# 7 System comparison

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## 7.1 Introduction

This chapter compares the performance of integrated and organic vegetable farming systems within and between vegetable production regions in Europe. Unless otherwise stated, the data are for the year 2000. In some cases, these data are compared with the average data for the whole project period, and target values and/or reference data of average practice.
Research in Spain, Italy and the Netherlands was done on experimental farms, whereas, in Switzerland, it was done on integrated and organic pilot farms. The experimental farms reflect the standard farm types in the specific regions.
The comparison between countries and system types is hampered, due to different climatical and pedological conditions, different crops involved, influence of different farm management etc. For the comparison of organic and integrated systems within a country, the pairs that are best comparable are indicated with an asterix. The Spanish and the Dutch pairs are the most useful for comparing integrated and organic systems. In these cases both the organic and integrated systems were situated on the same location, had the same farm management and partly consisted of the same crops. In the Spanish situation the organic and integrated systems were even exactly the same in their crops and rotation.

## 7.2 Structural differences (farm structure)

### Differences in farm type

There are many different farm types involved in vegetable farming in Europe. The differences are mainly brought about by cultural, climatic and economic conditions. At one end of this range of farm types are the small, intensive vegetable farms with low mechanisation, high labour input per ha, mostly with a low degree of specialisation. At the other end, there is the large, highly mechanised and highly specialised type of farm. The farms that were tested in the Vegineco project are representative of this range. However, in spite of their differences, all the farms were required to fulfill a series of sustainable production criteria. These criteria, formulated as the target values set for a series of parameters, were, in some cases, farm specific. For example, in some cases, the targets for production quality were different for organic and integrated systems. Farms were compared according to the degree in which these target values were met.

### Differences between organic and integrated farming

The most important difference between organic and integrated farming is the use or rejection of mineral fertilisers and synthetic pesticides. On closer examination, however, 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.

*Table 7.1 Integrated and organic farms used in the comparison*

| | System | Abbreviation | Farm size ha | Manpower number | No of crops/farm number | Rotation length years | Main vegetable crops |
|---|---|---|---|---|---|---|---|
| NL | Brussels Sprouts** | NL INT1 | 47 | 3.3 | 4 | 4 | Brussels sprouts, potatoes, fennel, celeriac |
| | Iceberg lettuce** | NL INT2 | 28 | 3.1 | 4 | 4 | iceberg lettuce, fennel, celeriac, potatoes |
| | Organic** | NL ORG | 28 | 3.7 | 6 | 6 | Brussels sprouts, iceberg lettuce, fennel, potatoes |
| I | Integrated industry | I INT1 | 27 | 1.7 | 6 | 4 | tomato, melon, green beans, spinach |
| | Fresh market, integrated** | I INT2 | 4 | 2.3 | 6 | 4 | lettuce, strawberry, melon, celery |
| | Fresh market, organic** | I ORG | 4 | 2.7 | 5 | 4 | lettuce, strawberry, melon, fennel |
| ES | Pilar de Horada | ES INT1 | 4 | 4.1 | 8 | 4 | pepper, celery, little gem, watermelon |
| | Benicarlo | ES INT2 | 4 | 2.9 | 7 | 4 | artichoke, lettuce, tomato, cauliflower |
| | Paiporta, Integrated** | ES INT3 | 4 | 3.0 | 7 | 4 | watermelon, fennel, artichoke, onion |
| | Paiporta, Organic** | ES ORG | 4 | 3.0 | 7 | 4 | watermelon, fennel, artichoke, onion |
| CH | CH INT1 | CH INT1 | 20 | - | 25-30 | 4 | divers |
| | CH INT2** | CH INT2 | 1 | - | 25-30 | 4 | divers |
| | CH INT3 | CH INT3 | 9 | - | 25-30 | 4 | divers |
| | CH ORG1 | CH ORG1 | 20 | - | 30-40 | 4 | divers |
| | CH ORG2** | CH ORG2 | 2 | - | 30-40 | 4 | divers |
| | CH ORG3 | CH ORG3 | 8 | - | 50-60 | 6 – 8 | divers |

** = the integrated and organic systems marked with double asterix are compared within a region

To compare the performance of integrated systems with organic farming, comparable farms within a region were selected as far as possible (see Table 7.1). The organic and integrated systems in Spain were not only located in the same area, at Paiporta, but they also had the same crops and rotation. For the Netherlands, the two integrated farms and the organic farm had the same location, and the crops farmed were mostly the same, but the length of rotations was different. In Italy, the crops grown on I ORG and I INT2 were mostly the same, but they were located in different places and their rotation system differed. The integrated and organic farms were the same farm types in Switzerland, most of their crops were similar, but they were located in different places.

## 7.3 Overview of Results

In Figure 7.1 the overall view of both systems is given as a pie chart. We will focus on the different parameters in the following sections. Production quantities fell short of the targets in both types of system, but the shortfalls were more pronounced in the integrated systems than in the organic ones. However, nitrate content was low in the products from both system types.

Most of the organic systems failed to reach the clean environment nutrient targets. This was due to the intensity of the systems and the exclusive use of organic fertilisers containing fixed ratios of nutrients. Because of these fixed ratios, it is very difficult to completely balance fertilisation to the needs of the crops. However, organic systems scored better than the integrated ones regarding to clean environment pesticides, mainly because synthetic pesticides are either used very sparingly or not at all. The only poor results, in organic systems, were in the use of copper. In the integrated system, the use of a few pesticides with a high potential for leaching into the groundwater resulted in very high levels for the parameter EEP-groundwater. The target for nature and landscape could not be reached in Italy and Spain, due to the small scale of the vegetable farms.

Due to high fertiliser use in the past, the nutrients in the soil of both systems are over abundant. This is a common picture in vegetable farming. However, the balance of organic matter was not good enough in half of the cases The organic systems performed a more positive organic matter balance, mainly caused by the greater use of organic fertilisers. In the integrated systems, there was no reason to use organic fertilisers, because of the high levels of nutrients in the soil.

The most striking difference between the organic and integrated systems lays in their capacity to meet the target set for farm continuity. In most cases, the integrated systems failed to reach this target, whereas the organic systems scored much better.

### 7.3.1 Farm continuity

The figures obtained by comparing farm continuity (see ‘revenues per 100 costs’, Figure 7.2) are difficult to compare because they are based on different crops, sites and prices in different countries. Despite this, it is obvious, that:

- For most tested integrated systems, as well as for the conventional farms used as reference, costs exceed income.
- For all organic systems, income exceeds costs.

The favourable revenue/cost ratio for organic systems in Spain and Switzerland was due to the high prices gained for organic vegetables sold directly at the farm gate. In the other countries too, the good financial results were

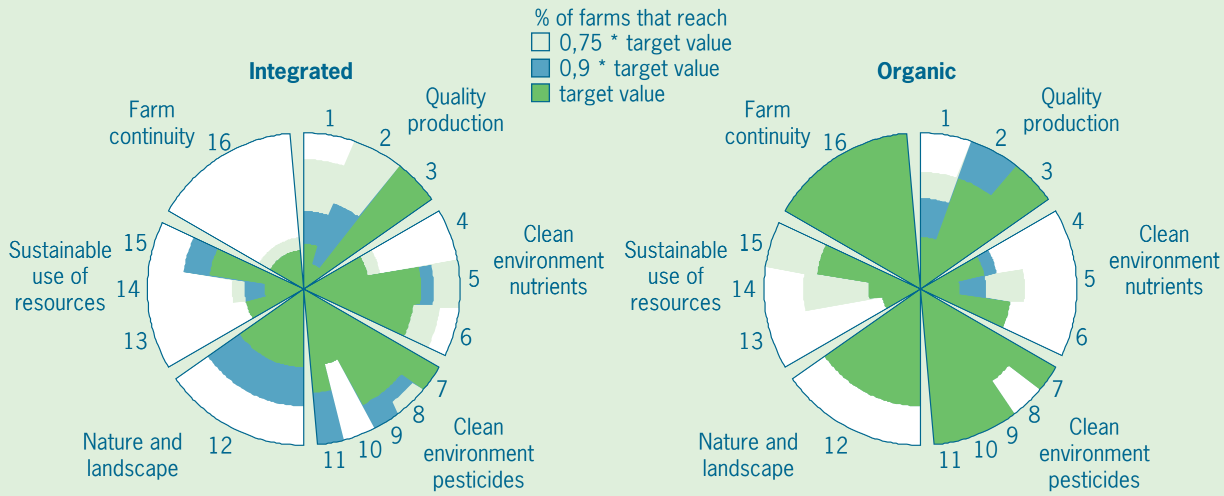


*Figure 7.1 Comparison between integrated and organic systems, percentage of farms that reach 75%, 90% and 100% of the target value*

due to high market prices. The higher prices paid for this produce compensated for lower yields and the extra number of hours needed for hand labour.

The numbers of hours needed for hand weeding, as demonstrated by the Spanish and Dutch systems, were two to four times higher in the organic system and thus made up a substantial proportion of the total costs. To reduce the time needed for hand weeding in farms with large fields significantly, mechanical weed control needs to be investigated. Experiments in large fields, in the Netherlands, showed that less than 10 hours $ha^{-1}$ were needed in the integrated system and 40 hours $ha^{-1}$ in the organic system, representing 5 - 15% of the total labour input. In Spain about 150 hours $ha^{-1}$ were needed in the integrated system and about 350 hours $ha^{-1}$ in the organic system, i.e. 10 - 22% of the total labour input.

In all integrated systems in the project, the costs of fertilisers and pesticides were considerably reduced compared with average farm practice. However, in vegetable farming, this cost category was a very small part of the total costs. In the test systems it was only between 3% and 7% of the total costs, and so had little effect on the farm's cost/income balance.

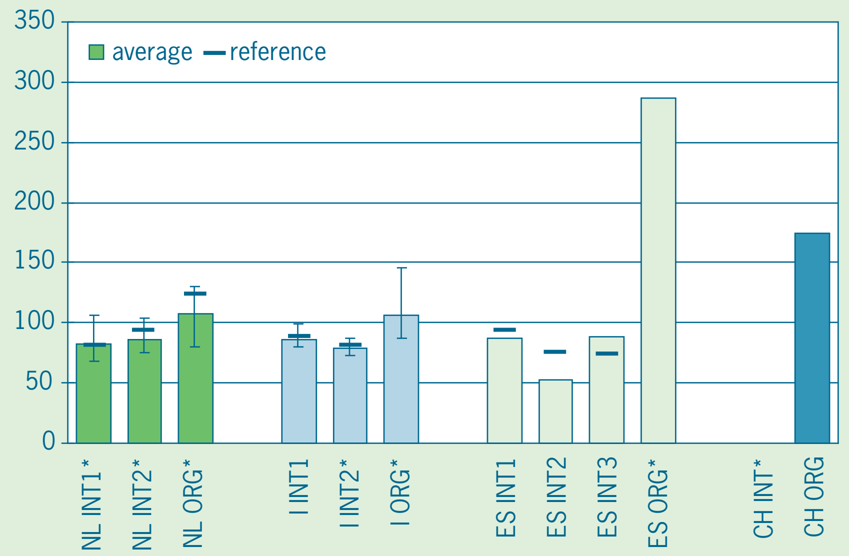


*Figure 7.2 Income per 100 costs per farm (€ $ha^{-1}$)*

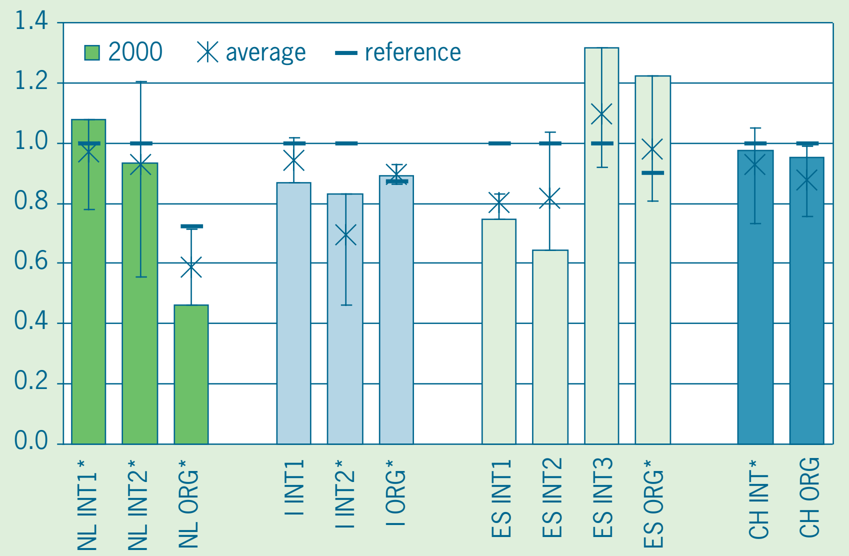


*Figure 7.3 Integrated and organic yields on test system levels and regional good yields relative to integrated target yields*

### 7.3.2 Production quality

The production quality levels achieved in the test systems were compared with accepted levels of good production quality for regional standard (conventional) farming. Production quality in the organic systems was also compared with this regional standard for conventional farming. Depending on the crop, the average achievement in standard practice is normally 80 to 100% of this regional good production standard. In most cases, average yields from the test systems (see Figure 7.3) was between 80 - 100% of the regional good production standard, which is comparable to the average result on conventional farms. Remarkable were the good results achieved by three of the four organic systems in the project, where the quality of produce equaled that of the regional good quality standard. The only organic systems to show significantly lower yields relative to this standard were the Dutch, where the quality was only 70% of the regional standard.

Depending on the crop, yields varied widely. For example, due to uncontrollable circumstances, the whole of lettuce crop was lost. Of course, both organic and integrated farms are subject to pests and diseases and to weather problems. In integrated production, however, the farmer has more possibilities to react to threats from pests and diseases. The differences in yields between integrated and organic systems are also strongly dependent upon the crop. Pests and diseases cause most of the losses in organic grown crops. A comparison of fennel, potato and lettuce yields in the Netherlands and Spain (Figure 7.4) it shows that fennel is an 'easy' crop, because there is no difference in yield between the organic and integrated systems. However, if yields per country are compared, important differences emerge (20 tons in the Netherlands and 30 tons in Spain), probably because of different growing conditions (light, temperature, rainfall, etc.). Potato and lettuce are clearly more difficult crops. In the organic system, substantially lower yields — up to 50% lower than integrated — were obtained. For lettuce, this was caused by aphids in the Netherlands and Spain and downy mildew in the Netherlands. In the Dutch potato crop this was caused by late blight due to humid conditions and, in the organic system, it was partly due to rejecting the use of 'bio' pesticides, such as copper.

### 7.3.3 Sustainable use of resources

In this theme, one can distinguish between on-farm resources, e.g. as soil or biodiversity, and off-farm resources such as energy and water. A methodology for the quantification of farm input of (fossil) energy was developed during the project, but it has not been used as a steering parameter yet. The efficient use of water has neither been quantified nor used as a steering parameter, but should definitely be considered in future, as it plays such an important role, especially in the Mediterranean countries.

Comparisons under this theme will only deal with soil as an on-farm resource, taking into account the reserves of phosphate, potash and organic matter in the soil. Changes in these soil parameters are very slow and can hardly be established within a 4-year period. Therefore priority was given to creating strategies to move reserves in the desired direction.

For phosphate and potash, an agronomically sufficient and environmentally desired range was defined of (available) reserves in the soil. Figure 7.5 shows the relative deviation of actual soil reserves from this desired range. Levels above this range mean that soil nutrients have to be decreased because they are detrimental to the environment. This occurs very often with phosphate in fields used to produce vegetables and is also the case for a number of the tested systems (see Figure 7.5). A long-term reduction in these excess soil reserves is easily manageable where only mineral fertilisers are used, but in organic systems or in systems where the organic-matter content in the soil is too low, the need to apply organic fertilisers makes a

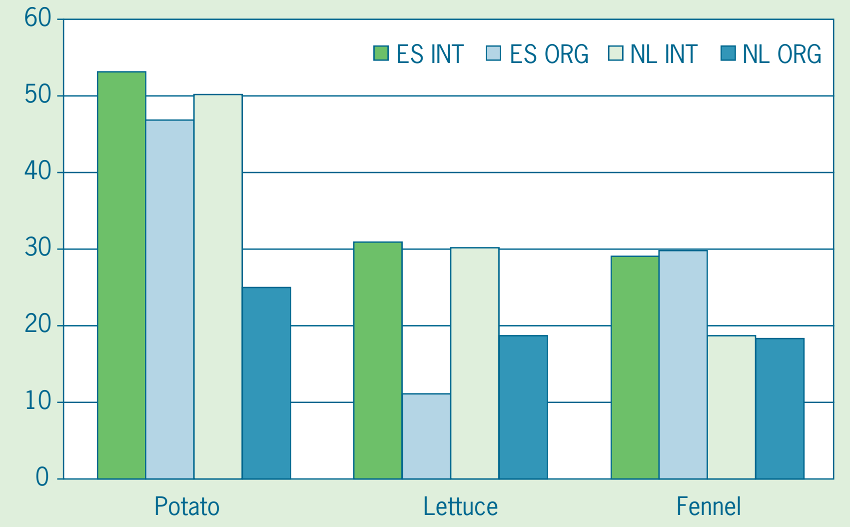


*Figure 7.4 Average yields of potato, lettuce and fennel in the Netherlands in the INT 1 and 2 systems, and in the Spanish INT3 and ORG systems (tons ha$^{-1}$)*

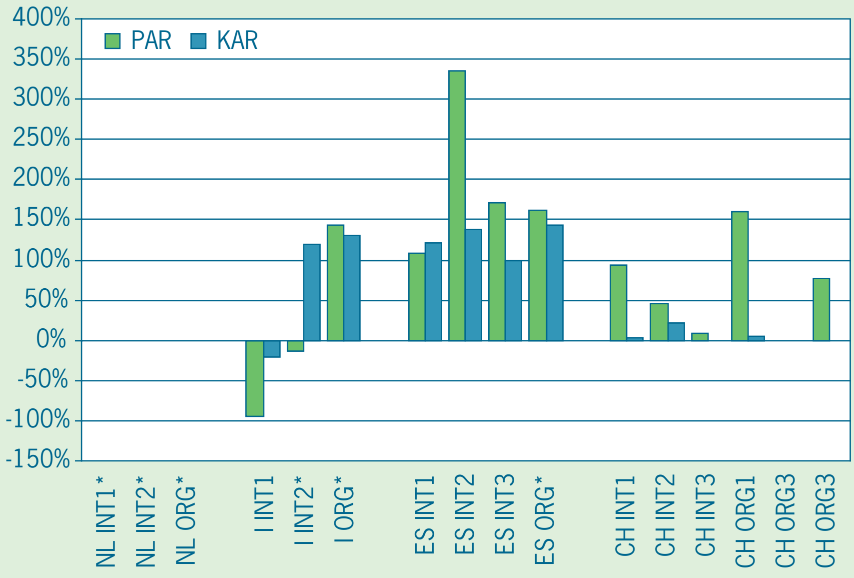


*Figure 7.5 Phosphate and potash reserves, the relative deviation of the desired range per system*

long-term reduction of excess reserves more difficult to achieve. The effects of fertilisation strategies regarding surpluses of phosphate and potash can be found under the heading 'environment nutrients'.

Not enough information has been gathered so far to establish the optimum range for organic matter content. The Italian I INT2 seemed to need more input of organic matter in order to improve the soil structure. The strategies applied for the input of organic matter focused on at least maintaining existing levels of organic matter content. The desired level of input was based on a respiration rate of soil organic matter of 2-3% per year. Except for the Italian fresh market systems (I INT2 and I ORG), all other systems showed sufficient input of effective organic matter. In I INT2 and I ORG, the extra input of effective organic matter required conflicted with the need to reduce phosphate (in I ORG) and potash (in I INT2 and I ORG) inputs.

### 7.3.4 Clean environment nutrients

**Risks from nitrate leaching**

For the Netherlands, Italy and Spain, the available reserves of nitrogen in autumn (NAR) are at least in a reasonably good balance with the nitrate concentration in the upper layer of the groundwater. Although NAR is influenced by controllable factors such as the fertilisation strategy, it is also partly influenced by certain factors that are partly or entirely uncontrollable in the long term, such as the rate of mineralisation, precipitation surplus, nitrogen deposition, nitrogen in irrigation water, and crop choice. For these reasons, the efforts to lower the NAR in the Italian and Spanish systems was only partially successful. In this cases regional- and farm-specific measures can only improve this situation in the long term.

Nitrogen surplus, which is one of the factors causing leaching, did not exceed a level of 125 kg ha$^{-1}$ (excluding deposition) in any of the Dutch, Italian or Swiss systems. In practice, in the Dutch and Italian systems, this meant an average reduction in the nitrogen level of 60 to 80 kg ha$^{-1}$. In the Spanish systems, the nitrogen surplus in the year 2000 varied from –120 kg ha$^{-1}$ because of a high rate of mineralisation to +470 kg ha$^{-1}$ because of the high concentration of nitrates in irrigation water.

The target value for available reserves of nitrogen in autumn (NAR) was set at 70 kg nitrogen ha$^{-1}$ (layer 0-100 cm). In Spain and Italy, the available reserves of nitrogen were much higher than the target value in both the integrated and organic systems. In Spain and Italy, the available nitrogen reserves in integrated or organic systems varied greatly. In most cases, the extremely high levels of NAR in these systems were reduced during the project. In Switzerland and the Netherlands, the variation between different systems and years was much smaller, presumably due to lower rates of mineralisation and lower nitrogen surpluses. In spite of the decrease in nitrogen input in the Spanish systems during recent years, the level for nitrogen in autumn was too high in the year 2000, as shown in Figure 7.6. Further improvements are needed in nitrogen fertiliser management to reduce the risk of leaching, particularly in view of the high nitrate content in irrigation water. In Italy, in the organic system, high nitrogen values were caused mainly by the mineralisation of ploughed in crop residues, or, in the integrated system, by a high input of fertiliser (in the celery crop). The situation could be improved by including additional catch crops in the rotation.

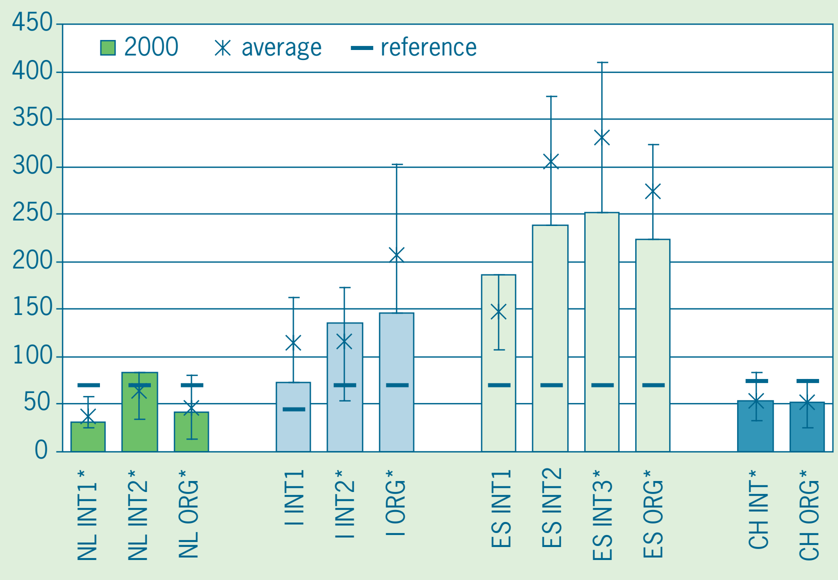


*Figure 7.6 Available nitrogen reserves in autumn (data from 2000, average and variation in years; for Switzerland, data from 1998 and variation over farms) (kg ha$^{-1}$)*

**Phosphate and potash balance**

Phosphate and potash balances depend very much on the level of available reserves in the soil. In the Spanish and Italian fresh market system, as these reserves were very high, only small additional amounts would be needed (see the section on 'sustaining resources').

The phosphorous balance is shown in Figure 7.7. In Italy and the Netherlands, there is some phosphate surplus, particularly in the organic systems. This is caused by applying organic fertilisers with high concentrations of phosphate. In Italy, the phosphate surplus in I INT2 and I ORG was drastically reduced during the project by reducing the input of mineral fertilisers and by choosing different organic fertilisers. In the Netherlands, a 20 kg ha$^{-1}$ surplus is tolerated to compensate for unavoidable losses. Taking the project period as a whole, the average surplus almost equaled the tolerated loss in both systems. On the other hand, the results in organic systems in Spain and Switzerland were negative, indicating that the output was higher than the input. These systems profited from reserves accumulated from previous years. This is a desirable situation, because these soils are too high in phosphate compared with the environmentally and agronomically desirable levels. Where the balance was negative, the potential risk of phosphate emission to the groundwater could be reduced. In the ‘reference’ situation — the situation found on the average farm — input was mostly much higher than output.

In both types of system, except for the Netherlands, available reserves of potash in the soil were very high, so there will be no need to refill the potash reserves in the near future (see Figure 7.8). In the Netherlands, the reserves are within the target range, and, in the integrated systems, the 4-year average surplus is close to zero. The positive surplus in the organic system was caused by an unbalanced composition of nutrients in manure and the priority that was given to obtaining a sustainable phosphate balance.

### 7.3.5 Clean environment pesticides

The adverse effects of using pesticides can be quantified in several ways. None of these approaches gives a complete picture, because there is still much to be learnt about what happens to pesticides when they are released into the environment. In the Vegineco project, two approaches were adopted to minimise the adverse effects of pesticides: (1) lowering the total input of active ingredients and (2) lowering the risks of emissions (EEP, see section 2.3.) to environmental compartments by carefully selecting the pesticides used. When additional criteria were available e.g. toxicity for humans, selectivity or potential damage to non-target biota, these aspects were also occasionally taken into account.

Figures 7.9 to 7.12 give an overview of the input of active ingredients and the risks of pesticide emission in the tested organic and integrated systems. Pesticides can be divided into synthetic pesticides, copper, sulphur

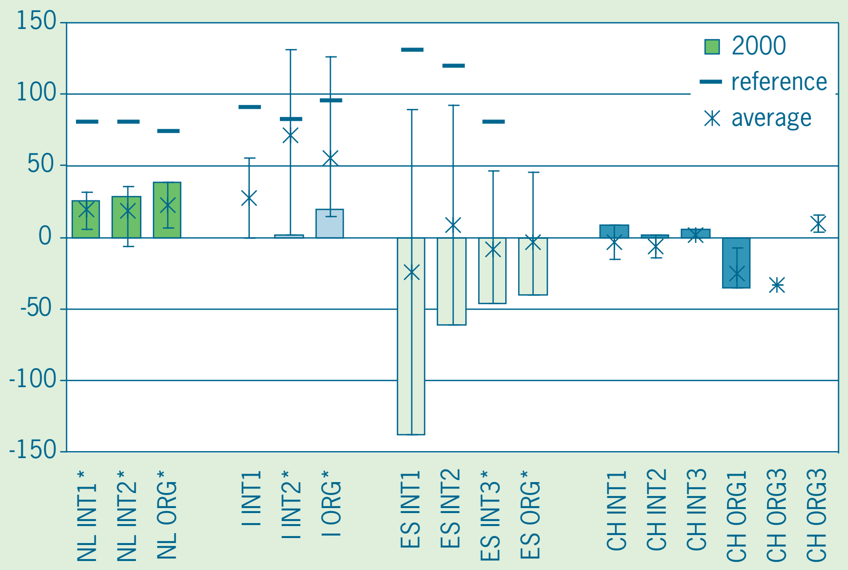


*Figure 7.7 Phosphate surplus (kg ha$^{-1}$) for organic and integrated systems, compared with the average phosphate balance in practice*

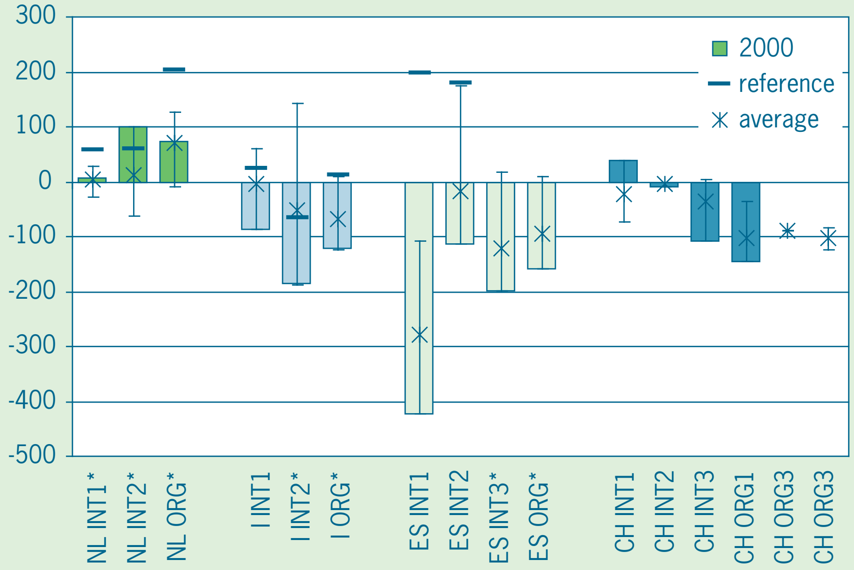


*Figure 7.8 Potash surplus (kg ha$^{-1}$) for organic and integrated systems, compared with the average potash balance in practice*

and other pesticides (mainly Bacillus thuringiensis, Bt.). Where Switzerland is included in the figures, the data are averages for five croptypes grown on three pilot farms and not averages per farm. The synthetic pesticides used in all integrated systems contain about 1.5 to 4 kg active ingredients ha$^{-1}$ (see Figure 7.10.). Due to the intensity of land use, the integrated system in Spain had the highest input of pesticides at the start of the project. This was reduced drastically during the course of the project, by replacing organophosphates with synthetic pyrethroids.

Synthetic pesticides can be replaced by other classes of pesticides such as sulphur compounds. These were used intensively in Spain, in the integrated and organic systems, and also in the integrated system in Italy. These alternatives tend to be less effective, however, so the input is usually quite high. On the other hand, they are usually less risky for the environment. Application of copper is another possible alternative, as was done in Switzerland, Spain and Italy. Copper was used in organic farms to control harmful fungi in onion or lettuce, such as downy mildew. The input of copper compounds increases the risk of them accumulating in the soil if the input is higher than around 1 kg ha$^{-1}$ (which is the estimated off-take by produce). For organic farming, the planned revision in EU legislation will restrict or forbid the use of copper.

In the organic system in the Netherlands no pesticides were used at all, assuming that all pesticide agents would have a negative effect either on the environment or on human health. In the Swiss situation, pesticide input is not presented in kg active ingredients ha$^{-1}$. Since every treatment has known or unknown negative side effects, the Swiss partner preferred to express pesticide input (and the pesticide emission) by the number of treatments.

A comparison was made between the average input in comparable systems in practice, and the actual (reduced) input of active ingredients achieved in the tested systems (see Figure 7.11). The data for the averages in practice were based on available input data per crop and on the crop protection strategies currently used in practice. Figure 7.11 shows that a huge reduction has been achieved compared with the pesticide input in average practice. By reducing inputs by between 55-85%, all systems achieved the reduction target of 50%. The reduction in input of pesticides was achieved by:

- focusing on prevention in all systems,
- using mechanical weed control instead of herbicides,
- using damage thresholds,

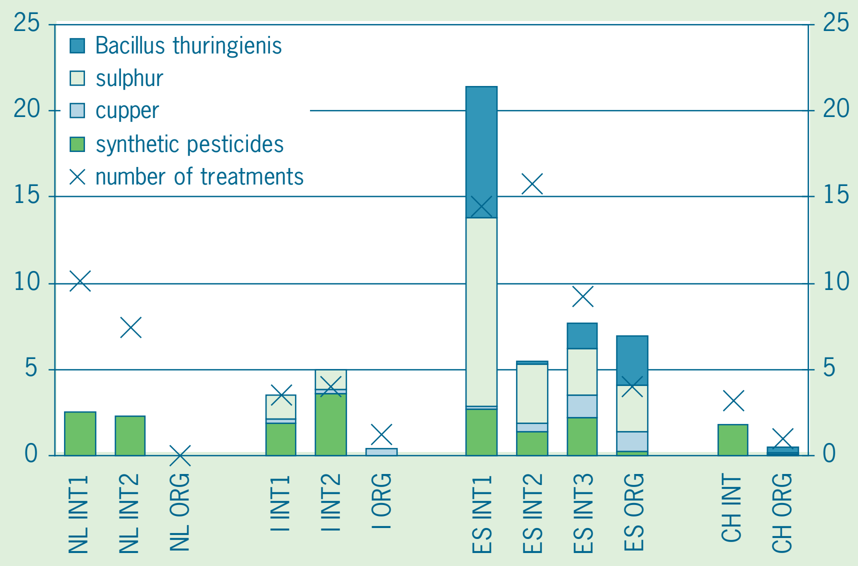


*Figure 7.9 Pesticide use in integrated and organic systems (kg a.i./ha and number of treatments ha$^{-1}$) (sum of all types of application)*

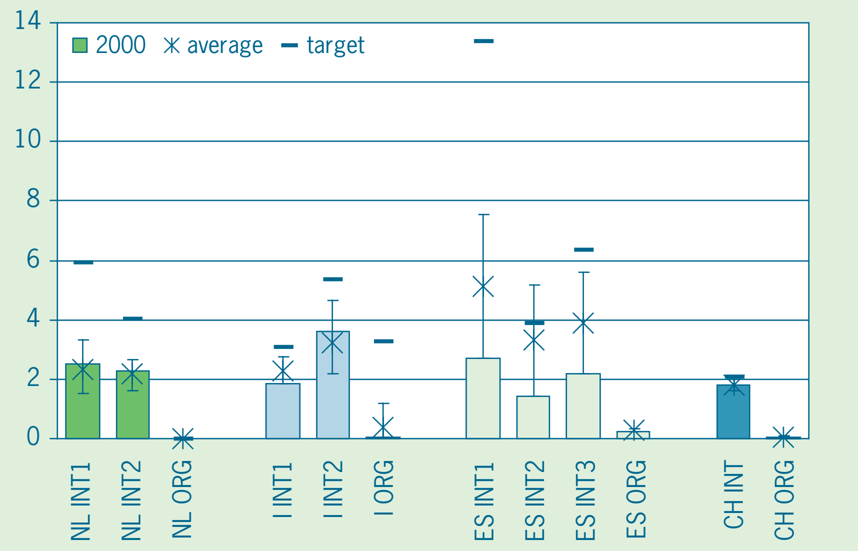


*Figure 7.10 Input of synthetic pesticides (kg ha$^{-1}$) in the tested systems compared with the target of reducing conventional levels by 50%*

guided control, weather forecast systems and other techniques to reduce the number of treatments,
- by optimising the timing of the treatment, and in some cases using improved spraying techniques to reduce the dosage per application.

Figure 7.11 shows that emission risks (EEP) in the systems were also substantially reduced. As no legal or scientific norms were available, the targets set for EEP-air and -soil were 70% of the general levels resulting from average farming practice. For all systems, the results for EEP-air and EEP-soil either met the target, or came close to it. In 2000, the actual figures over all systems ranged from 0.20 - 0.66 kg $ha^{-1}$ for EEP-air, and from 60 - 270 kg days $ha^{-1}$ for EEP-soil. An example is shown in Figure 7.12 of the effect on EEP-air of reducing input and pesticide selection in I INT 2.

The EU guideline of 0.5 ppb was used as the target for EEP-groundwater. Pesticide selection proved an important factor in meeting this parameter. Nevertheless, all the systems except the Spanish ES INT3 and the Italian I INT1 met this target, or came close to meeting it. These systems failed initially because there were no effective or economic alternatives for one or two pesticides used in these systems.

### 7.3.6 Nature and Landscape

A methodology was developed during the project to quantify and evaluate nature and landscape values, but it has not yet been used to improve these values. A description can be found in this report under 'new approaches', and in a method manual on the development of on-farm nature, published as a result of this project. The percentage of farm surface which should function as ecological infrastructure was established for all systems. In Switzerland, all farms achieved the target of 5%, but, in Spain, especially on small farms and some of the experimental farms operating on a semi practical scale this target was not reached.

## 7.4 Discussion and conclusions

Basis for the conclusions are the data presented in the previous paragraphs and the data in the country chapters. In some cases they are complemented with experiences in the project and expert knowledge both of which cannot be abstracted from the hard data. The conclusions on the comparison between organic and integrated systems, are mainly based on the comparable pairs of Spain and the Netherlands. These systems were situated at the same location and had an equal or comparable set up. Keeping in mind the flaws of the comparison between different systems, the next general picture arises:

**Economic performance**

- For all integrated systems producing for the EU market, costs are higher than the revenues.

When looking at the farms from a purely economic point of view, none of the integrated systems (as well as conventional farms) could survive. In practice these type of farms survive because the entrepreneurs accept a low hour rate, partly live from the interest of their capital or can hire cheap labour. EU-market (or world market) prices are actually to low to guarantee a economical sound farming system. The Swiss situation is an exception because integrated farms are rewarded for their public services and at the same time the prices at the Swiss home market tend to be higher than the EU market prices.

- The organic farms showed a better economic performance as the integrated systems in all countries.

This better economic performance of the organic systems was established in spite of slightly (Spain) or considerably (Netherlands) lower yields and a higher labour input for handweeding (Spain, Netherlands).
The good economic results were realised by the high market prices realised for the products. In some cases

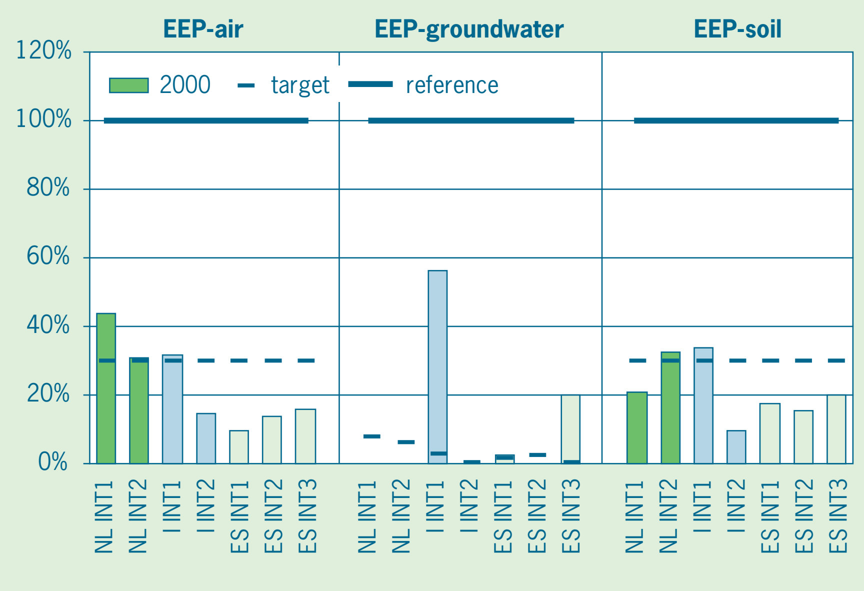


*Figure 7.11 Percentage reduction of emission parameters compared with emission in conventional practice and Vegineco targets (year 2000 results)*

prices three times higher than the integrated products were realised. These high prices were possible because of specific marketing channels (in some cases direct sales from farm to consumer) and a high market demand for organic products. With the further expansion of organic production, including sales by supermarkets, it may be expected that product prices will decrease to a level that will be about 25% to 50% higher than conventional produce.

**Production**

- The integrated farms reach a level of quality production which is comparable to, or slightly lower than conventional farms.

- Depending on crop and production conditions, organic yields ranged from comparable with, to much lower than integrated yields.

Hard data to found the first conclusion were not available. The conclusion is based on the expert knowledge of the involved researchers and farm managers. Reduction of yield and quality was in most cases caused by pests and diseases. Of course, both organic and integrated farms are subject to pests and diseases and to weather problems. In integrated production, however, the farmer has more possibilities to react to threats from pests and diseases. Considering an expected decrease of the market price for organic produce, solutions have to be found to improve the low yields of some crops.

**Clean environment nutrients**

- In some systems and in specific crops the nitrate mineral reserves gave risks of a high level of nitrate leaching.
- The nitrate leaching risks in the organic and integrated systems were at the same level.

Nitrate leaching risks as quantified in nitrogen mineral reserves in autumn, depend only partly on the fertilisation strategy. Crop choice, soil conditions and weather conditions also play major roles. Long term effects of the fertilisation strategy could not be established. In the organic systems a gradual increase of the organic nitrogen reserves in the soil was caused by the use of organic fertilisers. This could in the long term result in a higher mineralisation rate and a higher risk of nitrogen leaching. The use of a crop cover (including catch crops) all year around can be a helpful instrument to reduce these risks.
In spite of their efforts and a substantial reduction, NAR remained too high in the Spanish and Italian systems. This was possibly partly due to high organic nitrogen reserves and/or a high mineralisation rate of the organic matter in the soil. Also in the Dutch and Swiss systems high levels occurred for specific crops. Especially leaf vegetables (lettuce, leek, spinach etc.) cultivated in autumn resulted in a high NAR.

- Both in the organic and integrated systems there was no environmentally unwanted (further) accumulation of potash and phosphate in the soil.

Phosphate- and Potash-balances cannot be judged without knowledge of the level of the soil-reserves of these nutrients.
An environmental unwanted (high) level of soil nutrient reserves means that a zero or negative surplus is wanted. For the integrated systems this situation was quite easy to realise. For the

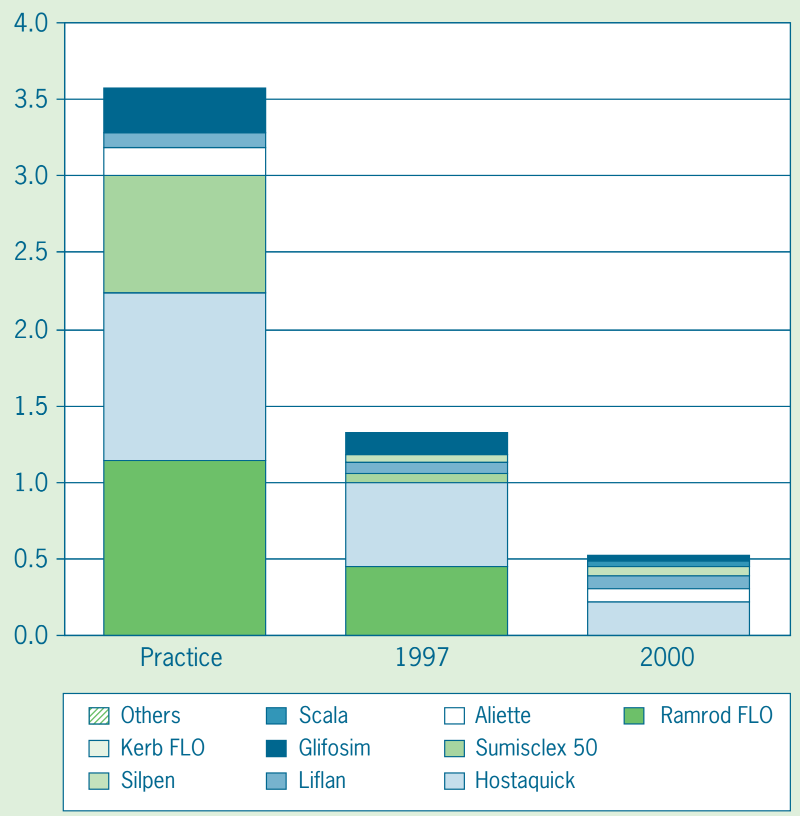


*Figure 7.12 Example of the reduction in EEP-air in the Italian I INT2 system (kg ha$^{-1}$). The figure depicts the emission from different pesticides used in average practice, at the starting year of the project, and in the final year.*

organic systems a big effort was made to minimise the potash and phosphate input. In some cases specific types of manure had to be selected. It is questionable whether in the farmers-practice this selection of the right type of manure will be feasible (availability and costs). The realised phosphate and potassium surplus in the organic systems was slightly higher (or less negative) than in the comparable integrated systems.

**Clean environment pesticides**

- Compared to conventional farming, large reductions of pesticide input and emission risks were realised with no or minor negative effects on quality production.

The combination of integrated crop protection using all available knowledge to reduce the necessity of pesticide inputs with a careful pesticide selection proofed to be successful. For the Swiss situation no reference data were available but the reduction in these pilot farms were not so drastic because integrated farming practices are already standard farming practice. Reduction of the pesticide leaching risk to the level of the drinking water directive of 0.5 ppb was in some case not realised. The exceeding of the norm was due to one or two herbicides for which there was no feasible alternative. The use of this type of pesticides will probably not be admitted in the future. The use of the EEP instrument for selection of pesticides will possible (and hopefully) be less effective after completion of the EU harmonisation on pesticide admittance. However this EU harmonisation in some cases seems to work contra productive. Especially in situations were there are no alternatives left for control, practice tends to use illegal applications which can give rise to even bigger emission problems.

- In the organic systems use and emission of pesticides is (much) lower than in integrated systems.

A logical conclusion, as synthetic pesticides are not allowed in organic farming. However toxic compounds are allowed to be used in organic farming. Because of their sometimes low efficacy these toxic compounds are often used in high quantities. Moreover toxins used in organic farming are not necessarily safer than synthetic pesticides. This is a point of attention for the guidelines and legislation on organic farming.