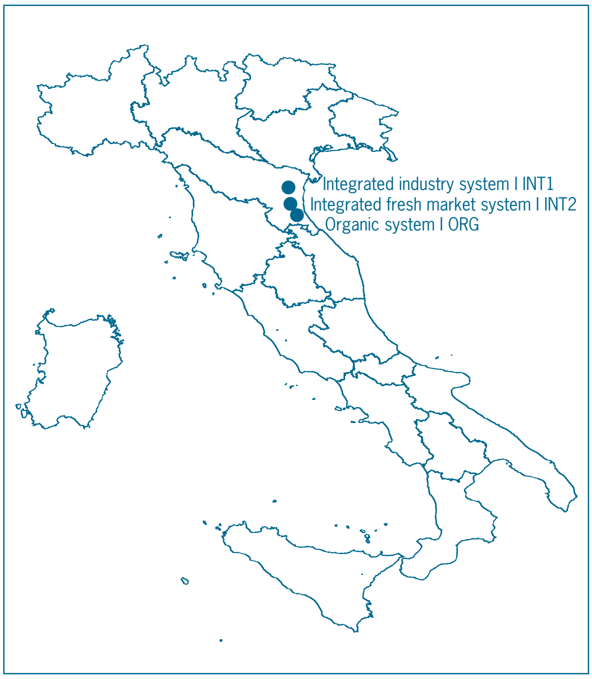
Integrated fresh market Brussels Sprouts (labour extensive) (NL INT1)	Integrated fresh market Iceberg Lettuce (labour intensive) (NL INT2)	Organic fresh market system (NL ORG)
1. potatoes	1. potatoes	1. iceberg lettuce
2. Brussels sprouts	2. fennel / celeriac / cauliflower	2. cereal / clover
3. winter wheat / spring barley	3. winter wheat / spring barley	3. Brussels sprouts
4. fennel / celeriac / iceberg lettuce	4. iceberg lettuce	4. fennel
		5. cereal / clover
		6. potato

Emilia-Romagna, Italy

Regional context
In Emilia-Romagna, Italy, there are almost 4 000 specialised farms and 35 000 non-specialised farms in vegetable farming. Some 54 000 hectares are cultivated with vegetables at medium and large sized farms (5-20 ha). The main crops grown on large farms for industrial processing are tomatoes, green beans, (water)melons and onions. These farms have a high level of mechanisation. At small farms (2-5 ha), the main crops are grown for the fresh market (lettuce, fennel, spinach, celery, potatoes, melons and cauliflower). These small farms have a low level of mechanisation. Since 1993, integrated vegetable farming have produced crops under Quality Control (QC) labels.

Tested systems
In Emilia-Romagna, two integrated and one organic systems were tested in the eastern part of the region in Ravenna (I INT1) and Cesena (I INT2 and I ORG). I INT1 is focussed on industrial vegetable crops in combination with arable crops while I INT2 and I ORG are focussed on fresh market vegetables.

Location



Site information

Soil characteristics	I INT1	I INT2	I ORG
soil type	silt loam	silt clay	silt clay loam
% clay	20	42	35
% silt	63	47	53
% sand	17	12	12
% organic matter	1.2	1.8	2.7
pH (H_2O)	7.8	7.7	8.0

Climatic information	RAVENNA (I INT1)	CESENA (I INT2 and I ORG)
annual average precipitation	581 mm ('88-'94)	591 mm ('92-'94)
annual average sunshine	4.139 hour	4.139 hour
annual average radiation	439 kJ cm^{-2}	541 kJ cm^{-2}
annual average temperature	13.1 °C	13.9 °C
average latitude	44-45 °N.	44 °N.
average altitude	5 m above sea level	16 m above sea level

Rotation

Integrated industry system (I INT1)	Integrated fresh market system (I INT2)	Organic fresh market system (I ORG)
1. spinach tomato	1. lettuce spr./sum./aut. catch crop	1. green beans fennel
2. wheat green beans	2. green beans	2. melon
3. sugar beet catch crop	3. strawberry celery + catch crop	3. catch crop
4. melon	4. melon	4. strawberry lettuce summer + autumn

Valencian Community, Spain

Regional context

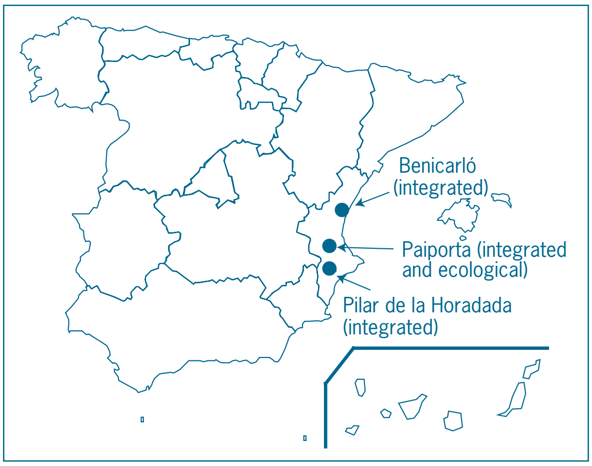
In Valencia Region, Spain, an area of about 44 000 hectares are grown each year with more than 30 vegetable crops (including potato). The most important crops are tomato, onions, potato, artichoke, watermelon and cauliflower. Most of the vegetables are grown for fresh market production. The farms are small (more than 50% of the farms have a surface area less than three ha, and about 20% of the farms have a surface area less than one ha). Levels of mechanisation are generally low. Irrigation is necessary because of the dry conditions and low natural rainfall. Crops can be grown all year round.

In Spain, the area cultivated for organic farming was about 150 000 hectares (less than 1% of the agricultural area). In Valencia, the area with organic farming is about 3 000 ha, with about 3% area for vegetable crops.

Tested systems

In the Valencian region, three integrated and one organic systems were tested at different locations. The three integrated systems are representative for their area: Pilar de Horada (ES INT1 in the south of the Valencian Region, Benicarlo (ES INT2) in the north and Paiporta (ES INT3) in the centre. The organic system (ES ORG) is located at the same experimental farm as ES INT3. ES INT1 and ES INT2 are located at private farms, ES INT3 and ES ORG are located at an experimental station.

Location



Site information

Geodesic	co-ordinates	ES INT1	ES INT2	ES INT3 and ES ORG
Situation	Latitude	37° 51' N.	40° 23' N.	39° 28' N.
	Longitude	0° 43' W.	4° 4' E.	0° 25' W.
	Altitude	<50 m above sea level	17 m above sea level	52 m above sea level
Province		Alicante	Castellón	Valencia
Town		Pilar de la Horadada	Benicarló	Paiporta

Soil characteristics		ES INT1	ES INT2	ES INT3 and ES ORG
Soil texture	Sand (%)	23	27	34
	Loam (%)	44	47	49
	Clay (%)	33	26	27
Organic Matter (%)		2.3	2.5	1.8
pH (soil/H_2O 1/5)		8.4	8.1	8.5

Climatic characteristics	Mean temperatures	ES INT1	ES INT2	ES INT3 and ES ORG
Temperature	Max (°C)	26.2	20.7	21.9
	Min (°C)	11.1	10.7	13.2
	Mean (°C)	18.2	16.5	16.7
Average rainfall (mm)		292	482	481

Rotation

Pilar de la Horada integrated (ES INT1) private farm	Benicarlo integrated (ES INT2) private farm	Paiporta integrated (ES INT3) & organic (ES ORG) experimental station
1. vetch-oats	1. seed artichoke	1. artichoke
pepper + little gem	tomato	green bean
2. little gem	2. green bean	2. onion + watermelon,
sweet corn + broccoli	lettuce	cauliflower
3. lettuce	3. lettuce	3. potato
onion	watermelon	fennel
4. celery	4. cauliflower	4. oats
watermelon	vetch-barley + artichoke	seed artichoke

Switzerland

Regional aspects

In Switzerland, an area of 7 700 hectares is grown with open field-grown vegetables and 3 800 hectares with vegetables for industry. In total, it concerns 1 400 farms. Most of the farms grow many different crops. The most important crops are lettuces, cauliflower, carrot, onion, leek, fennel and celeriac. 40% of the national demand for vegetables is imported. Integrated crop production and organic farming is of increasing importance in Switzerland (production under label guidelines). The government intends to convert 90% of the farms to integrated or organic farming within the next ten years. At present, more than 75% of vegetable farms already met the requirements for integrated crop production. An increasing number of farms (5% to 20%) will convert to organic production in the near future. Practical difficulties on organic and integrated vegetable farms mainly concern the following topics: (1) availability of nitrogen, (2) weed control and (3) pests and diseases (Gysi et al., 1996).

Tested systems

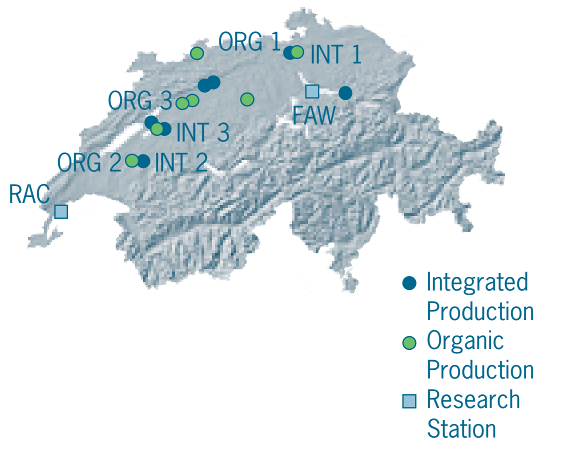
Three integrated and three organic pilot farms were tested:
INT1/ORG1: wholesale distributors, Zurich
INT2/ORG2: direct sale, French-Swiss
INT3/ORG3: retailers / wholesalers, Seeland

Main crops and rotation

Main crops
- head lettuce
- cauliflower
- carrots
- leek
- onions

Rotation length
- short: 3-4 years
- long with arable crops: 6-12 years

Location



Site information

Pedeological information	Bern/Biel		Zürich	
soil type	histosol[2]	eutric cambisol[2]	eutric cambisol[2]	gleyic/calcaric cambisol[2]
clay (%)		1-10/26-54[1]	15-20[2]	30-40[2]
sand (%)		71-94/16-55[1]	40-85[2]	10-70[2]
silt (%		6-19/20-44[1]	0-50[2]	0-50[2]
organic matter (%)	> 30[1]	1-26[1]	2-5[2]	2-5[2]

Climatic information[3]	Bern/Biel	Zürich
annual average precipitation	1 088 mm (Biel)	1 005 mm (Reckenholz)
annual average sunshine	1 681 hour (Liebefeld 95)	1 501 hour (Reckenholz 95)
annual average radiation	4 325 MJ cm^{2} (Liebefeld 95)	3 858 MJ cm^{2} (Reckenholz 95)
annual average temperature	8.5 °C (Biel)	7.8 °C (Reckenholz)
average latitude	47° 00' N.	47° 30' N.
average altitude	440 m above sea level	450 m above sea level

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[1] Organische Böden des schweizerischen Mittellandes, Presler/Gysi 1989
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Research programme

A selection of strategies, based on an inquiry and analysis of the main problems, were tested on the pilot farms to improve the cropping systems:

1. Nutrient management:
   soil cultivation strategies, leguminous intercrops, mineral soil nitrogen and nitrate in plant sap guided nitrogen supply, application of a nitrogen management model, different sources of nitrogen fertiliser.
2. Pest and disease control:
   choice of resistant varieties, mixed crops of different resistant or different coloured varieties, ridge planting, preconditioned for earlier development, soil cover with intercrops, silver foil or PP mulch, flowerbeds strips along crops, monitoring pests and diseases, crop cover, biological control strategies, application of threshold concepts.
3. Weed control:
   seedbed preparation in darkness, false seedbed technique, ridge planting, soil cover with cover crops or intercrops, mechanical control with weeder or roll harrow, (band) flaming, period threshold concept.

Farm level assessments

In each pilot farm, a field that represents a prototype farming system is selected. The prototype field was representative for the entire farm with respect to crop choice and site characteristics. The parameter values were determined on these prototype fields, either for each crop or for the subsequently grown crops on the field. Some parameters are not tested on all farms, and not all parameters were calculated on farm level.
Target values for the prototype fields were discussed and set together with the farm manager individually for each pilot farm. Recommendations and support from the project is focused on these prototype fields. Results from the prototype fields was extrapolated to the whole farm and compared to the reality of the farm assessed by a selection of the parameters.
On selected farms, experiments were performed to develop specific aspects of farming systems (weed management, disease and pest control, nutrient management). These experimental plots serve as pilot sites for the prototype farming systems. As much as possible, the parameters were used to assess the progress in the experiments.

Annex 2. Definitions of parameters

Parameters	Definition	Target
Quality production		
1. Quantity of produce (QNP)	The extent to which good regional yield is realised. QNP = realised yield (kg ha^{-1}) divided by good regional yield (kg ha^{-1}).	All crops should have a yield equal to or higher than good regional yields. QNP ≥ 1
2. Quality of produce (QLP)	The extent to which regional good quality is realised. QLP = realised amount in quality class 1 divided by regional good amount of quality class 1.	All crops should have a quality equal to or higher than regional good quality. QLP ≥ 1
3. NO_3^- content of crop produce (NCONT)	The nitrate content in leafy vegetables in mg kg^{-1} fresh matter.	All leafy crops should have a lower NCONT than the national standard. NCONT < x ppm
Clean environment nutrients		
4. Phosphate Annual Balance (PAB) 5. Potash Annual Balance (KAB)	Phosphate and Potash Annual Balances (PAB/KAB) are phosphate (P_2O_5) and potash (K_2O) inputs divided by phosphate and potash off-take with crop produce in one year.	The value of the target is dependent on the value of the soil reserves (PAR/KAR) (see 13,14) • PAB/KAB > 1 when PAR/KAR is below desired range • PAB/KAB = 1 when PAR/KAR is in desired range • PAB/KAB < 1 when PAR/KAR is beyond desired range
6. Nitrogen Available Reserves (NAR)	Mineral Nitrogen Reserves (NAR) in the soil (0-100 cm) at the start of the leaching season (kg ha^{-1}).	The target values are set such that the EU-norm for drinking water (50 mg NO_3^- l^{-1}) should not be exceeded. NAR < x kg ha^{-1} x = 45 kg ha^{-1} on sandy soils x = 70 kg ha^{-1} for clay soils
Clean environment pesticides		
7. Synthetic pesticides input active ingredients (PESTAS-Synth)	Pesticide input of synthetic pesticides in kg ha^{-1} active ingredient per year.	The use of pesticides in kg active ingredient ha^{-1} should be as low as reasonably possible. PESTAS-Synth < x kg a.i. ha^{-1}
8. Copper input active ingredients (PESTAS-Cu)	Copper input in pesticides in kg ha^{-1} per year.	The use of copper in kg ha^{-1} should be as low as reasonably possible. PESTAS-Cu < x kg a.i. ha^{-1}
Environment Exposure to Pesticides 9. EEP-air, 10. EEP-groundwater, 11. EEP-soil	Emission potential of pesticide active ingredients (a.i.) to the environmental compartments: • air (kg ha^{-1}) • groundwater (ppb) • soil (kg days ha^{-1})	The potential emission of pesticides should be as low as reasonably possible or fulfil legal standards (EU directive on drinking water) • EEP-air < x kg a.i. ha^{-1} • EEP-groundwater < 0.5 ppb in total and 0.1 ppb (EU countries) • EEP-soil < x kg days ha^{-1}

Parameters	Definition	Target
Nature and landscape		
12. Ecological Infrastructure (EI)	EI is the part of the farm laid out and managed as a network of linear and non-linear habitats and corridors for wild flora and fauna, including buffer strips.	Area with ecological infrastructure should be at least 5% of total farm area EI > 5%
Sustainable use of resources		
13. Phosphorus Available Reserves (PAR) 14. Potassium Available Reserves (KAR)	Phosphate and potash plant available reserves in the soil (kg per unit soil).	PAR/KAR should be within a range that is agronomically desired and environmentally acceptable: x_p < PAR < y_p x_k < KAR < y_k
15. Organic Matter Annual Balance (OMAB)	OMAB is the proportion between annual input and annual output (respiration, erosion) of effective organic matter.	The target value is dependent on the actual and desired level of the organic matter content: • OMAB > 1 when actual organic matter content is lower than desired level • OMAB = 1 when actual organic matter content is equal to desired level • OMAB < 1 when actual organic matter content is higher than desired level
Energy Input (ENIN)	Input of direct and indirect (fossil) energy in MJ ha^{-1} used for crop cultivation.	No target established
Farm Continuity		
16. Net Surplus (NS)	Difference between total revenues and total costs (including labour) in € per ha.	Gross revenues should be larger than total costs. NS ≥ € 0
Hours hand weeding (HHW)	The amount of hours needed for hand weeding per ha as indicator of the success of the mechanical and/or chemical weed control.	Hours hand weeding should be as low as possible. HHW < x hours ha^{-1}

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