Chapter 2:

Socio-economic impact & ‘state of the art’ blight management

Chapter 2: Socio-economic impact & 'state of the art' blight management

Introduction

Within Europe, the economic impact of late blight varies between countries and regions. This is due to a variety of factors, but in organic production systems differences in climatic conditions, potato varieties used and agronomic techniques are thought to be important factors. As a result, the impact of the prohibition of copper-based fungicides for late blight control will also differ between countries and regions of the EU.

In 2001, a detailed inventory and survey of economic variables and agronomic techniques (including blight management systems) relating to organic potato crops grown in 2000 in seven European countries (Denmark, France, Germany, Netherlands, Norway, Switzerland, United Kingdom) was undertaken. This made it possible to assess the effect of late blight in organic production in different regions; the efficacy of existing blight management practices; the impact of the prohibition on copper fungicides on the economic viability of different potato varieties and overall farm incomes.

In combination with information from the field trials which compared production with and without the use of copper-based fungicides (see Chapter 8: Integrated Systems Approach) the survey data were used to make cost/benefit (profit margin) analyses of currently used blight management systems. This approach helped to quantify the economic importance of blight in different regions of the EU under various scenarios, notably after the ban on copper fungicides has been implemented and to provide a focus for the target efficacy/activity of blight management and treatment systems to be developed in the project.

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REPORT

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Assessment of the Socio-Economic Impact of Late Blight and State-of-the-Art Management in European Organic Potato Production Systems

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1 Summary

1.1 Introduction

In the Europe, late blight, caused by *Phytophthora infestans*, is the most devastating disease affecting organic (and conventional) potato production. Under suitable environmental conditions the disease can spread rapidly and it can cause complete crop loss. The extent of economic damage varies between European regions. The extent of damage due to late blight depends on several factors: in organic production systems these factors include climate, choice of variety, soil management and use of crop protection agents. Therefore, a reduction or ban of copper use will have varying impacts in different regions. A detailed survey was conducted in 7 European countries as a subproject of the EU-funded project Blight-MOP (QLRT 31065). The survey investigated legislative, socio-economic and production parameters. The aim of this study was: (i) to obtain an inventory of the current organic potato production techniques, (ii) to assess the impact of a potential ban of copper on yields and viability of organic potato production and (iii) to identify alternative plant protection strategies that are used by organic farmers. This study was conducted in Denmark (DK), The Netherlands (NL), Germany (D), France (F), Great Britain (UK), Norway (N), and Switzerland (CH). We used data obtained from interviews with organic growers and experts. These data were completed by use of background information such as late blight epidemiology or varietal susceptibility. In each of the seven countries 15 to 20 organic farmers were interviewed in detail about structure of the farm, economy, and potato production techniques. In addition, we asked the farmers about their education, information sourcing and use of training opportunities. Emphasis was placed on the practical experience of the farmer. Furthermore, each farmer was asked for an assessment of his own motivations, the development of the market and social and political tendencies. A total of 118 farmers participated in this study. The farmers were selected in order to obtain a broad spectrum of type of production (organic and bio-dynamic), time period since conversion, and regional distribution. Farms included in this survey were certified as organic for at least 2 years. The data analysis includes: (i) statistics on yields, farm gate prices, and production techniques, (ii) an analysis of farmer observations and experiences on the extent and impact of late blight epidemics, (iii) an analysis of the farmer's motivations, expectations and their assessment of the potential impact of a copper ban. Using multiple linear regression we identified production factors (independent variables) which appear to consistently contribute to production success (dependent variables). Success was judged against two criteria, gross yield (t/ha) and a wider definition which included gross yield but also profitability and nutrient-use efficiency.

1.2 Results and discussion

Production statistics, yields and farm gate prices, development of production area and legislation: The area of organic potato production increased between 1998 and 2000 in all countries. In contrast, the area of conventionally managed potatoes did not change. The area increased between 11% (D) and 89% (N). However, the organic potato production area has lower rates of increase (111 to 189%) than the total organic arable area (117 to 356%). There is a large variation in potato yields between the countries. Organic farms obtain between 15 t/ha (N) and up to 30 t/ha (CH, NL, UK). In D, F, and DK yields between 20 and 25 t/ha are obtained. In conventional production, potato yields are consistently higher. Except for Norway (26 t/ha) average yields vary between 36 and 43 t/ha. These data suggest that in
6 Assessment of the Socio-Economic Impact of Late Blight and State-of-the-Art-Management in European Organic Potato Production Systems organic potato production only 50 to 80% of conventional yields are reached. The differences in yields show up in the farm gate prices that can be obtained for organic potatoes: Farm gate prices of organic potatoes are consistently higher (260 to 440 Euro/t) whereas conventional potatoes are sold at 60 to 300 Euro/t. However, the premium that can be obtained for organic potatoes varies considerably between countries. Experts expect an increase of organic potato production although profitability is expected to decrease in the next years. Experts say also that consumers prioritize (in

decreasing importance)'production type', 'price', 'variety', and 'taste'. Other parameters such as 'exterior quality' or 'convenience' are considered as less important. These assessments need careful interpretation since consumer polls may show different preferences. Processors emphasise other preferences such as processing quality and variety. Organic and conventional farmers do not grow the same choice of varieties. The varieties grown by organic farmers tend to be a compromise between robustness in production and acceptance on the market.

There are legislative differences in the countries included in this study, which have an influence on production conditions. Copper use is not possible in Scandinavian countries and in NL, copper use was allowed only as an exception in 1998. In CH and D copper use is allowed although quantities are limited by state (CH 4 kg/ha) or by label organisations (D). In F and UK copper use was not limited until 2001. At present, copper use is limited within the EU by EU regulation 2092/91 to 8 kg copper/ha and year. In NL organic potato production is further limited by legislation since potato foliage has to be destroyed as soon as late blight incidence exceeds 5%.

Experiences of farmers in organic potato production: The data given by farmers are related to their experience in the year 2000 on a specific reference plot. The reference plot was usually the largest potato field planted with the most important variety. Potato yields obtained on the reference plots in 2000 were equal to the average yields over the past 5 years given above, thus indicating representative results. However, there was a large variability in yields between individual farms. For instance, yields obtained in D varied between 5 and 35 t/ha. Surprisingly, the parameter 'profitability' assessed subjectively by farmers was not directly correlated with yield or farm gate price. Farmers in UK, CH, and D assessed potato production as relatively profitable, whereas N, NL, and especially DK felt that profitability was unsatisfactory.

The late blight epidemic and disease pressure vary considerably between different regions of Europe. In 2000, serious disease outbreaks were observed in NL, D, and UK, followed by N, F, CH, and DK. Not all farmers suffered yield losses due to late blight infection between 1996 and 2000, and the impact varied between individual years. However, in D, NL and UK more than 70% of the farmers suffered losses constantly throughout all years. Late blight infection in organic potato plots led to criticism by neighbours in NL, F, D, N, and CH. In these countries, between 5 and 20% of the farmers said that neighbours had personally criticized them.

Copper was used at least once between 1996 and 2000 by 60% of German farmers, 45% of the Dutch farmers (only in 1998 with exceptional permission), by 65% of the Swiss farmers, by 80% of the UK farmers and by 100% of the French farmers. Farmers in the other countries may not use copper. UK and French farmers declared that they had used up to 16 kg/ha, although the majority used less than 7 kg/ha. Swiss farmers used between 2 to 4 kg/ha whereas German farmers used in general less than 2 kg/ha. Alternative products (e.g. plant strengtheners or bio-dynamic products) have been applied, depending on country, by 30 to 60% of the farmers. However, the farmers generally did not report high efficacy rates of the applied products on incidence and severity of *P. infestans*. In total, 40 different products have been applied on seed tubers or foliage. These include extracts of algae, biodynamic preparations, microorganisms or extracts thereof, rock powders, plant extracts, soaps of fatty acids, and milk extracts, plus a variety of plant strengtheners with unspecified mode of action. Identification of important success factors: Several agronomic factors have been identified that correlate with success in potato production in the year 2000 on the reference plots. After a stepwise elimination and concentration process the final model included the following parameters:

i) Plant nutrition and soil fertility was characterized by ‘intensity of animal husbandry on farm’, ‘intensity of soil cultivation practice’ (i.e. intensity of ploughing, weed control etc), ‘soil fertility management strategy’ (i.e. timing of application), ‘nutrient input intensity’ (i.e. total available NPK), ‘soil type and nutrient supply status’ (based on soil analyses).

ii) Agronomical techniques were characterized by the parameters ‘resistance class of variety (scale 0-9), source of seeds (certified vs. own production), ‘chitting’, ‘competition by weeds’, ‘planting week’, ‘harvest week’, ‘removal of foliage’, and ‘irrigation’.

iii) Crop protection strategy was characterized by the parameters ‘use of crop protection products/plant strengtheners’, ‘total mount of copper applied’, and ‘number of copper applications’.

iv) The regional disease pressure in the environment was described by the parameters ‘distanceto the next potato field’, ‘regional infection pressure’ (weighted by number of spray applications in conventional potato plots), and ‘first occurrence of late blight in the region’.

Data analysis indicates that some of the parameters have a strong impact on the overall success of the potato production. The variables ‘planting date’ (the earlier the better), ‘harvest date’ (the earlier the better), ‘removal of foliage’, ‘total amount of copper’ (the more the better), and ‘varietal foliar resistance’ (the more resistant the better) do correlate significantly and consistently with success if potato ‘gross yield‘ is considered as success variable. However, ‘fertilizer input intensity’, ‘planting date’ (the earlier the better), ‘removal of foliage’ (if yes), and ‘number of copper applications’ (the more the better), are identified if ‘success’ includes next to gross yield also the parameters N-use efficiency, and profitability (assessed by the farmer). This analysis suggests that some production factors, which can be altered by the producer, are responsible for differences between individual farms. The fact that these factors show up in the analysis indicates also that not all farms fully exploit the available production technology. Obviously, there is still a potential for many farms to stabilize and increase yields by the known production strategies.

Key points:
i) Reduction of growing season by early planting and chitting
ii) Use of a soil fertility strategy that leads to sufficient nutrient supply (nutrient supply is in general sub-optimal)
iii) Use of resistant or robust varieties (or strategies that lead to the same effect)
iv) Efficient crop protection

The farmers’ experience expressed in the interviews corresponds in many aspects with this data analysis. However, reality often limits the extent to which these strategies can be included at farm level. For instance, choice of resistant varieties (if available on the market) is often limited by acceptance by consumers and wholesalers. In the farmers’ experience, the plant nutrition and the soil fertility management are key factors for yields but also for the susceptibility of the potato crop. Farmers find very consistently that a weak crop is much more susceptible than a vigorously growing potato crop. This suggests (mirrored by the data provided in the interviews) that organic potato crops find, in general, suboptimal nutrient availability which probably leads to physiological imbalances and, as a result, to increased susceptibility to late blight. However, the relevance of such an interaction needs verification.

Impact of copper ban on potato production: Farmers expect substantial changes in the organic production area if the scenario ‘copper ban’ becomes reality and if no alternatives are available at that time. A decrease in production area is expected by 71% of the farmers in F, 61% in CH, 57% in UK, and 35% in D. In contrast, increase of production surface is expected by 11% of the Dutch farmers, and 7% of the French farmers. Farmers in N and DK do not expect any changes as the copper ban is already reality.

Motivations and expectations of farmers: Besides the production technology and economy, farmers have also been interviewed in detail about their motives and expectations of the development of markets and society. When asked about their most important motives to produce organically, more than 70% of the farmers listed non-economical motives first, namely (in decreasing priority) (i) 'to produce food which is healthy and safe', (ii) 'to produce without exhausting natural resources', (iii) 'to live and work in harmony with nature and the landscape', and (iv) 'to leave behind a viable farm for the next generation'. The economic motives (v) 'to obtain a reasonable income or salary from the farm', (vi) 'to obtain good market prices for the products grown', (vii) 'to retain/maintain family ownership of the farm', and (viii) because of 'social contacts with staff and consumers' ranked as less important. However, nearly all farmers mentioned the economic motives as second or third most important motive, suggesting that altruistic motives are important but only as long as economic viability is maintained. As most important opportunity for the development of organic farming, farmers listed 'concerns about food safety in Europe' as top reason for further increase. However, 'scaling-up in the marketing of agricultural products' and 'continually decreasing producers prices for organic products' were considered as major threats and/or challenges for the future of organic farmers.

1.3 Conclusions

This survey indicates that a region-specific optimization and integration of production technologies should lead to a substantial improvement of gross yields and yield stability in organic potato production. The survey shows also that copper has been a key component of the organic potato production system. Therefore, a ban of copper in the absence of adequate alternative production strategies (which will be developed in the Blight-MOP project would most likely lead to destabilisation of organic potato production, decrease in production area and shortage of market supply. The survey has identified key factors for successful organic potato production which need further development and exploitation. Within the Blight-MOP project, these key factors (i) crop resistance management strategies, (ii) agronomic strategies, (iii) soil fertility management, and (iv) novel crop protection strategies are fully evaluated for exploitation under various regional conditions.

Concept, design of interviews, data management and data analysis of this survey was done by Bert Smit,
Bas Janssens, Jan Buurma, Monique Hospers, Scott Phillips, and Lucius Tamm. The interviews and
background data gathering has been performed independently by all co-authors.

2 Introduction

In Europe, late blight, caused by *Phytophthora infestans*, is the most devastating disease affecting organic (and conventional) potato production. Under suitable environmental conditions the disease can spread rapidly and it can cause complete crop loss. The extent of economic damage varies between European regions. The extent of damage due to late blight in organic potato production systems depends on several factors such as, variety choice, soil management and use of crop protection agents. Therefore, a reduction or ban of copper use will have varying impacts in different regions. The effect of EU Regulation No 2092/91 which would include the banning of the use of copper fungicides in organic potato production is difficult to assess, due to a lack of reliable data on: (i) blight incidence and resulting yield losses in organic potato production, (ii) the blight management strategies currently used in organic potato production in different regions of the EU and (iii) the potential socio-economic impact of the ban on copper fungicides on EU organic potato production and its competitiveness in an international market.

A detailed survey of the currently used blight management systems of organic potato production and the agronomic and economic impact of the disease on organic potato production in different regions of the EU is a prerequisite for the assessment of the impact of copper ban and/or novel alternative methods. The collection of data allows to describe the state-of-the-art technology in Europe and in order to identify key factors that lead to successful late blight control and potato production in organic systems.

The aim of this study is to obtain an agronomic/socio-economic impact assessment which quantifies:

- to what extent existing late blight control strategies are implemented in organic potato production in different regions of the EU
- the reliance on copper fungicides of existing organic production systems (the effect of such fungicides on profit margins) and the potential economic effect of the ban on copper fungicides
- the efficacy required from alternative blight management strategies (to be developed in Blight-MOP) to maintain the economic viability of EU organic potato production systems.

At regional level, data from the past five years were obtained in each of the 7 countries. Data were obtained from agricultural institutions such as extension services, research facilities, and weather forecasting organisations: The data included

- statistics on density and type of potato crops within the region (proportion of early crops, varieties etc.)
- onset of epidemic development at the regional level for the last 5 years
- market analysis based on an assessment of availability and quality of product versus market demand, prices, marketing type (direct marketing, retailers, health food shops etc.)

A total of 118 organic certified farms were selected in Denmark, France, Germany, The Netherlands, Norway, Switzerland and the United Kingdom and interviewed in detail on their experiences in organic potato production1. Farmers were selected in order to obtain a broad spectrum of type of production (organic and bio-dynamic), time period since conversion, and regional distribution. Farms included in this survey were for at least 2 years certified organic.

1 The questionnaire is available at www.orprints.org/00002936

At field level, data on unit size, variety, crop rotation, soil type, soil cultivation, and distance to nearest neighbour's potato growing fields/area were obtained from farmers. If available, data on nutritional status of soil and crops (N, P, K), phenology of growth as well as assessment of spatial and temporal progress of the occurrence of *P. infestans* between units/fields were also recorded. Records included

i) Cropping plan, acreage, rotation, farm size, other activities
ii) Varieties, type of potato (ware, starch, seed), marketing, yields, prices
iii) Inputs used, including costs (fertility inputs, crop protection agents, seed potato) and field operations
iv) Last year's late blight infection and incidence, estimation of yield loss
v) Experiences and preferences on late blight management practices used during the past 5 years
vi) Key variables on economy
vii) Farmer preference and market demand for varieties
viii) Farmers' social background and expectations (age, education, knowledge of prevention strategies for late blight, motivations and general strategy for the farm)

Data analysis included simple descriptive statistics of background data and the inventory of agronomic practices. Important variables which contribute to successful potato production where identified by means of a multiple linear regression. When necessary, principal components of groups of variables were used in this process (see respective chapters for details).

The data obtained from expert interviews as well as individual farmers were used (i) to give an overview of the organic and conventional potato production in European countries in order to describe the regional economic context in which an individual farmer lives (chapter 3), (ii) to provide a representative inventory of farming practices (chapter 4), (iii) to identify management practices which contribute to successful organic potato production (chapter 5), and (iv) to derive recommendations for researchers and advisory services (chapter 7).

3 Organic potato growing and late blight in seven European countries: production, market and legislation

S.R.M. Janssens, A.B. Smit, J.S. Buurma

3.1 Introduction

Organic potato production and marketing are likely to differ between European countries. Differences are due to climatic conditions, market demands and opportunities as well as to the legal framework. Background data were obtained by expert interviews and review of local statistical data.

The aim of this study was to obtain representative background data which are not available by means of interviews of individual farmers. The assessment included (i) a description of the legal framework of potato production in each country, (ii) information of the market organisation, (iii) statistics on organic and conventional potato production (including yields, farm gate prices), (iv) usage of varieties, (v) regional distribution of potato production, and (vi) the experts views and expectations on consumer preferences and the future development of the market.

3.2 Methods

The project partners in Denmark, France, Germany, the Netherlands, Norway, Switzerland, and the United Kingdom provided data on legislation, sector organisation, and market development based on a questionnaire. The individual partners obtained information from statistical sources (FAOstat, 2004; Foster C. & N. Lampkin, 2000. Organic an in-conversion land area, holdings, livestock and crop production in Europe. Report of FAIR3-CT96-1794) and by means of interviews with experts from advisory services, government and industry. The standardised recording protocol2 was provided by researchers from LEI.

3.3 Results

3.3.1 Legal framework

Legislation on the use of crop protection agents against *Phytophthora infestans* varies substantially between European countries. Depending on country, the use of pesticides is not only regulated by the legal framework but also by private standards of producers' associations.

countries regulations do not differ between regions. However, in France, obligatory destruction of crop
waste and volunteer plants were imposed in Nord-Pas de Calais in 2001.
In conclusion, rules for late blight control differ substantially between countries. As a consequence,
farmers of different countries do not have the same opportunities to control late blight in potato crop,
resulting in unequal economic conditions between countries.

Table 3.1. Regulations for late blight control in organic and conventional production

Country	Regulation
Denmark	No copper allowed in organic or conventional farming
France	Copper allowed in organic or conventional farming No differences on copper use between conventional and organic farming: no limitation for copper use no obligation to defoliate
Germany	Copper allowed in organic or conventional farming No differences in copper use between conventional and organic farming: Amount of copper/ha limited to 3 kg/ha year The Demeter label allows no copper products. The Bioland-label allows copper products only as an exception. The procedure is as follows: After the visit of an advisor and his assessment of the attack, the farmer is allowed to use copper. The copper amount of the soil has to be checked regularly.
Netherlands	No copper allowed in organic or conventional farming
Norway	No copper allowed in organic or conventional farming No chemical haulm destruction allowed in organic or conventional farming.
Switzerland	Copper allowed in organic or conventional farming No differences in copper use between conventional and organic farming: Amount of copper/ha limited to 4 kg/ha year The Demeter label allows no copper products.
United Kingdom	Copper allowed in organic or conventional farming No differences in copper use between conventional and organic farming: Amount of copper/ha limited to 4 kg/ha year. Permitted salts of copper hydroxide, copper oxychloride, (tribasic), copper sulphate, copper oxide. A need should be recognised by the inspection of authority or inspection body. The Demeter label allows no copper products.

Labels

All participating countries have at least two organic labels. In France and the United Kingdom the use of copper fungicides is allowed for several labels. In some countries fungicide use is not permitted at all; so differences between labels do not exist as a consequence of national regulation (Denmark, Netherlands and Norway). In Switzerland and Germany the use of copper fungicides is still permitted but the rules on use of these copper fungicides differ between labels within each country. In general, the bio-dynamic label 'Demeter' prohibits copper use whereas the other labels do allow the usage within the legislation.

Alternative crop protection products

An inventory is made of (alternative) copper-free products that are authorised against late blight in each
country. An overview is given in table 3.2.

Table 3.2: Alternative products authorised against late blight

Country	Authorised products against late blight
Denmark	None
France	Foliar fertilizers (with or without copper) with oligo elements.
Germany	Plant strengtheners (e.g. stone meal, extract of Equisetum arvense)
Netherlands	Plant-strengtheners
Norway	Bio-dynamic preparations
Switzerland	Plant strengtheners (e.g. stone meal, extract of Equisetum arvense)
United Kingdom	None

Haulm destruction
Haulm destruction in the early stages of a blight epidemic is a means to limit further spread of *P.infestans.* Haulm destruction at a specific level of disease is imposed in the Netherlands and UK. Table 3.3 gives an overview on regulations in European countries.

Table 3.3. Instructions for haulm destruction per country

Country	Regulation/instruction
Denmark	No regulation but some farmers use haulm shredding and gas burning
France	None
Germany	None
Netherlands	Regulation of the public branch organisation HPA. It is not allowed to have non-planted potatoes or waste potatoes on which stems with foliage occur (outside), without covering these potatoes in a way that stems cannot occur above these cover. Defoliation if more than 1000 leaflets/20m2 or more than 2000 leaflets /100m2 are infected by *P. infestans*
Norway	None
Switzerland	Mechanical and thermical haulm destruction are applied but not related to late blight.
United Kingdom	Defoliate using a flail as soon as sufficient yield has been achieved or when more than 25% of leaf area is blighted. Defoliate at least 14 and preferably 21 days before lifting.

Variety
All countries provide a list of varieties which may be grown legally. These lists do not specify varieties for organic and conventional farming. The number of varieties as well as the variety names (varieties) on the free lists differ between countries.

Nutrient balance restrictions
Regulations on use of fertilizer inputs differ between countries. Two out of seven countries do not have any nutrient balance restrictions (France, United Kingdom; see table 3.4).

Table 3.4. Description of nutrient balance restrictions per country

Country	Regulation
Denmark	The use of nitrogen fertiliser is regulated by The Danish Plant Directorate. Example: For ware potatoes yielding 40 t/ha it is legal to use 164 kg N/ha (N standard) on irrigated sandy soil. This is adjusted from the yearly N-prognosis based on soil samples taken in 400 to 600 fields throughout Denmark. Conversion factors for animal manure exist. The N-standards are adjusted according to current yield.
France	None
Germany	Legislation for farming in general. The underlying concept is to limit fertilisation to the level of nutrient extraction. Organic farming: No restrictions in the sense of a definite level of nutrients in kg/ha but it is not allowed to use more than 1,4 manure units per ha and year. That is equal to the manure production of two livestock units and means more or less 80 kg N and 70 kg P_2O_5 per ha.
Netherlands (2003)	Defined by the Dutch nutrient balance system (MINAS) applies to organic and conventional farmers. The part of the total supply which is not taken up by crops (normatively) is called loss. If this loss exceeds the permitted loss level, farmers have to pay a levy. Farmers have to report based on a mandatory book keeping. P_2O_5: loss permitted (kg P_2O_5/ha): 20 (grassland)/20 (arable land) N: Loss permitted (kg N/ha): 180 (grassland)/100 (arable land) Levy when exceeding permitted loss: P_2O_5: euro per kg: 9 (grassland)/9 (arable land),- N: euro per kg: 2 (grassland)/2 (arable land),- Max. manure supply (kg N/ha): 250 (grassland)/170 (arable land)
Norway	Total nitrogen: maximum 140 kg/ha per year. Of those 140 kg/ha/year, maximum 80 kg/ha (not on average) may come from certain not certified sources (e.g. conventional farms). Green manure, soil covering and other plant residues are not included in this limit.
Switzerland	The balance of nutrient input (from animals and purchased) minus the nutrient use (tabulated data) is calculated separately for N, P, K. The balances calculate the amount of nutrients in the manure of the farm animals plus fertilizer purchased minus the nutrient demand of the plants. The values of the nutrient balance were determined in field trials. IPM and organic farmers have to fulfil this measure calculated. The tolerance is 10 % of the nutrient demand.
United Kingdom	-

The way the nutrient problems are handled differ between countries. In all cases the use of nutrients is restricted more or less.

3.3.2 Organic potato production

Present state and development of organic potato production:

Figure 3.1 gives an overview of the total number of organic certified farms in each country. There is a lack of comparable data of different countries because statistical definitions between countries differ and the distinction between conventional and organic farming is not always clear within national statistics. Compared to conventional agriculture, mixed farming is more common in organic agriculture. For example, grass-clover meadow is a common and necessary part of the crop rotation in organic farming. However, it is not always clear in statistical resources which part of the temporary grassland is part of the crop rotation (F, UK, NL). The figures given in table 3.5 were obtained from FAOstat (2004) and Lampkin & Foster (2000).

Figure 3.1. Number of organic farms per country (2000). Source: Own data from national administration and certification bodies

Table 3.5 confirms the modest position of the organic area as compared to total area in 1998. However, table 3.6 shows the rapid increase of organic arable farming. This indicates the growing importance of organic farming. Table 3.7 shows the development of the potato acreage in different countries and the development of the conventional and organic arable acreage.

Table 3.5. Total area of arable crops and organic arable crops per country (1998). Sources: FAOstat and Lampkin & Foster, 2000

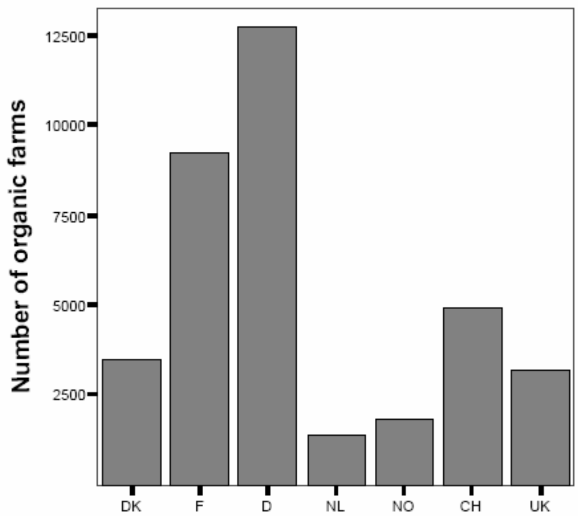

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Table 3.5. Total area of arable crops and organic arable crops per country (1998). Sources: FAOstat and Lampkin & Foster, 2000

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom
Total agricultural area (ha)	2'672'000	29'927'000	11'879'000	1'973'000	1'047'000	1'580'000	17518000
Total organic agricultural area (ha)	99'161	218'790	416'518	19'323	15581	77'842	274519
Percent organic agricultural area	3.71%	0.73%	3.51%	0.98%	1.49%	4.93%	1.57%

Table 3.6. Development of area (hectares 2000 as percentage of hectares 1998). Sources: FAOstat and Lampkin and Foster, 2000, Own data from national administration and certification bodies

	DK	F	D	NL	N	CH	UK
Total arable	99	99	99	100	101	98	101
Total potato	109	103	101	99	86	101	102
Organic arable	167	169	131	108	356	117	129
Organic potato	146	120	111	130	189	113	154

The figures in table 3.6 not only confirm the growing importance of organic farming in all countries but show the increase of the area of organic potatoes as well. In all countries the organic potato area increased while the conventional potato area stagnated or slightly increased. In some countries the growth of the organic potato area exceeds the development of the organic arable area while in other countries the potato area growth stays behind the growth of organic acreage.

Table 3.7 gives an impression of the area of organic potatoes in each country. In all countries except Germany the organic potato area is rather small and less than 1000 hectares.

Table 3.7. Area organic arable farming and organic potato area (1998). Source: FAOstat and Lampkin et al., 2000, Own data from national administration and certification bodies

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom
Total organic arable agricultural area (ha)	38'787	35'900	140'000	4'948	1'045	4'366	8'248
Total organic potatoes (ha)	755	579	4'700	749	125	500	911
Total potatoes (ha)	36'000	164'000	297'267	126'528	16'900	13'866	164'100
Percent potato in organic crop rotation	1.95%	1.61%	3.36%	15.14%	11.96%	11.45%	11.05%

The proportion of potato area divided by the total arable area roughly indicates the intensity of organic potato production in different countries. Figure 3.1 gives an impression of the intensity of conventional and organic potato growing. The intensity of potato growing is considered as a risk factor for late blight infection. In most countries except the United Kingdom and The Netherlands the intensity of organic potato production is similar or less intensive as compared to conventional farming.

Use of potato

Table 3.8 indicates the relative importance of organic ware potatoes (for table and processing purposes respectively) and seed potatoes.

Table 3.8. Share of organic potatoes in terms of purposes (in %; 2000). Source: Own data from the processors and traders

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom
Table	76,2	89,5	Nd	76	100	72	80
Processing	2	0	Nd	4	0	16	10
Seed	21,8	11,5	Nd	20	Nd.	12	10

Nd: no data

The majority of all organic potatoes (at least 75%) in all countries is marketed as table potato. The distribution patterns of traditional and organic potatoes differ because a greater part of all conventional potatoes is used in the processing industry or sold as seed potatoes.

Early potatoes under fleece

In some countries (UK, CH) a very small part (< 1%) of the organic table potatoes is grown under fleece. Only in Denmark a more substantial part of all organic table potatoes (5%) is grown under fleece.

3.3.3 Yields, prices, and production

Yield

In all countries except Norway the average yield over 3 years of conventional ware potatoes reaches 35 to 45 tons per hectare (Fig. 3.2). The average yields of organic ware potatoes are 30% - 50% lower. In most countries the harvested yield is not completely marketable. Farmers are expected to deliver potatoes "field sorted", i.e. to make a first rough sorting (removal of stones, rotten potatoes, etc.). The marketable part differs between countries and depends largely on national and local circumstances (e.g. stony soils, crop management, market requirements). Depending on country, between 75% and 95% of the harvested organic potato yield is marketable.

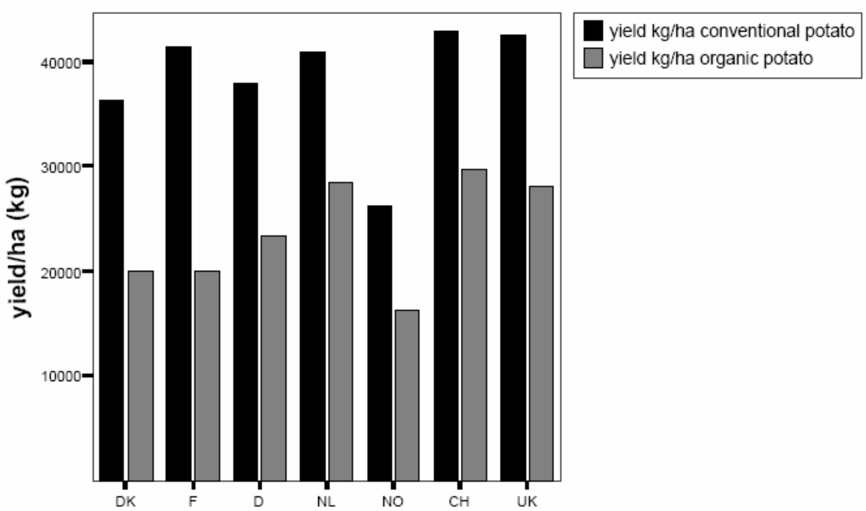

Figure 3.2. Average yields of conventional and organic ware potatoes per country (harvested kg/ha; 1998-2000)[3]. Source: Own data from the processors and traders. (Norway: organic yield as given in farmers' questionnaire)

Potato prices

Prices of organic and conventional potatoes differ considerably (Fig. 3.3). Interestingly, the relative price differences vary drastically between countries. In Germany, organic potatoes were up to 5 times more expensive than conventional, whereas in France, organic potatoes were app. 20% more expensive. Price differences give an indication of the economical attractiveness of organic potato growing. **3** Harvested yield is not marketable yield.

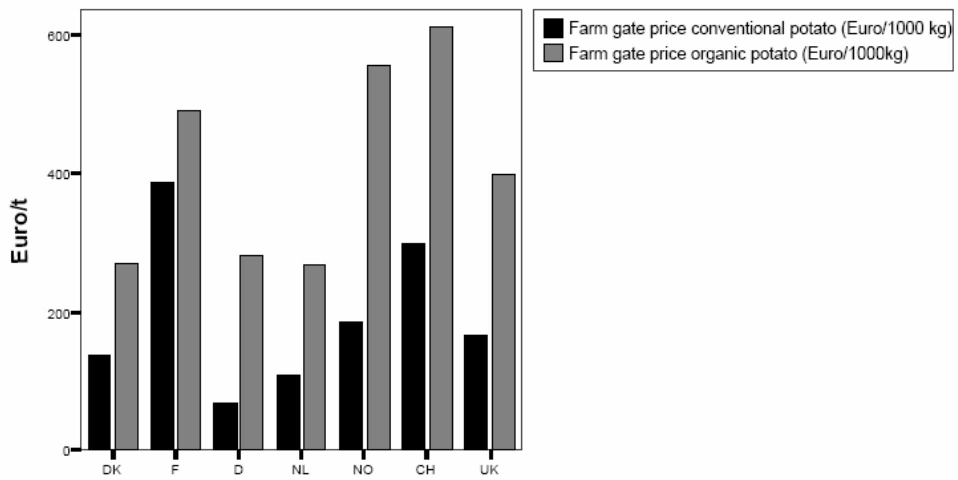

Figure 3.3. Average farm gate prices of organic and conventional ware potatoes (1998-2000; Euro per ton)[4]. Source: Own data from the processors and traders

Respondents were asked to give price information for the October delivery. The available price information contains effects of differences in delivery time, product quality, etcetera. Nevertheless, the price information in figure 3.3 gives a good impression. Due to bad weather conditions the potato yield of 1998 was extremely low in some countries. To make the price information somewhat more reliable 3 year averages have been calculated. Nevertheless, figure 3.3 shows substantial differences between potato prices.

The price differences between organic and conventional potatoes are enormous: in some countries organic potato prices exceed traditional prices by 200% to 300% or even more. In countries of non EUmembers (Norway, Switzerland) conventional potato prices are relatively high (regulated market by limiting imports); as a consequence, price differences between organic and conventional potatoes look not as extreme as elsewhere. It is known that in an open market product prices between organic and conventional differ more than in a limited market. The extent of price differences between conventional and organic products influence the farmers' decision to switch from conventional to organic farming.

The monetary output /ha also varies substantially between countries (Fig. 3.4). In general, organic potato production generated higher monetary output per ha than conventional production. In these cases, higher farm gate prices compensated for lower yields. However, in Denmark monetary yield was similar in both production systems, and in France the monetary output was lower in organic than in conventional production.

4 Swiss prices do not include the effects of sorting/grading, and organic potato prices represent Agria. French organic potato prices represent Charlotte.

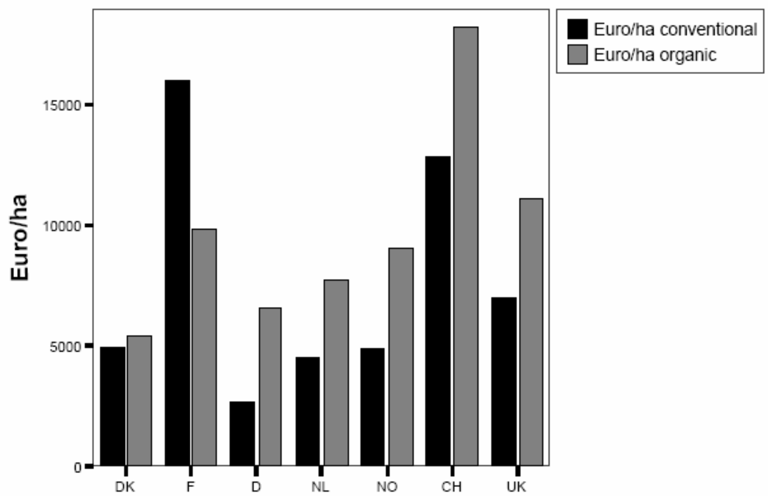

Figure 3.4. Average monetary output of organic and conventional ware potatoes (1998-2000). Source: Own data from the processors and traders

Ware potato production
Respondents were asked to collect data of the national ware potato production. These figures (Table 3.9) give approximate insight in the importance of the organic ware potato production through comparison with the conventional ware potato production. Table 3.9 shows the national production of organic and conventional potatoes of each country in 1998.

Table 3.9. Potato production in 1998. Source: Own data from the processors and traders

	DK	F	D	NL	NO	CH	UK
Conventional potato (tonnes)	311'260	4250'000	11338'000	2'210'491	434'000	545'020	6'100'000
Organic potato (tonnes)	12'980	11'500	107'000	20'000	2'000	14'980	25'500
Total (tonnes)	324'240	4'261'500	11445'000	2'230'491	436'000	560'000	6'125'500
Proportion of organic potato	0.040	0.002	0.009	0.008	0.004	0.026	0.004

Besides the differences between countries on the level of national potato production Table 3.10 shows clearly that in most countries, organic ware potato production is a small fraction (one percent or less) of the total ware potato production. Only in Denmark and Switzerland, the organic potato production fraction has exceeded the one percent level. Compared to the total potato production the extent of organic potato production is rather small. Nevertheless it is important to take into account the differences between the organic and conventional potato market. A large part of conventional potatoes is produced for the processing industry while most organic potatoes are used for fresh consumption (table potatoes). Organic potatoes are more important within the submarket of table potatoes than in the total ware potato market. In almost all countries industrial processing of organic potatoes is still unimportant.

3.3.4 Important varieties
Variety choice is a key factor in conventional and organic potato growing. All countries provide a list of available varieties. Farmers may select those varieties which correspond best with the conditions of their farming system and personal motives. To get some insight in the use of different varieties in different farming systems (conventional and organic) in each

country, partners were asked to give the national variety top five in 2000 for both conventional and organic potatoes. The respondents were also asked to add the acreage of each variety in 2000 if available. Unfortunately, only a few countries had these acreage data available. Table 3.10 gives an overview of the most important varieties used in conventional and organic farming per country.

Table 3.10. Top five of most important potato varieties used in conventional and organic farming (2000). Source: Own data from the processors and traders

	Denmark	France	Germany	The Netherlands	Norway	Switzerland	United Kingdom
Conventional							
1	Sava	Bintje	Agria	Bintje	Beate	Bintje	Maris Piper
2	Folva	Spunta	Cilena	Bildstar	Saturna	Agria	Estima
3	Bintje	Charlotte	Solara	Eigenheimer	Pimpernel	Eba	Cara
4	Ukama	Nicola	Quarta	Nicola	Laila	Sirtema	Saturna
5	Jutlandia	Désiree	Secura	Irene		Charlotte	Pentland Dell
Organic							
1	Sava	Charlotte	Linda	Santé	Troll	Agria	Santé
2	Folva	Juliette	Nicola	Agria	Peik	Sirtema	Nicola
3	Ditta	Mona Lisa	Agria	Escort	Mandel	Charlotte	Cara
4	Revelino	Spunta	Granola	Ditta	Oleva	Nicola	Valor
5	Marabel	Samba	Aula	Junior		Désiree	Claret

The combined top five lists of seven countries show an impressive number of different varieties used in practice: 26 varieties in conventional farming and 27 varieties in organic farming. Some varieties are used in both conventional and organic potato growing or in several countries. As expected, Bintje is still one of the most important multipurpose varieties but is grown in conventional farming only (four countries, three times number one). Agria is a well known alternative used in both conventional (two countries) and organic farming (four countries; in two cases number 1) as well. Nicola, Santé, Charlotte and Estima are popular varieties in organic farming. Besides international popular varieties some countries prefer other, local varieties. For instance, varieties used in Norwegian organic farming do not occur on top five lists of any other partner country. Most Norwegian varieties have been adapted to the northern conditions. Farmers select a variety because of more properties than blight resistance. However, a preliminary check on potato blight resistance of varieties listed in the Dutch variety list in table 3.10 show a higher resistance level of varieties used in organic farming.

3.3.5 Regional distribution

Compared to conventional farming the acreage of organic farming and potato cropping is very small in all countries. The relative importance of regions for potato production was assessed for both organic and conventional potato production. Organic potato is grown in the same regions as conventional potato. Therefore, experts were asked to indicate the main potato regions in their country including the conventional and organic area (hectare) and its share of the national conventional and organic potato area, respectively.

Denmark

The main part of the Danish potato production is concentrated in Jutland (figure 3.5). conventional

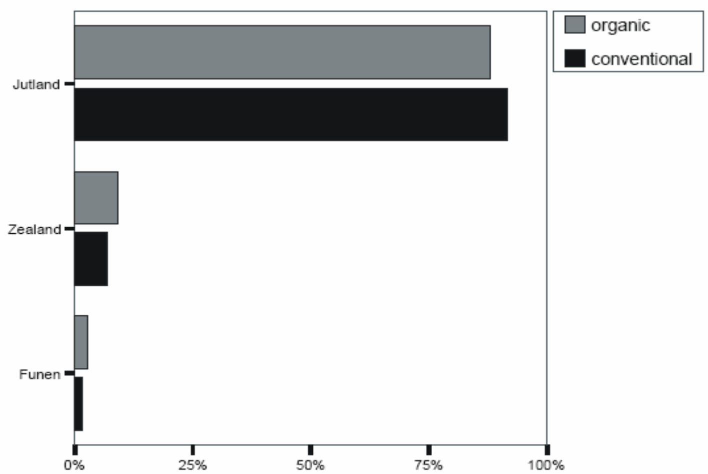

Figure 3.5. Regional production of potato in Denmark (% of total area). Source: Own data from the processors and traders.

It is remarkable that both conventional and organic potato production show almost the same figures per region. The national as well as the regional conventional potato areas are much larger than for organic potato. It is possible that potato growing in highly concentrated potato regions increases the late blight infection risk.

France

The organic potato area in France is rather small (579 ha) compared to the conventional potato area (164'000 ha). Figure 3.6 shows the most important regions of potato growing in France. The most important organic production areas do not match with the distribution of the conventional production areas. Organic potato growing is less important in traditional arable areas (Picardie, Nord-Pas de Calais) whereas the organic cropping system is more important in other regions (45% of the organic potatoes). Organic potato cropping in France is not concentrated in traditional arable regions but distributed more evenly over the country. Despite the small acreage organic potatoes have a better position in Bretagne and Rhône-Alpes. Bretagne is known as a region where traditional seed potato growing is concentrated.

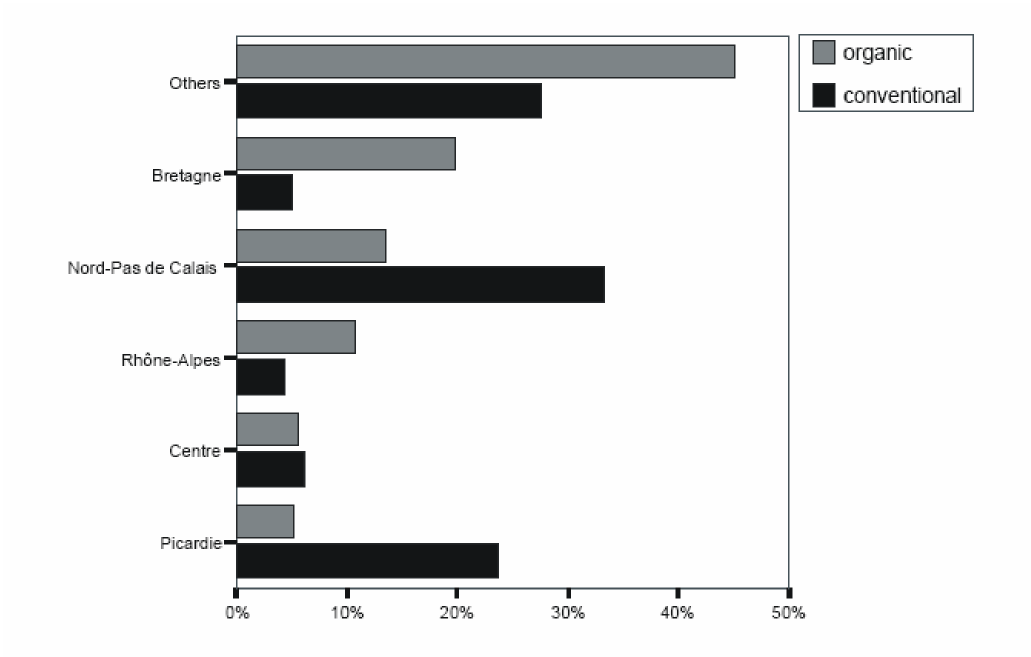

Figure 3.6. Regional production of potato in France (% of total area). Source: Own data from the processors andtraders.

Germany
Figures of the regional distribution and concentration of traditional and organic potato cropping in Germany were not available. In the opinion of the German partner in the Blight-Mop project organic potato production is less concentrated compared to traditional potato growing.

Netherlands
In contrast to France the distribution of organic potato growing in The Netherlands is more concentrated (figure 3.7). Almost 60 percent of the Dutch organic potatoes are grown in the province of Flevoland. This province is well suited for organic farming since the soil conditions are favourable and weed populations are well controlled. Furthermore, the market and the technical facilities are well established. This region is also an important area of conventional farming: 440 hectares of organic potatoes production are integrated in an area of 22’500 hectares of conventional potato production.

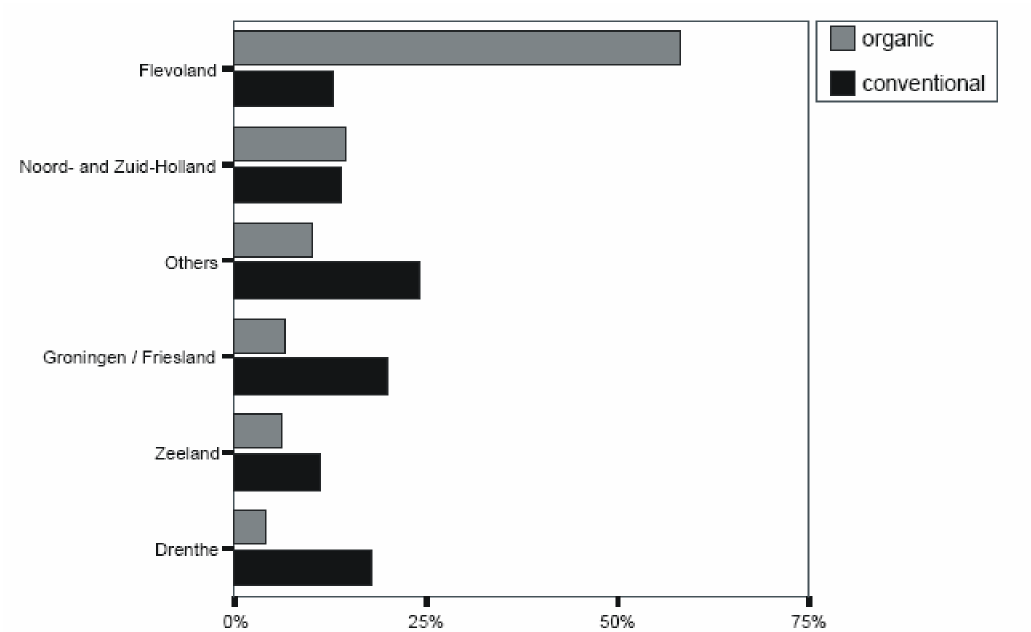

Figure 3.7. Regional production of potato in the Netherlands (% of total area).

Norway

In Norway almost fifty percent of the total organic potato area (160 ha) is grown in 'other regions' (Figure3.8). An important part (33%) of conventional potato growing is concentrated in the Hedemark region which has less than 20% of the organic potato area. Almost the same part of the organic potatoes grow in the Oppland region. The hilly Norwegian landscape differs strongly from the flat landscape in countries like The Netherlands or some parts of France. These differences of landscape partly explain differences in density and distribution of potato cropping. These data suggest that the small Norwegian organic potato area is distributed more evenly over the country than the conventional area.

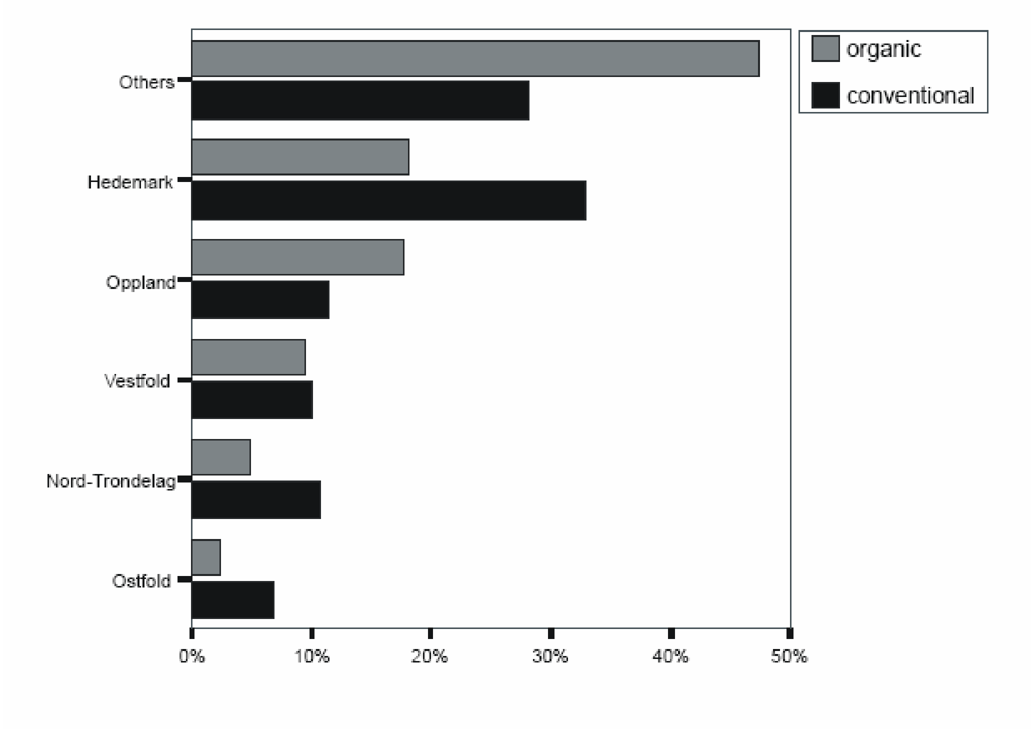

Figure 3.8. Regional production of potato in Norway (% of total area) United Kingdom
No regional figures were received from the United Kingdom.

Switzerland
In Switzerland, potato production is concentrated in three main regions. There is no detailed data on regional distribution of organic potato production available, but the distribution is assumed to be parallel. (figure 3.9). In the French-speaking part (‘Westschweiz) a lower proportion of organic potato production is expected as in this region organic production is less intensive as in the other regions.

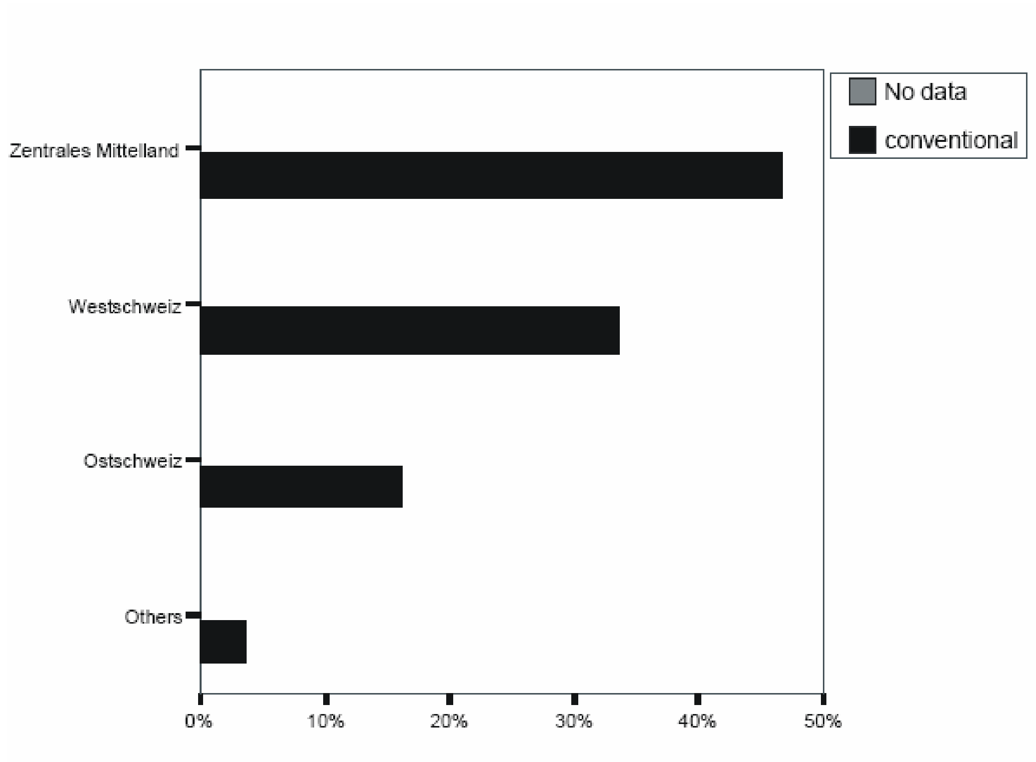

Figure 3.9. Regional production of conventional potato in Switzerland (% of total area).

3.3.6 International trade

International trade of organic potato tubers is generally expected to represent only a very small proportion of the total organic potato trade volume. However, respondents found it very difficult to obtain figures on processing, imports and exports of organic potatoes and organic potato products since trade companies are often reluctant to divulge figures or export destinations. As a consequence, the international market of organic potatoes is not transparent and therefore it is difficult to obtain insight.

Import: Except Denmark all countries import small volumes of organic potatoes. Almost ninety percent of these imports are destined for fresh consumption or seed potatoes. Only in the Netherlands a large part of the organic potato imports are industrially processed. Countries listed from which organic potatoes are imported: Spain, Italy, Austria, Netherlands, Israel and Denmark.

Export: A few countries (Denmark, Germany, The Netherlands, Switzerland) export organic potatoes
(fresh, seed) or organic potato products (prefried frozen).

3.3.7 Outlook

Market trends

The respondents were asked to describe their expectations of the development of the organic potato market in their country based on several criteria (figure 3.10). The scores range from strongly decreasing, decreasing, stable/unchanged, increasing to strongly increasing. The respondents were advised to consultofficial resources and stakeholders in order to obtain representative expectations.

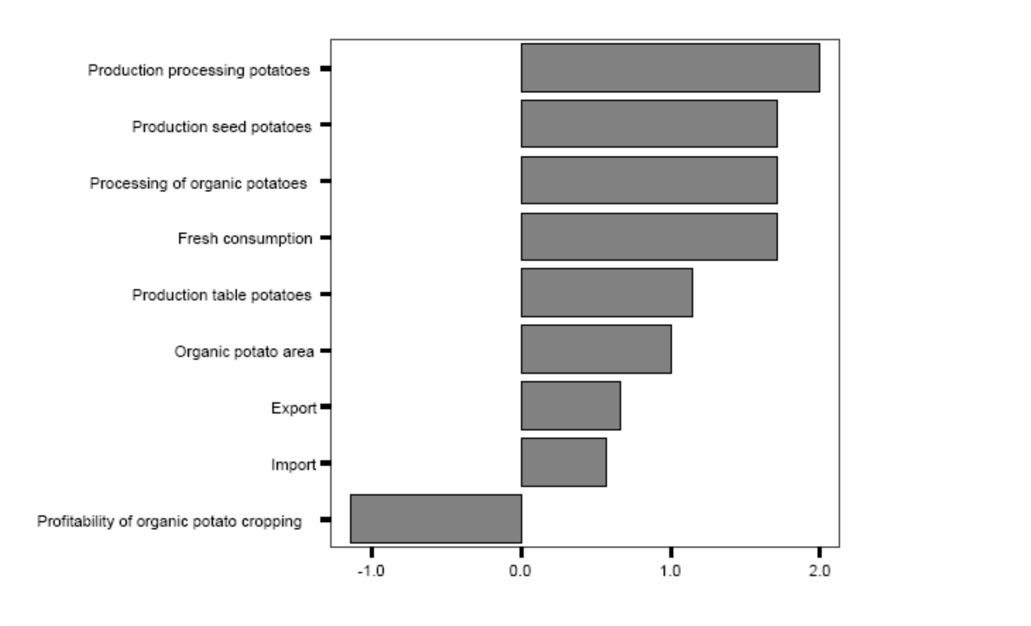

Figure 3.10. Expected developments in the organic potato market5. Source: Own data from the processors and traders.

All the respondents expect that the profitability of organic potato production will not improve in the near future. Expectations on profitability vary between stable to decreasing. These expectations are influenced by experiences of the organic potato market over the last years. For instance in Denmark, the production in 2001 decreased dramatically because of overproduction in 2000. The respondents expect the organic potato area will increase in Germany, The Netherlands, Norway and Switzerland whereas in France, United Kingdom and Denmark a stable to decreasing production is expected. However, the production of table, seed and processing potatoes has good prospects. The organic potato area is still too small to produce the minimal volumes necessary in the processing industry. An increase of area and production will improve the perspectives for the industrial processing of organic potatoes, in particular at small processing facilities. However, an increasing share of processed potato may influence the price negatively on the long term. It is expected that both, fresh consumption and the processing of organic potatoes will increase and will remain focused on domestic trade and home market. Imports and exports of organic potatoes are considered to be increasing but less important.

Consumer preferences

The country respondents were asked what consumers in their country mostly prefer when they buy organic potatoes. The experts had to rank 3 attributes out of 9. The results presented here are not based on full scale consumer panel research but give an assessment of the experts in seven countries. Almost all respondents indicate the cropping system as the most important motive to buy organic potatoes.

5 Score ranking: strongly decreasing (-2), decreasing (-1), stable/unchanged (0), increasing (+1), strongly increasing (+2).

Consumers intentionally select potatoes of organic origin when they buy them. The second most important motive is the price of organic potatoes. Next to these main preferences consumers also decide based on variety, taste, cooking type, outside colour and appearance. Convenience and inside colour are less important. Figure 3.11 shows the scores of consumers' preferences on different items per country as indicated by the respondents. Interestingly, motives to purchase organic potato seem to vary between countries.

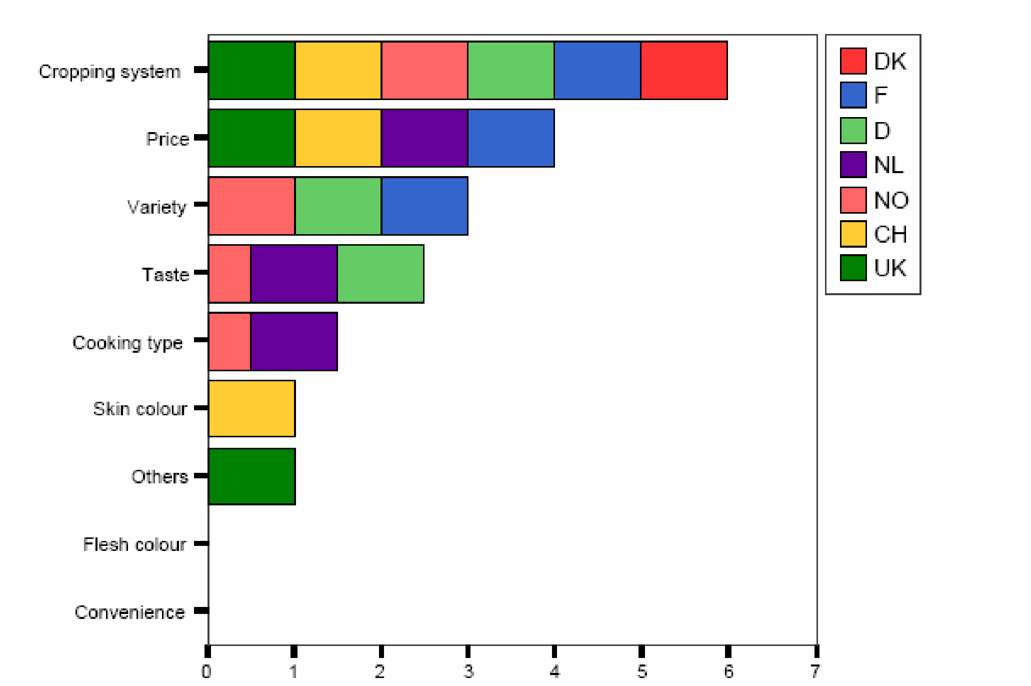

Figure 3.11. Relative importance of product attributes of potato for consumers in 7 European countries. Source: Own data from the processors and traders.

Preferences of industrial processors

The requirements of the industrial processors of organic potatoes do differ from the consumers' preferences (figure 3.12). They could give at most two answers out of five. No information has been received from France. Not all countries do have industries processing organic potatoes. Two attributes are of great importance to industrial processors: variety and processing quality. Outside quality and inner quality are less important to processors.

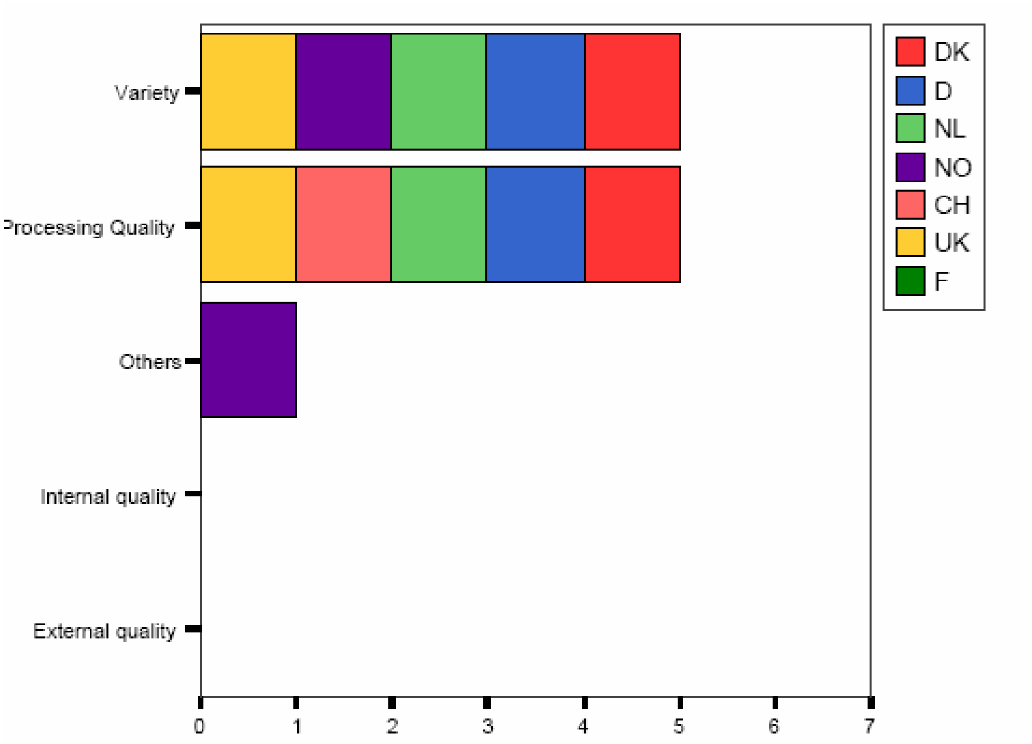

Figure 3.12. Quality requirements for organic potato processors in 7 European countries. Source: Own data from the processors and traders

3.3.8 Labels

The experts were asked which labels were applied in their country and how these labels are distributed among farmers. An overview of organic labels is given in table 3.11. In some cases labels overlap other labels. There is variation in number, kind and control of labels between countries. The Demeter label which is associated to bio-dynamic farming is present in most countries. The part of bio-dynamic farming is rather small compared to the total acreage and number of organic farms. In some countries chain partners like retailers have developed their own label to positively distinguish and profile their organic products and image.

Table 3.11. Organic labels in seven European countries (1998). Source: Own data from the processors and traders

	Label	Supervision	Surface (ha)	Certified farms
Denmark	Ø-Label	Controlled by the Danish Ministry of Food, Agriculture and Fisheries		
	LØJ – National Association of Organic Farming (Denmark)	Controlled by the National Association of Organic Farming (Denmark)		
France	AB (Agriculture Biologique)	Official label of the ministry of Agriculture	270000	9260
	Nature & Progrès	Obligatory members of AB	n.a.	450
	Demeter	Obligatory members of AB	4000	150
Germany	Bioland (since 1971)		129935	3583
	Demeter (since 1924)		51175	1336
	Naturland (since 1982)		55366	1357
	Biopark (since 1991)		127244	575
	Füllhorn, Bio-Wertkost, Bio-Siegel	"New label" names created by whole-salers. Products include products certifies under EU regulation 2092/91, but also products with "old labels" like Bioland, Demeter, Naturland. There is no information how these are distributed among the organic farmers. But the way of distribution are the big "conventional" stores like REWE, EDEKA or ALDI.		
Nether-lands	EKO	All organic farmers		2200
	Demeter	Bio Dynamic farmers		180
Norway	Ø-Label		98,6% of organic area	98,5% of organic farms
	Ø / Demeter Label		1,4% of organic area	1,5 % of organic farms
Switzer-land	Bio Suisse	Bio-Suisse + Migros Bio-production: 96.9%		
	Demeter	3% (2,97 are also Bio Suisse)		
	None	4.1%		
United Kingdom	Soil association (UK 5)	Largest certification body, all types of holdings (quality distribution)		
	Organic farmers and growers	Greater prevelance in meat / poultry production (holding type distribution)		
	Scottish organic producers association	Scottish sector body (regional distribution)		
	Organic Food Federation			

4 Inventory and state of the art of organic potato production techniques

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4.1 Introduction

Within Europe the economic impact of late blight varies between countries and regions. This is due to a variety of factors including climatic conditions, potato varieties used and agronomic techniques. So far, there is no comprehensive inventory available which describes in detail the potato production strategies which are currently used by organic farmers. As organic farming techniques have been developed to a large extent by pioneer farmers without much aid by scientists, techniques are not well described in the literature and successful techniques may be known only locally. Therefore, an in depth inventory of the potato production management is a useful tool to identify successful practices and also potential for improvements. The survey does not only include production techniques per se, but also information about the farm situation, local properties (soil, climate), social background of the farmer, and the economic context (e.g. market situation).

4.2 Methods

A total of 118 certified organic farms were selected in Denmark (n=15), France (n=15), Germany (n=15), Netherlands (n=19), Norway (n=20), Switzerland (n=19) and the United Kingdom (n=15) and interviewed in detail on their experiences in organic potato production. Farmers were selected in order to obtain a broad spectrum of type of production (organic and bio-dynamic), time period since conversion, and regional distribution. Farms included in this survey were for at least 2 years in organic agriculture and grew potato on a surface of at least 0.2 ha. Data at farm level were obtained by means of a structured interview of a stratified random set of 15 to 20 farmers in each of the 7 countries and analysis of historical data. The standardised recording protocol was prepared as a simple structured questionnaire by researchers from LEI and LBI. Data asked from the farmers included:

i) climatic conditions (local weather station data/blight forecasting systems used)
ii) agronomic techniques (crop rotation, planting dates for different cultivars, fertility inputs, weed/volunteer control, defoliation method/timing, application rates and frequency of copper/other permitted spray treatments, sanitation regimes used to prevent late blight)
iii) historic data on blight incidence, including the date of onset of blight and epidemic progress recorded in potato crops over the last 5 years (extension service trial/survey data) and
iv) potato cultivars grown, yields, market demand for different varieties, farm gate prices
v) Cropping plan, acreage, rotation, farm size, other activities
vi) Varieties, intended use of potato (ware, starch, seed), way of selling, yields, prices
vii) Inputs used, including costs (fertility inputs, seed potato, crop protection inputs) and field operations
viii) Last year's late blight infection and incidence, estimation of yield loss
ix) Experiences of farmers with existing blight management techniques
x) Farmer preference for different late blight management practices
xi) Late blight management practices used during the past 5 years
xii) Financial results at farm level
xiii) Farmer preference and market demand for varieties
xiv) Farmer age, education, knowledge of prevention strategies for late blight, personal objectives

Prior to the actual interviews, the draft questionnaire was revised by all project partners and adapted accordingly. The questionnaire6 was subsequently translated in local languages by each partner. The farmers were selected and interviewed in 2001.

Data were prepared for analysis in several steps. As a first step, data were transferred to excel sheets by each partner. As a second step, all original data were typed into an Access database prepared by LEI in order to avoid problems during data processing. Finally, a file ready for analysis by SPSS 10.0 was generated from the data base. This file contained a total of more than 1000 individual variables which were quantitative or categorial. Depending on the nature of the question, data were normal, binomial, or poisson distributed. The original data were submitted to thorough analysis for mistakes derived from data transfer and/or misunderstandings. All variables and results from analysis were examined by plausibility checks. The origin of suspect data were verified in the original interview sheets if necessary. Subsequently, summary descriptive statistics of the potato production techniques were generated by means of the statistical software package SPSS version 10.0. The data analysis was conducted at FiBL.

4.3 Results

4.3.1 Farm descriptions

A total of 118 farms was selected and interviewed in 2001 by members of the partner institutions. In order to obtain a wide range of production techniques, farms were selected based on geographic distribution, size, specialization, duration since conversion, and production method (i.e. organic and bio-dynamic producers). The total farm size varied between 3.8 and 1744 ha (Table 4.1). Accordingly, areas cultivated with potato differ substantially between individual farms. The ratio 'arable/total farm area' gives a rough indication on how much a farm specializes on arable/vegetable crops or relatively extensive animal husbandry. Most of the farms in this survey have high to very high ratios, indicating that arable crops are important. The ratio 'potato/area under cultivation' indicates the intensity of potato production in the crop rotation. Typically, farms use 5 to 15% of the arable area for potato crops. However, individual farmers have intensities of up to 30 to 47%, indicating very intensive crop rotations.

6 The questionnaire is available at www.orprints.org/00002936

Table 4.1 Land usage on interviewed farms

		total farm area (ha)	area under cultivation (ha)	area potatoes (ha)	arable/total farm area	potato/area under cultivation
Denmark	Median	103.70	100.00	12.00	.95	.11
	Minimum	30.60	29.00	3.00	.60	.03
	Maximum	420.00	266.00	33.10	1.00	.33
France	Median	55.50	40.50	4.00	.94	.11
	Minimum	9.72	8.10	.40	.67	.03
	Maximum	238.50	238.50	16.00	1.00	.41
Germany	Median	74.00	58.00	6.60	.99	.13
	Minimum	14.93	13.93	1.24	.59	.03
	Maximum	380.00	380.00	63.00	1.00	.47
Netherlands	Median	39.00	36.00	5.00	.96	.16
	Minimum	3.80	3.60	.60	.78	.05
	Maximum	1744.69	1696.69	95.56	1.00	.32
Norway	Median	54.60	20.35	1.25	.43	.06
	Minimum	6.80	3.00	.10	.02	.01
	Maximum	613.00	96.50	5.20	1.00	.14
Switzerland	Median	21.32	20.09	1.30	.93	.06
	Minimum	7.00	6.96	.30	.57	.02
	Maximum	135.00	117.00	6.00	1.00	.15
United Kingdom	Median	121.00	106.00	9.60	.91	.11
	Minimum	23.00	18.00	1.00	.35	.02
	Maximum	445.00	436.00	81.00	1.00	.38
Total	Median	54.10	39.75	3.80	.94	.10
	Minimum	3.80	3.00	.10	.02	.01
	Maximum	1744.69	1696.69	95.56	1.00	.47

In order to assess the degree of specialization on potato production, the farmers were asked to indicate the amount of time the invest in arable crops and more specifically in potato growing as opposed to the time investment in animal husbandry. As Table 4.2 indicates, there is a high variability between farms, ranging from farms where only minute amounts of time are devoted to highly specialized farms that invest - according to the farmer - up to 90% of total time in potato production. At a later stage in the data analysis, the parameter ‘time investment in animal husbandry’ was also used as a rough indicator on availability of manure for fertilization. The available manpower varies considerably between farms, reflecting the broad range of farms that have been selected for the survey (table 4.3).

Table 4.2 Percentage of labour time devoted on arable crops, potato cultivation and animal husbandry on interviewed farms

County		arable farming	potato production	animal husbandry
Denmark	Median	50	20	35
	Minimum	20	5	0
	Maximum	100	40	80
France	Median	60	15	0
	Minimum	1	1	0
	Maximum	100	50	40
Germany	Median	40	20	15
	Minimum	13	5	0
	Maximum	100	90	70
Netherlands	Median	60	13	0
	Minimum	10	3	0
	Maximum	100	35	70
Norway	Median	10	7	71.5
	Minimum	2	2	10
	Maximum	40	30	95
Switzerland	Median	30	8	58
	Minimum	5	2	0
	Maximum	50	20	75
United Kingdom	Median	43	10	20
	Minimum	10	5	0
	Maximum	100	75	66
Total	Median	30	10	30
	Minimum	1	1	0
	Maximum	100	90	95

Table 4.3. Available labour on interviewed farms

Table 4.3. Available labour on interviewed farms

Country		total labour full >6 months	total labour part > 6 months	total labour full < 6 months	total labour part < 6months
Denmark	Median	2	0	0	1
	Minimum	0	0	0	0
	Maximum	10	1	3	100
France	Median	2	0	0	0
	Minimum	0	0	0	0
	Maximum	6	2	1	12
Germany	Median	3	1	0	0.5
	Minimum	1	0	0	0
	Maximum	14	5	1	5
Netherlands	Median	2	1	0	1
	Minimum	1	0	0	0
	Maximum	no data available	no data available	no data available	no data available

Country		total labour full >6 months	total labour part > 6 months	total labour full < 6 months	total labour part < 6months
Norway	Median	1	1	0	2
	Minimum	0	0	0	0
	Maximum	7	3	9	11
Switzerland	Median	2	1	0	0
	Minimum	0	0	0	0
	Maximum	8	30	2	4
United Kingdom	Median	3	0	0	2.25
	Minimum	0	0	0	0
	Maximum	26	30	4	50
Total	Median	2	0	0	0
	Minimum	0	0	0	0
	Maximum	26	30	9	50

The selected farms represent all important organic production labels (Table 4.4). Demeter which is the international label of the biodynamic farmers totals 20% whereas the organic production totals 80% of all interviewed farms.

Table 4.4. Labels of the interviewed farmers

	n	Percent
EKO/Ø	23	19.5
Demeter	24	20.3
BIO-SUISSE	16	13.6
Bioland - Verband für ökologischen Landbau e.V.	11	9.3
Debio	18	15.3
Soil Association	10	8.5
Organic Farmers and Growers	1	.8
Scottish Organic Producers Association	1	.8
Organic Farm Food	1	.8
Agriculture Biologique	11	9.3
Nature et Progrès	1	.8
Qualité France	1	.8
Total	118	100.0

The interviewed farmers use the potential outlets very individually, indicating that highly market oriented producers as well as farmers who produce for local consumption are included in the survey. However, the selected farmers tend to market a large proportion via wholesalers, cooperatives and growers' associations (Table 4.5).

Table 4.5. Farm outlets used by organic potato growers

Country		Own use	Direct Farm Sales	Farmers market	Organic vegetables boxes	Whole-saler	Co-op-erative	Growers' association	Others
Denmark	Mean	2	5	0	0	15	42	36	0
	Median	0	0	0	0	0	50	25	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	5	30	100	95	100	100	60	50
France	Mean	1	4	16	12	33	23	8	4
	Median	0	0	0	0	0	0	0	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	1	85	50	30	98	80	77	19
Germany	Mean	0	21	3	2	55	7	10	1
	Median	0	10	0	0	65	0	0	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	1	45	0	25	100	100	20	100
Netherlands	Mean	0	7	0	3	15	64	1	10
	Median	0	0	0	0	0	83	0	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	20	60	25	30	95	96	0	15
Norway	Mean	2	10	3	3	13	65	0	2
	Median	0	5	0	0	3	80	0	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	30	40	0	0	99	100	25	80
Switzerland	Mean	6	11	0	0	9	59	3	13
	Median	2	5	0	0	0	70	0	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	50	50	20	50	100	100	100	30
United Kingdom	Mean	4	5	2	10	55	12	10	2
	Median	0	0	0	0	79	0	0	0
	Minimum	0	0	0	0	0	0	0	0
	Maximum	50	85	100	95	100	100	100	100
Total	Mean	2	9	3	4	26	42	9	5
	Median	0	3	0	0	0	30	0	0

4.3.2 Experiences on potato production 1996-2000

In the period from 1996 to 2000 organic farmers reached potato yields from virtually nil to more than 50 tons/ha (Fig. 4.1). The data suggest that in the UK, Switzerland and the Netherlands higher yields are reached than in Germany, France and Norway. The fact that individual years are more or less favourable for potato growing is also well reflected in these data. However, the variability between individual farms within a country is much larger that any other effect. For instance, yields varied in the Netherlands in 1996 between approximately 20 and almost 60 tons per ha.

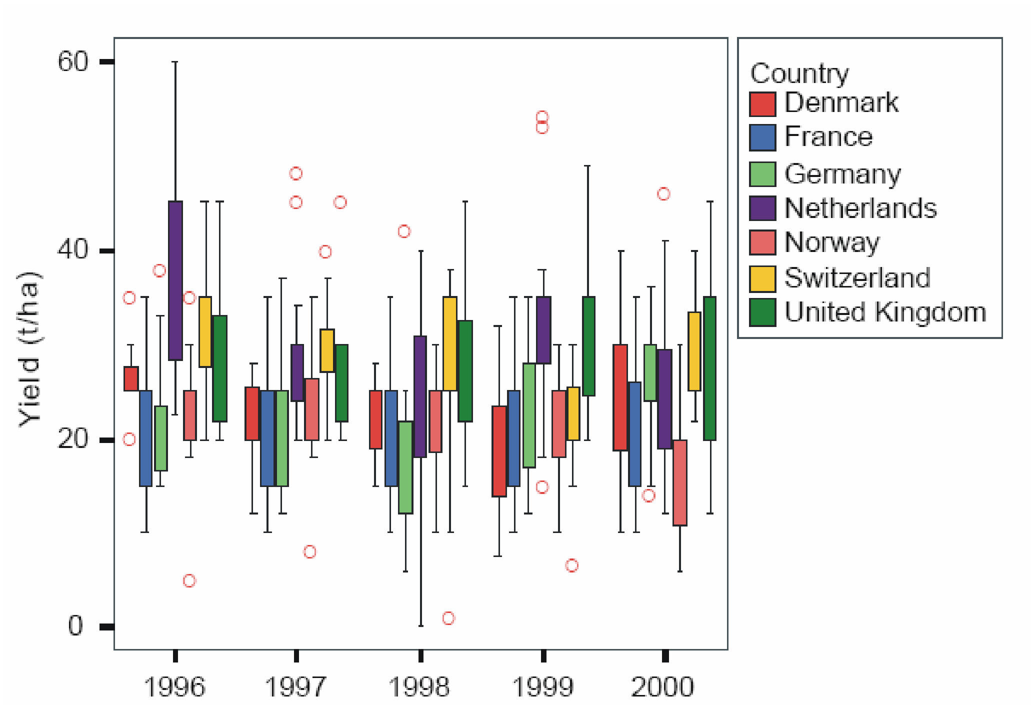

Figure 4.1. Potato yields on organic farms 1996-2000. Boxes include 50% of all values; circles indicate outlier values

Post-harvest losses due to pests and diseases were experienced by a large proportion of farmers. The extent of losses was estimated between 5 and 10% but reached up to 100% in extreme cases (Figure 4.2).

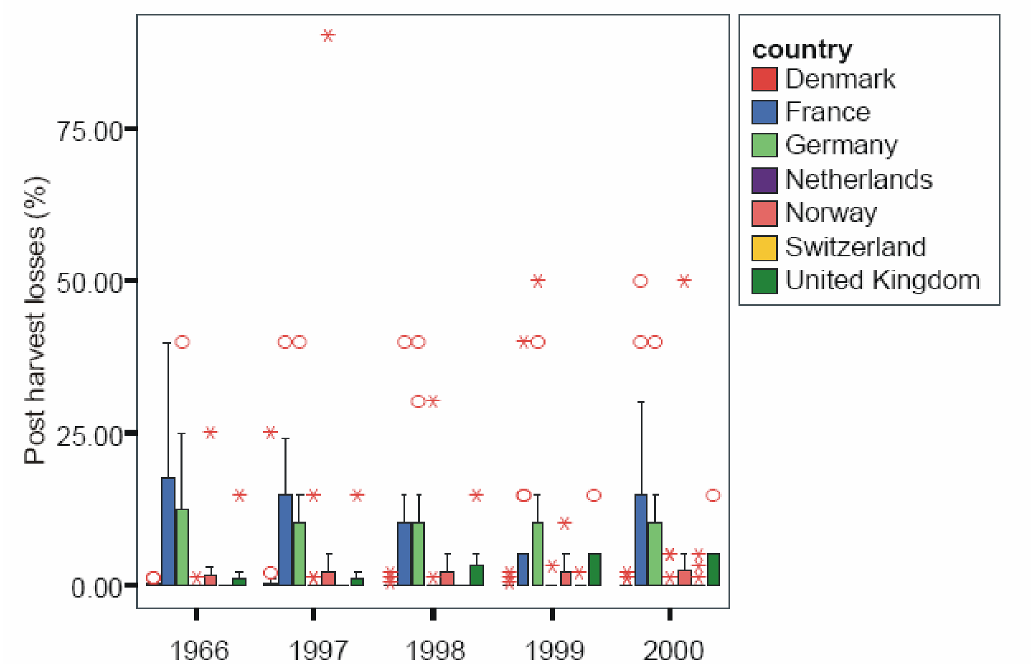

Figure 4.2. Post harvest losses (estimated percentage of total yield) experienced by organic farmers in 1996-2000

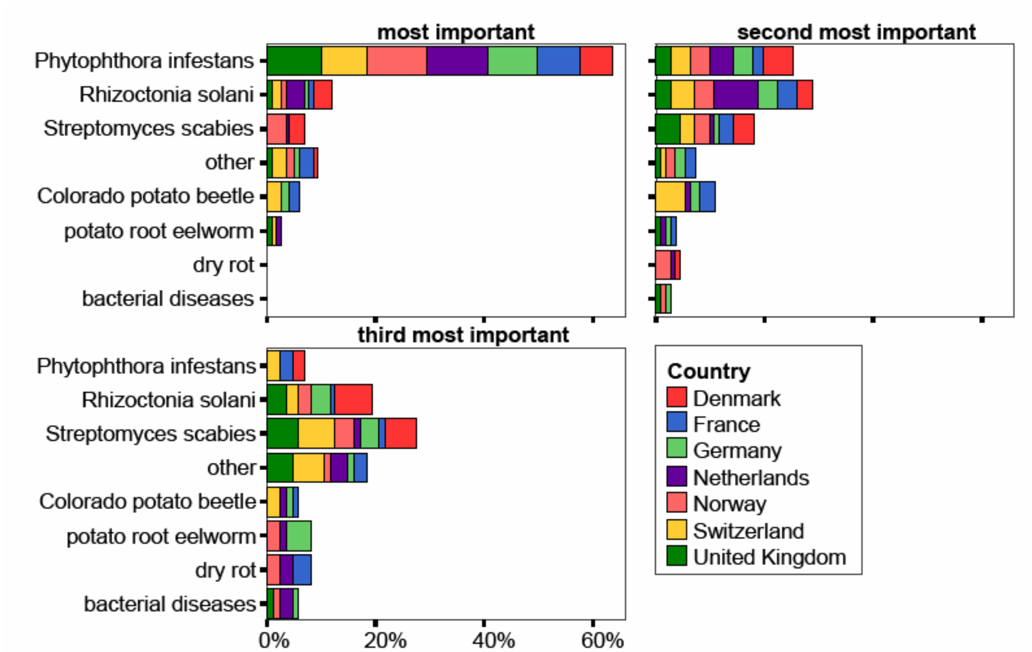

Figure 4.3. Relative importance of pests and diseases 1996 - 2000. The rank indicates the pest/disease which hasbeen mentioned most often in all three categories

Between 50 and 100% of the interviewed farmers also reported that, depending on region and year, late blight epidemics caused yield losses (Table 4.6). Late blight epidemics and yield losses are experienced regularly in UK and the Netherlands, whereas the epidemic seems to occur more erratically in France or Switzerland. Organic farmers have been criticised because of late Blight epidemics by neighbouring (conventional) farmers, in particular in the Netherlands, Switzerland and Norway (Table 4.7). This indicates that late blight epidemics, in particular if originating on organic farms, can expose farmers to criticism.

Table 4.6. Proportion of farms where a late blight epidemic occurred and losses were experienced (%)

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	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom	Total
1996	58	69	86	75	73	43	88	70
1997	64	50	87	94	83	44	89	73
1998	57	57	93	100	74	29	92	72
1999	100	50	87	95	75	74	93	82
2000	60	67	93	100	80	68	93	81

Table 4.7. Proportion of farmers who have been criticized by neighbours because of late blight outbreaks (%)

Table 4.7. Proportion of farmers who have been criticized by neighbours because of late blight outbreaks (%)

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom	Total
1996	8	0	0	17	13	6	0	7
1997	7	0	0	17	17	6	0	7
1998	0	0	7	21	16	17	0	10
1999	0	0	0	16	15	26	7	10
2000	0	7	7	21	15	16	0	10

4.3.3 Potato production strategies in 2000

The inventory of the state of the art production technique is based on a detailed description of the 'reference plot' in the 2000 growing season. All farmers in the survey were asked to denote one particular plot as the 'reference plot'. The plot was, according to the farmer, representative of the farm. In most cases, it was the largest plot of the farm with the most important variety.

4.3.3.1 Yields, quality and market in 2000

The potato gross yields obtained on the reference plots in 2000 varied between 5 and approximately 50 tons per ha (Figure 4.4). As suggested by the data from earlier years, yields vary substantially between individual farms. The proportion of marketable yield varied between less than 40% to up to 100% in the best cases (Figure 4.5). The 2000 potato crop included ware, seed, and processing potatoes. In all countries, the potatoes were sold between July 2000 and June 2001 (Table 4.8). The farms sell most of the potato crop in autumn, indicating that the main proportion of potato is not stored on the farm. In contrast, Danish farms sell the major proportion of the harvest in spring. Farm gate prices (Table 4.9) varied substantially between commodity, country and throughout the season. On average, ware potatoes were sold at approximately 0.55 Euro/kg. However, prices during the season varied in countries such as Denmark between 0.15 and 0.64 Euro. Seed potatoes were only slightly more expensive than ware potatoes. However, these data may not be representative as only few farmers referred to seed potato as a reference. Farm gate prices for packaged ware potatoes were approximately 0.20 Euro higher than unpackaged potatoes (Table 4.10).

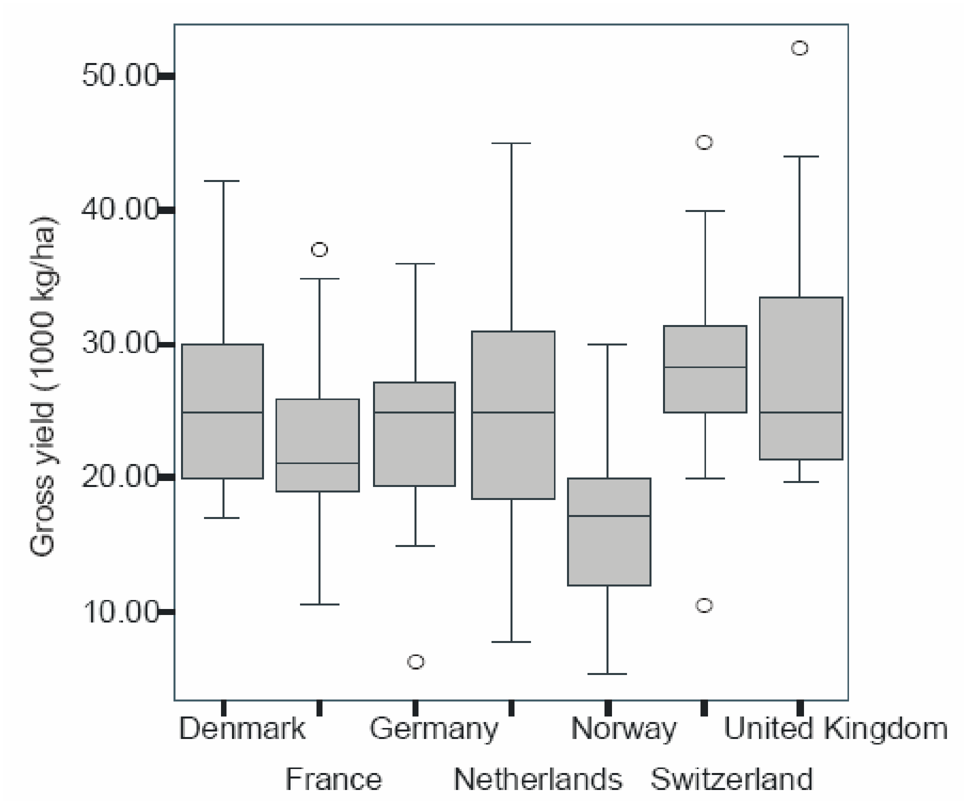

Figure 4.4. Gross yields obtained on reference plots in 2000

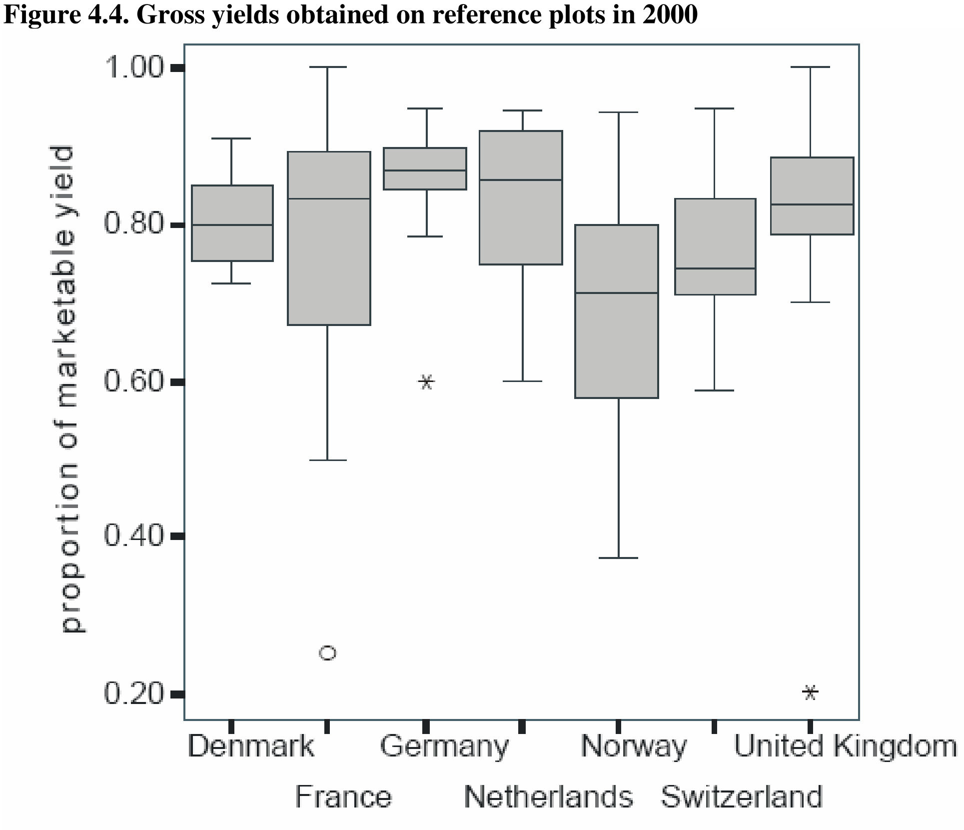

Figure 4.5. Proportion of marketable yield on reference plots in 2000.

Table 4.8. Commercialization of the total 2000 harvest (tons) from reference plots (seed, ware, and processing potato)

Country	Commodity	July-August	September-October	November-December	January-February	March-April	May-June
Denmark	seed	0.0	0.0	0.0	0.0	92.4	0.0
	ware	27.0	178.0	164.0	289.5	607.1	112.5
	Total	27.0	178.0	164.0	289.5	699.5	112.5
France	seed	0.0	89.0	9.0	9.0	8.0	2.0
	ware	284.8	278.5	77.2	66.2	10.1	14.6
	Total	284.8	367.5	86.2	75.2	18.1	16.6
Germany	seed	0.0	0.0	0.0	0.0	168.0	0.0
	ware	0.0	58.2	340.7	75.8	84.7	34.2
	proc	0.0	152.0	0.0	0.0	0.0	0.0
	Total	0.0	210.2	340.7	75.8	252.7	34.2
Netherlands	seed	19.9	0.0	0.0	16.5	16.4	0.0
	ware	431.3	505.9	263.0	321.0	264.4	163.3
	proc	69.0	9.1	0.0	0.0	0.0	0.0
	Total	520.2	515.0	263.0	337.5	280.8	163.3
Norway	ware	5.7	64.9	72.8	54.4	23.2	0.5
	Total	5.7	64.9	72.8	54.4	23.2	0.5
Switzerland	ware	85.7	130.6	74.0	7.1	11.7	15.1
	proc	3.2	70.0	0.4	0.0	0.0	0.0
	Total	88.9	200.6	74.3	7.1	11.7	15.1
United Kingdom	ware	143.0	426.0	474.3	96.3	65.4	25.0
	Total	143.0	426.0	474.3	96.3	65.4	25.0
Total	seed	19.9	89.0	9.0	25.5	284.8	2.0
	ware	977.5	1642.0	1466.0	910.3	1066.6	365.2
	proc	72.2	231.1	0.4	0.0	0.0	0.0
	Total	1069.6	1962.1	1475.3	935.8	1351.4	367.2

Table 4.9. Farm gate prices (Euro) of the 2000 potato (seed, ware, and processing potato) derived from referenceplots

Country	Commodity	July-August	September-October	November-December	January-February	March-April	May-June
Denmark	seed					0.23	
	ware	0.64	0.40	0.26	0.17	0.15	0.15
France	seed		0.74	0.88	0.88	0.88	1.00
	ware	0.46	0.51	0.67	0.69	0.57	0.69
Germany	seed					0.46	
	ware		0.57	0.49	0.58	0.59	0.61
	proc		0.19				
Netherlands	seed	0.23			0.39	0.39	
	ware	0.38	0.36	0.43	0.47	0.30	0.39
	proc	0.05	0.06				
Norway	ware	0.83	0.78	0.72	0.63	0.70	1.11
Switzerland	ware	0.68	0.70	0.84	0.89	0.89	0.83
	proc	0.50	0.50	0.50			
United Kingdom	ware	0.66	0.48	0.46	0.45	0.43	0.48
Average	seed	0.23	0.74	0.88	0.72	0.50	1.00
	ware	0.58	0.60	0.57	0.54	0.49	0.62

Table 4.10. Farm gate prices (Euro) of the in 2000 harvested ware potato (packaged or bulk) derived from reference plots

Country	Sale	July-August	September - October	November - December	January-February	March-April	May-June
Denmark	packaged	1.07	0.63	0.33	0.33	0.33	
	bulk	0.20	0.25	0.23	0.14	0.13	0.15
France	packaged	0.66	0.59	0.68	0.71	0.54	0.69
	bulk	0.25	0.47	0.65	0.65	0.61	
Germany	packaged		0.60	0.53	0.60	0.62	0.65
	bulk		0.36	0.29	0.36	0.36	0.41
Netherlands	packaged	0.56	0.38	0.38	0.38	0.38	0.19
	bulk	0.35	0.35	0.49	0.54	0.26	0.49
Norway	packaged	0.83	0.80	0.72	0.64	0.72	1.11
	bulk		0.56		0.58	0.62	
Switzerland	packaged	0.72	0.84	0.85	0.92	0.95	0.88
	bulk	0.51	0.50				
United Kingdom	packaged		0.51	0.50	0.54	0.48	0.48
	bulk	0.66	0.46	0.40	0.37	0.38	
Average	packaged	0.77	0.62	0.57	0.59	0.57	0.66
	bulk	0.39	0.42	0.41	0.44	0.39	0.35

The quality of the potato crop harvested in 2000 was assessed by 74% of the farmers as equal or better than average, whereas 27% of the farmers stated that the quality was lower than average. However, as much as 40% of the German farmers reported inferior quality (Table 4.11). Buyers complained about a wide range of quality flaws but even the most frequent quality problems 'green tubers' and 'small grade tubers' were mentioned in only five cases (table 4.12). Buyers complained about quality problems in 8 to 38% of farms (table 4.13).

However, remarks on quality problems were only rarely followed by either price reductions or refusal of the batch, indicating that the problems were not severe.

Table 4.11. Quality assessment of the 2000 potato harvest

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom	Total
Low	27	20	40	29	15	32	31	27
Normal	40	47	33	53	35	47	46	43
High	33	33	27	18	50	21	23	30
Total	100	100	100	100	100	100	100	100

Table 4.12. Quality problems reported by buyers of potato in 2000

Quality problem	Denmark	France	Ger-many	Nether-lands	Norway	Switzerland	United Kingdom	Total
Green tubers	2				2	1		5
Small size grade						1	4	5
Mechanical damage	2	1					1	4
Agriotes sp.					1	2		3
Much tare	1						1	2
Glassiness of the tuber				2				2
Much soft rot	1				1			2
Much Rhizoctonia						2		2
Common scab	1						1	2
Common potato scab			1			1		2
After-cooking darkening	1							1
Hollow hearts and green tubers	1							1
Streptomyces		1						1
Click beetle		1						1
White spots			1					1
Had table potato				1				1
Hollow				1				1
Virus					1			1
Blue tubers due to lack of potassium					1			1

Table 4.13 Complaints about quality and penalties imposed by buyers

	Denmark	France	Germany	Netherlands	Norway	Switzer-land	United Kingdom	Total
no complaints	62	75	92	73	75	75	67	74
complaints	38	25	8	27	25	25	33	26
	100	100	100	100	100	100	100	100
regular price	93	93	86	89	95	95	87	91
price reduction	7	7	14	0	5	5	0	5
batch rejected	0	0	0	11	0	0	13	3
	100	100	100	100	100	100	100	100

4.3.3.2 Key dates of potato crop management and late blight occurrence in 2000

The key events of the potato management in the season 2000 are described in Figure 4.6. The relative earliness or delay of specific actions or phenological stages follow as much the geographic latitude of the countries as the relative mildness of the climate. However, there is a large variability within country. In France, for instance, the planting date may differ as much as 14 weeks. In other countries such as Denmark the planting concentrates in one single week. First occurrence of *Phytophthora infestans* was generally reported within the country much earlier than the epidemic started in the reference plots. Exceptions as observed in France (first regional report later than first report in reference plot) show that in some cases the observation networks might overlook an outbreak or a symptom might be misjudged.

4.3.3.3 Soil fertility management strategies 2000

The data on potato management strategies are based on one reference plot per farm. The size of the reference plots varies between 0.2 ha to more than 30 ha. However, typical plot sizes are approximately 3 ha in most countries. In Norway and Switzerland plot sizes tend to be 1 ha or less (Figure 4.6). All soil types were present but 'loamy sand' and 'clay loam' soils were most frequent (Table 4.14). The nutrient status was described for potassium and phosphorus. Almost half of the reference plots were deficient in potassium or showed a tendency to low potassium contents. Approximately 30% of the 'loam' and 'fine sand' soils were described as rich in potassium (table 4.14). Deficiencies in phosphorus levels were reported only rarely, indicating that phosphorus was not considered a limiting factor for potato production. Most of the farmers stated that the soil structure was good, only 'clay loam' and 'loam' soils showed a tendency to suboptimal structure and drainage capacity. The farmers stated that the position in the crop rotation was the single most important motive to select the plot for potato production. Other potential motives such as distance to other potato plots or superior microclimate were considered as important motives only by few farmers.

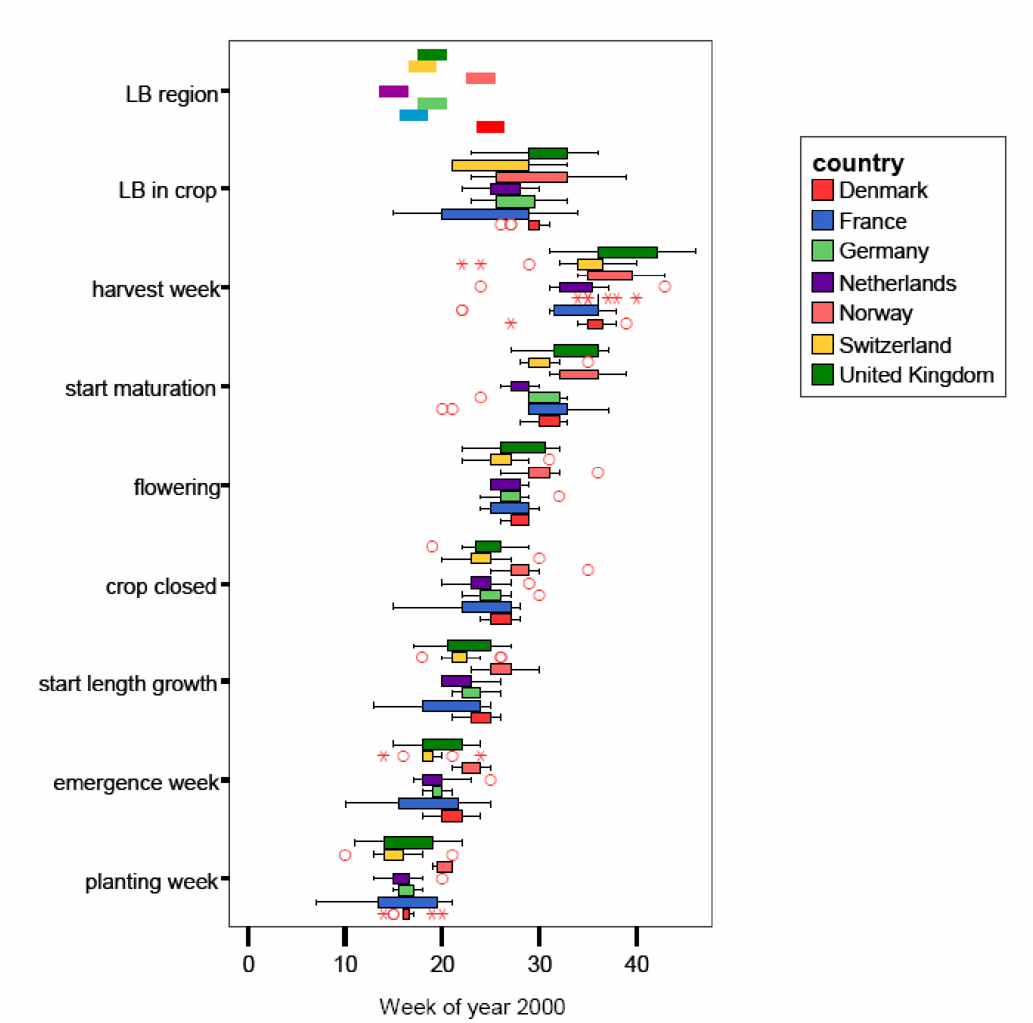

Figure 4.6. Key events of the potato crop in the season 2000 (LB region: first observation of late blight within the region of the farmer; LB in crop: Late blight observed in reference plot).

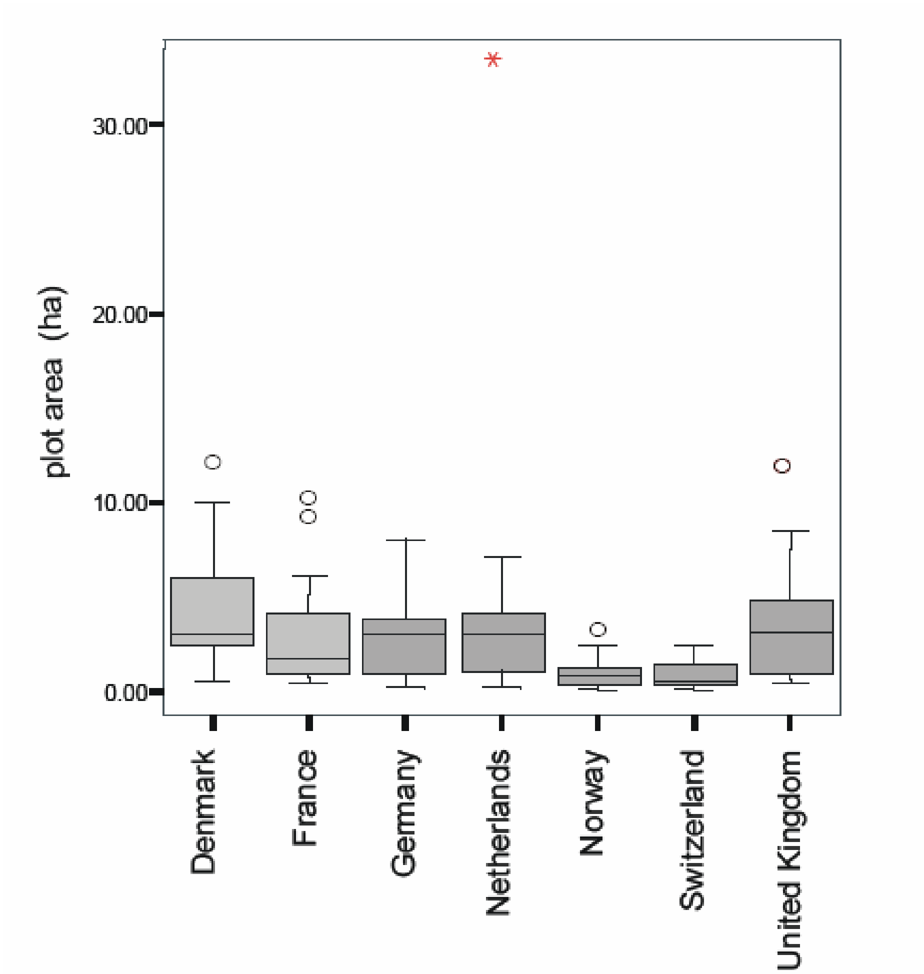

Figure 4.6. Size of selected potato reference plots in 7 European countries in 2000.

Crop rotation is a crucial element of the soil fertility management strategy. Figure 4.8 shows the crop rotations on all reference plots, sorted by similarity. Approximately 40% of the farmers grow as a precrop to potato cereals, 40% grass/clover for feed production, and 20% vegetable/root crops. Extreme crop rotations which are focussed on two commodities only such as cereals-potato, grass/clover-potato, or vegetables-potato do exist but are relatively rare. A majority of the farms prefers more diverse rotations with a potato crop every 4th to 7th year. Green manures between cereals or vegetables/root crops and potato are grown by approximately 40% of the farmers. The crop rotation patterns are not typical for specific countries/regions and there is no obvious relationship between soil type and crop rotation, indicating that farmers adapt the crop rotation pattern to specific needs and less to the environment.

Table 4.14. Soil types on the reference plots (% of plots in specific soil type category)

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom
Clay		43		47		26	
Coarse sand	60						
Fine sand	20			11	5		7
Sand		7	7	16	30	21	7
Sandy loam / loamy sand	20	7	73		45	32	33
Clay loam		21	7			21	40
Loam		14	13	26	15		13
Organic soil / peat				5			1
Chalk soil		7					
	100	100	100	100	100	100	100

Table 4.15. Part 2: Nutrient status and soil structure by soil type (% of soils in nutrient status category)

		Clay	Coarse sand	Fine sand	Sand	Sandy loam / loamy sand	Clay loam	Loam	Organic soil / peat	Chalk soil
Potassium level	missing data						10			
	Low		14	14	27	13	20	7		
	Low - normal	7	43	14	20	25	30	7		
	Normal	27	29	29	13	41	30	36	100	
	normal - high	33	14	14	40	9	10	29		
	High	33		29		13		21		
	Total	100	100	100	100	100	100	100	100	
Phos-phorus level	Low	13		14	7	3	10	7		
	low - normal	7	57	43	7	16	30	14	100	
	Normal	20	14	29	27	35	60	36		
	normal - high	33	14		40	29		14		
	High	27	14	14	20	16		29		
	Total	100	100	100	100	100	100	100	100	

Table 4.15. Part 2. Nutrient status and soil structure by soil type (% of soils in nutrient status category)

		Clay	Coarse sand	Fine sand	sand	Sandy loam / loamy sand	Clay loam	Loam	Organic soil / peat	Chalk soil
Drainage, ditches	good	70	89	71	73	69	43	64	100	
	moderate	25	11	29	13	23	43	21		100
	poor	5			13	6	14	14		
	no drainage					3				
	Total	100	100	100	100	100	100	100	100	100
Post-winter soil structure	weathered	80	78	100	88	89	64	79	100	100
	compacted	20	22		13	11	36	21		
	Total	100	100	100	100	100	100	100	100	100

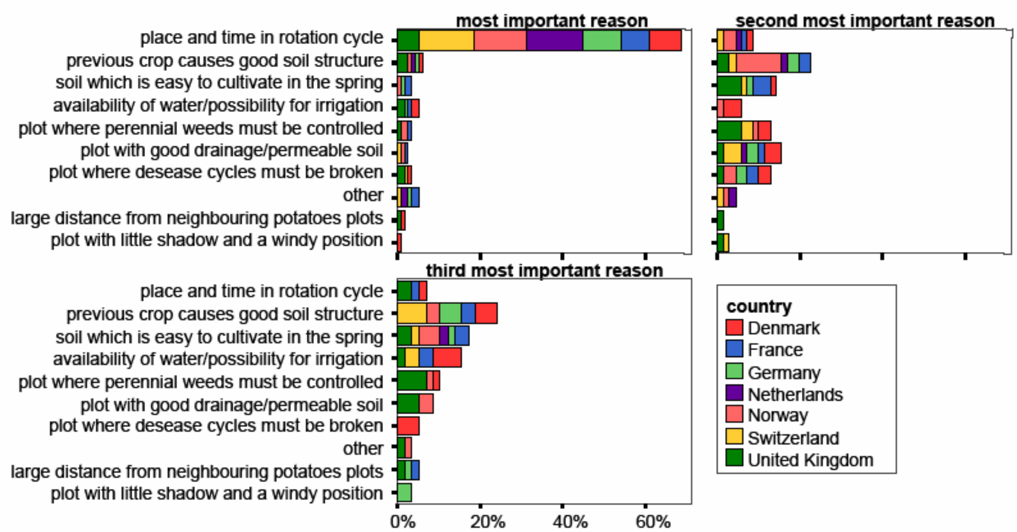

Figure 4.7. Motivation of the farmers to select the plot for potato cultivation 2000

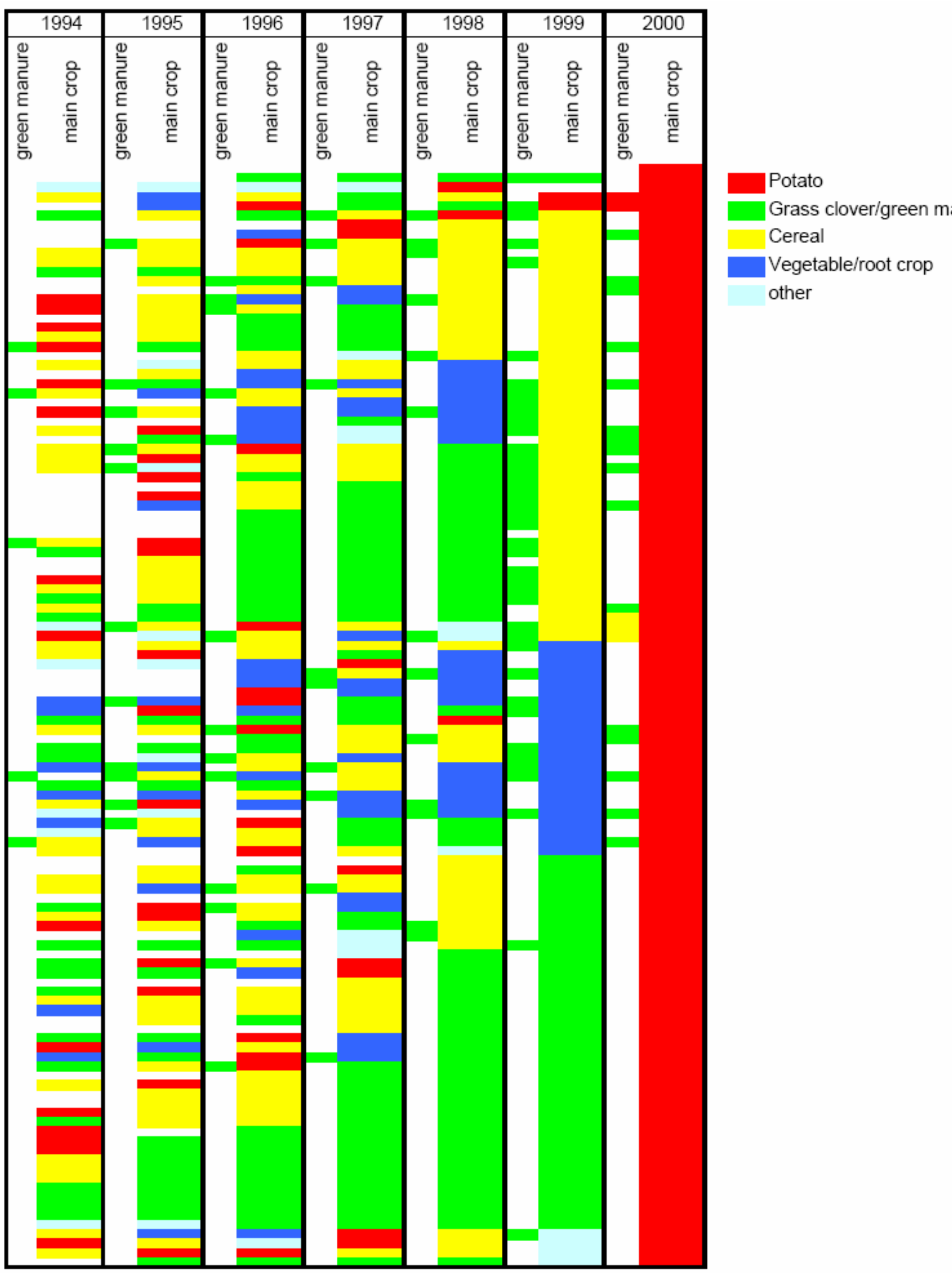

Figure 4.8. Crop rotation and green manure of 118 reference plots on 118 organic farms in DK, D, F, NL, N, CH,UK

The manuring strategies on the reference farms are as diverse as the crop rotation patterns (Table 4.16). In Germany 40% of the reference plots received no manuring at all, whereas in other countries manuring is a standard practice. Top manuring, i.e. fertilizer input after planting, was applied in 10 to 25% of the farms in France, Germany, the Netherlands, Norway and Switzerland but is very rare in Denmark and the UK. The presence or absence of top manuring reflects also a specific soil fertility strategy as farmers who use top manuring intend to feed the potato crop directly, whereas other farmers intend to feed the plant via improvement of soil fertility.

Table 4.16. Manuring strategies on reference plots in 118 organic farms in DK, D, F,

	Den-mark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No manuring			40	6			23	9
Green manuring only			13				8	3
Basic manuring only	80	53	13	38	100	47	69	58
Green + basic	20	20	20	31		21		16
Basic + top		27	13	25		21		12
Green + basic + top						11		2
Total	100	100	100	100	100	100	100	100

If manure was applied, then more than 90% of the farmers applied one basic manure and 36% gave a second manure (table 4.17 & 4.18). Cow farmyard manure and cow slurry was most popular whereas commercial organic fertilizers were applied very rarely. Composts (green waste compost or composted manure) were applied only in few cases. After planting, approximately 20% of the farmers applied top manuring once, and a second application was very rare. Liquid cow manure and commercial fertilizers were used for top manuring. The total input of the macronutrients N, P, and K were estimated based on the data given by the farmers. The nutrient content of farmyard manures was estimated, based on data given by Walther et al., 2001. (Walther et al., 2001. Grundlagen für die Düngung im Acker- und Futterbau. Agrarforschung 8(6): 2001), and the nutrient content of commercial organic fertilizers is based on the data given in the FiBL input list (Speiser et al., 2003; see www.fibl.org/beratung/hilfsstoffliste/index.php). Obviously, the nutrient contents of farmyard manure are very variable, and the proportion that is available for plant nutrition is only a rough estimate. The estimated total N input varied between 20 kg/ha and up to more than 500 kg/ha. The majority of farmers applied between 100 and 200 N kg/ha (figure 4.9). The available N is only a fraction of the total N input as mineralization processes take time. In all countries except France, less than 100 kg N/ha were available to the potato crop (figure 4.10). Conventional guidelines suggest N inputs of 120 kg/ha if a moderate yield of 45t/ha is expected. Therefore, N was probably a limiting factor on many organic farms in this survey. Applied P quantities varied over a wide range (figure 4.11). Typically, P input varied between 50 and 100kg/ha, suggesting sufficient nutrient availability to potato as Walther *et al* (2001) suggest a P application of 90 kg/ha. Potassium input varied between less than 50kg and over 500 kg/ha. Typically, quantities of 100 to 400 kg/ha ha were applied, suggesting that K input and availability (advised K input: 410 kg/ha) may be a limiting factor for the yield on many organic farms.

Table 4.17. Manuring strategies on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: Basic /preplanting manuring 1

	DK	F	D	NL	N	CH	UK	Total
no fertilizer/manure							7	1
Cow farmyard manure	27	27	42	53	55	68	57	48
Goat farmyard manure				16	5			4
Cow slurry	33			21	25	5	7	14
Horse manure		7					7	2
Pig manure			8				7	2
Sheep manure		7			5			2
Liquid manure (cow)					5	11		3
Chicken manure			25			5	7	4
Vinasse		27		5				4
Potassium			8					1
Pig slurry	33				5		7	6
Compost		7		5				2
Turkey manure			8					1
Manure of fur animals	7							1
Biomazor		7						1
Castor oil plant cake (52 1, 5)		7						1
Orgaveg 65 (2,5 2 1, 8)		7						1
Biorga						11		2
Organic manure 8-6-8		7						1
Calcium-mar (CAO)			8					1
Total	100	100	100	100	100	100	100	100

Table 4.18. Manuring strategies on reference plots in 118 organic farms in DK, D, F,

	DK	F	D	NL	N	CH	UK	Total
no fertilizer/manure	27	47	73	79	75	53	93	64
Cow farmyard manure	20		7			21		7
Goat farmyard manure			7	5				2
Cow slurry	13			11	5			4
Horse manure	7	20			5	11		6
Pig manure			7					1
Liquid manure (cow)			7		5	5		3
Chicken manure				5		5		2
Vinasse	33							4
Compost						5		1
Liguid manure (pig)					5			1
Seaweed					5			1
Turkey manure							7	1
Castor oil plant cake (52 1, 5)		20						3
Patentkali		7						1
Guanumus (2,5 3,5 2)		7						1
Total	100	100	100	100	100	100	100	100

Table 4.19. Manuring strategies on reference plots in 118 organic farms in DK, D, F,

	DK	F	D	NL	N	CH	UK	Total
No fertilizer/manure	100	73	87	79	100	68	100	86
Liquid manure (cow)						21		3
Chicken manure				5				1
Vinasse-potash (Vinasse-kali)				5				1
Dried blood				11				2
Rapeseed meal			7					1
Biorga (NPK) 8:2:4						5		1
8-6-6		7						1
NPK 4-12-16		7						1
Lithotamme (CaO+MgO)		7						1
0-7-17		7						1
Biorga						5		1
Potassium magnesia			7					1
Total	100	100	100	100	100	100	100	100

Table 4.20. Manuring strategies on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: Post planting/top manuring 4

	DK	F	D	NL	N	CH	UK	Total
no fertilizer/manure	100	100	100	95	100	89	100	97
Liquid manure (cow)						5		1
Dried blood				5				1
Biorga						5		1
Total	100	100	100	100	100	100	100	100

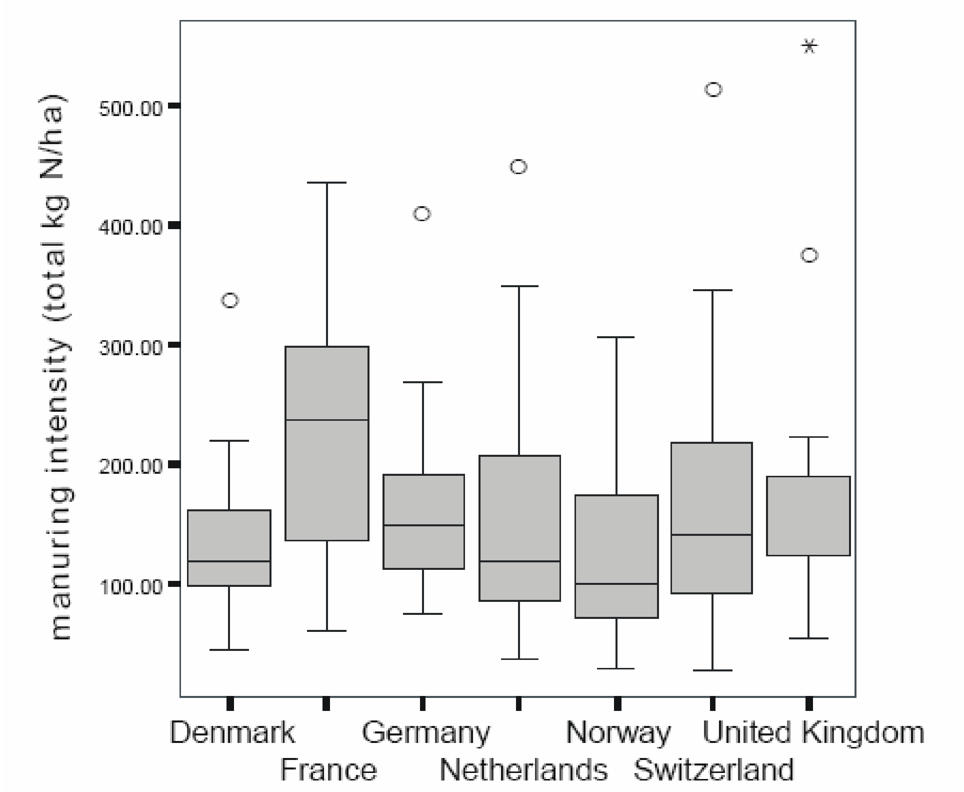

Figure 4.9. Manuring intensities on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: Total applied N input (kg/ha) (basic and top manuring)

Only few farmers used composted manures for fertilization. The duration of the composting process varied between 1 and up to 18 months. Motives to use farmyard manure included economic considerations (availability on farm) as well as agronomic reasons as farmyard manure was generally considered as a fertility input with several additional values such as added organic matter content. A majority of the farmers was satisfied with growth and vigour of the potato crop, despite the fact that the total nutrient input was relatively low compared to conventional standards (figure 4.21). As an exception, 40% of the Dutch farmers stated that there was a lack in vigour, suggesting sub-optimal plant nutrition.

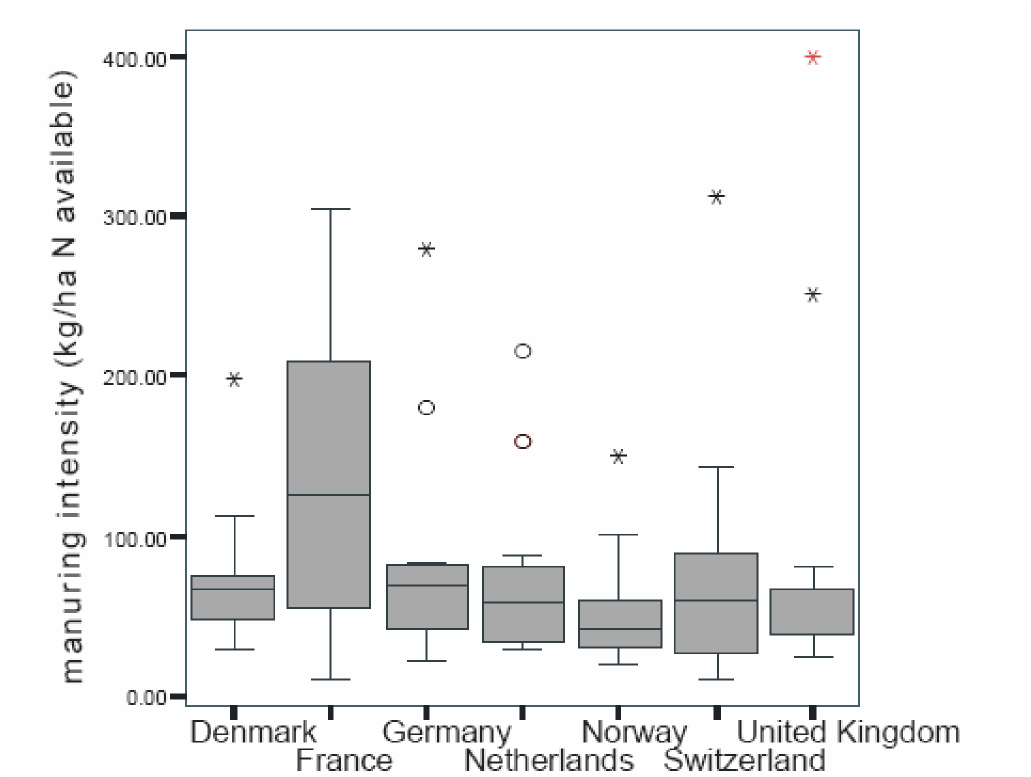

Figure 4.10. Manuring strategies on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: Total applied and available N input (kg/ha) (basic and top manuring)

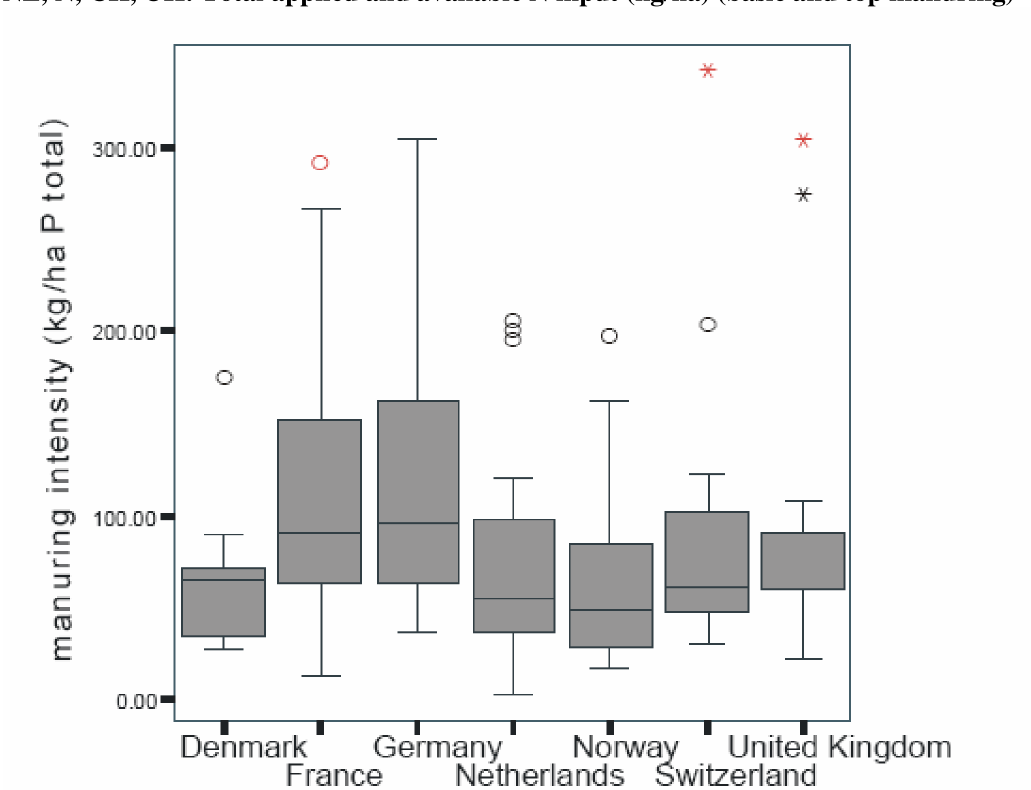

Figure 4.11. Manuring strategies on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: Total applied PO4 input (kg/ha) (basic and top manuring)

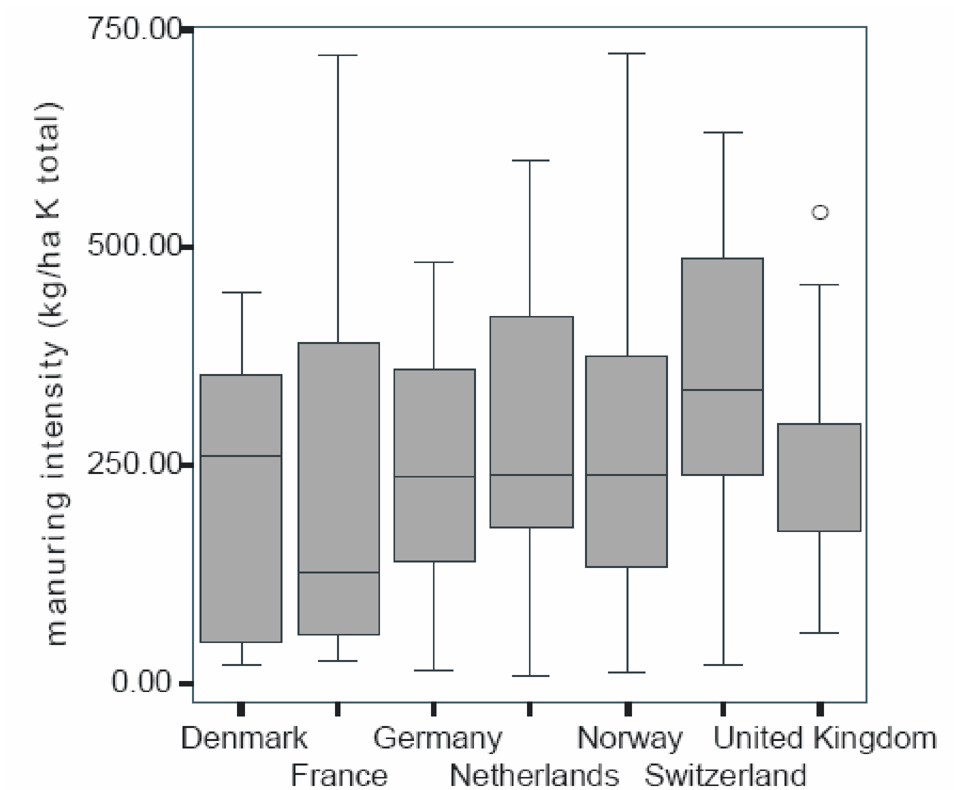

Figure 4.12. Manuring strategies on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: Total applied K input (kg/ha) (basic and top manuring)

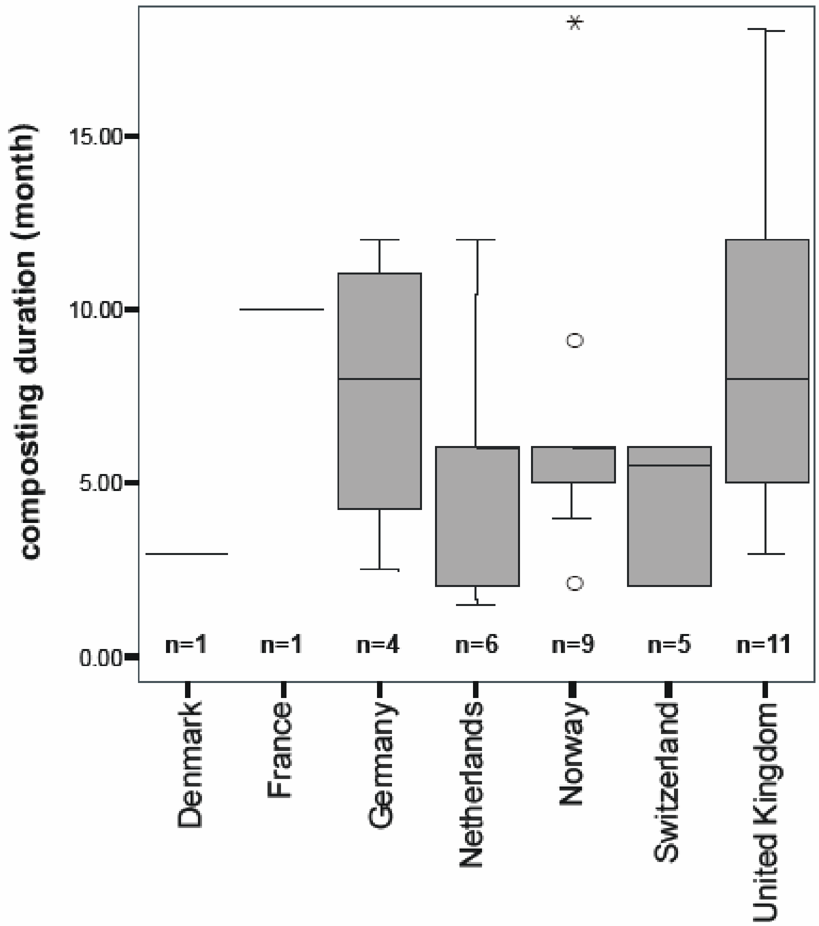

Figure 4.13. Manure quality: preparation and duration of the composting process. Of 118 farms 37 farms applied composted manure in 2000

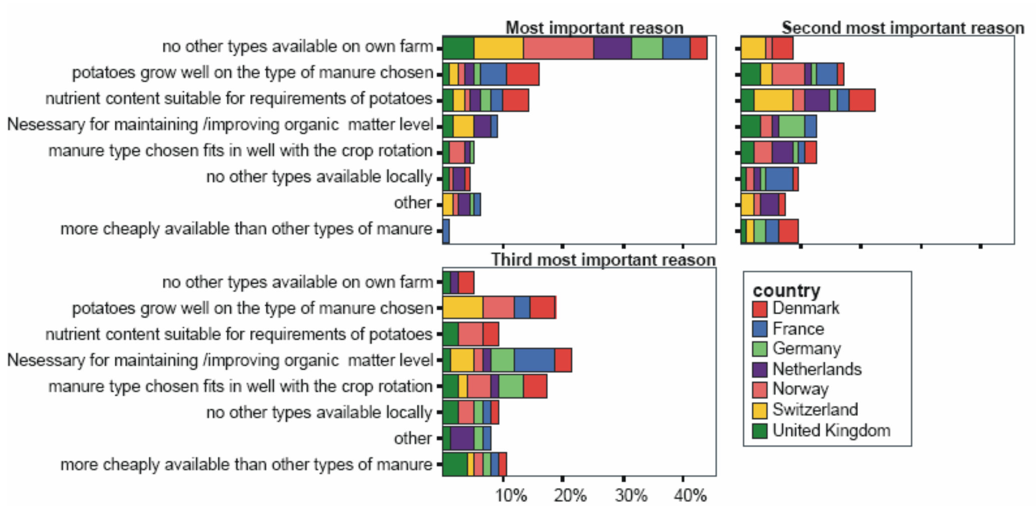

Figure 4.14. Motivation of farmers for the application of manure

Table 4.21. Manuring strategies on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK: assessment

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom	Total
Manure was poor/ poor crop	7	13	7	42	15	11	14	16
Manure was good/ ideal crop	80	73	93	58	75	84	57	74
Manure was more than enough/luxuriant crop	13	13			5	5	21	8
Other					5		7	2
Total	100	100	100	100	100	100	100	100

4.3.3.4 Plant material and crop management 2000

A total of 37 different varieties was grown by the 118 farmers on reference plots (table 4.22). Widely used varieties that were grown in several countries include Agria, Ditta, Cara, Charlotte, Nicola, and Santé. The foliar and tuber resistance to *P. infestans* is considered as medium as compared to other varieties. However, field resistance may differ considerably in different countries. Highly resistant varieties were not widely grown in 2000, indicating that available resistant varieties may not fulfil market demands or need more efforts to become more popular.

Table 4.22. Relative frequency (%) of potato varieties on reference plots in 118 organic farms in DK, D, F, NL, N,

	DK	F	D	NL	NO	CH	UK	Total	foliar resistance score (I)	foliar resistance (II)	tuber resistance	maturity
Adora		7						1	4	medium	medium	early
Agria	7	7	27	21		74		20	7	medium	medium	late
Aziza				5				1	8	high	high	early
Béa		7						1	3	low	low	Early
Cara							33	4	6	medium	medium	Late
Charlotte		33				11		6	6	medium	medium	Late
Désirée						5		1	5	medium	medium	late
Ditta	47	13		5				8	7	medium	high	early
Donald				11				2	5	medium	medium	late
Emeraude		7						1	6	medium	high	early
Escort				5				1	7	medium	high	late
Folva	13							2	5	medium	medium	late
Granola			7					1	5	medium	medium	late
Innovator				5				1	8	high	high	early
Kestrel							7	1	5	medium	low	early
Leyla			7					1	4	medium	medium	early
Marabel			7					1	Na	medium	medium	early
Marfona							7	1	5	medium	high	early
Monalisa		20						3	5	medium	medium	early
Nicola			20			5	7	4	4	medium	medium	late
Oleva					10			2	6	medium	high	late
Ostara					5			1	4	medium	medium	early
Pimpernel					5			1	6	medium	medium	late
Raja				11				2	4	medium	high	late
Remarka				5			13	3	6	medium	medium	late
Santé				21			33	8	5	medium	medium	late
Seresta				5				1	7	high	high	late
Spunta		7						1	5	medium	medium	early
Sava	33							4		medium	high	early
Troll					50			8	3	low	medium	late
Peik					10			2	Na	medium	medium	late
Cinja				5				1	6	medium	high	early
Mandel					20			3	2	low	medium	late
Forelle			7					1	6	medium	medium	early
Bettina			7					1	6	medium	high	late
Iroise						5		1	4	medium	low	early
Linda			20					3	Na	medium	low	early
Total (%)	100	100	100	100	100	100	100	100				

The costs for seeds varied between 0.40 and 1.18 Euro per kg, depending on variety, production type, and country (table 4.23). In general, organic seeds cost approximately 20% more than conventional seeds (table 4.23). Popular varieties were often available in organic quality, whereas seeds of rare varieties were only available in conventional quality. Although the use of organic seed was not mandatory in 2000, approximately 75% of the reference plots were grown with organic certified seed potato (table 4.24). The origin of the seed potatoes varies considerably between countries. Whereas in Denmark and Norway the use of seeds produced on-farm is very popular, growers in the United Kingdom, France, Switzerland and the Netherlands prefer seeds from domestic production or import (Table 4.25). No information is available whether the on-farm produced seed potato passed official quality control or if quality problems might be associated with on-farm produced seeds. The motive for the selection of a specific variety is mainly driven by market demand, agronomic quality and late blight resistance (figure 4.15). Costs and availability of seeds are only of minor importance. There is no common practice for seed preparation before planting. For instance, chitting of seeds is not widely used in Germany or UK, but common practice in Switzerland or France (Table 4.26). The data suggest that from the agronomic point of view, many farmers may find a potential in improving the seed preparation technique. The assessment of the seed quality before planting (Table 4.27) indicates that chitting reduces the proportion of weak chits substantially.

Table 4.23. Seed potato planted on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK

Variety	country	Production method	Average cost of seeds (Euro/kg)	Size class	Variety	Country	Production method	Average cost of seeds (Euro/kg)	Size class
Adora	France	conventional	€ 0.67	35-45	**Marfona**	United Kingdom	organic		35-55
Agria	Denmark	organic	€ 0.50	40-50	**Monalisa**	France	organic	€ 1.18	35-45
	France	organic	€ 0.91	25-30			conventional	€ 0.47	35-55
	Germany	organic	€ 0.64	30-40	**Nicola**	Germany	organic	€ 0.54	30-40
		conventional	€ 0.36	35-50		Switzerland	organic		35-45
	Netherlands	organic	€ 0.65	35-50		United Kingdom	organic	€ 0.57	40-50
	Switzerland	organic	€ 0.81	30-40	**Oleva**	Norway	organic	€ 0.68	35-50
		conventional	€ 0.83	30-40			conventional	€ 0.56	35-45
Aziza	Netherlands	conventional	€ 0.40	35-55	**Ostara**	Norway	organic	€ 0.68	35-45
Béa	France	conventional	€ 0.61	35-45	**Pimpernel**	Norway	organic	€ 0.68	35-45
Cara	United Kingdom	organic	€ 0.58	35-55	**Raja**	Netherlands	organic	€ 0.68	40-50

		conventional	€ 0.48	35-55	**Remarka**	Netherlands	conventional	€ 0.45	35-55
Charlotte	France	organic	€ 1.02	35-55		United Kingdom	conventional	€ 0.66	35-55
		conventional	€ 0.46	35-45	**Santé**	Netherlands	organic	€ 0.70	40-50
	Switzerland	organic	€ 0.53	30-40			conventional	€ 0.40	35-55
		conventional	€ 0.63	35-55		United Kingdom	organic	€ 0.62	35-55
Désirée	Switzerland	organic	€ 0.80	35-55			conventional	€ 0.40	35-55
Ditta	Denmark	organic	€ 0.40	30-40	**Seresta**	Netherlands	organic	€ 0.40	25-30
		conventional	€ 0.59	35-55	**Spunta**	France	organic	€ 0.18	40-50
	France	organic	€ 0.61	35-50	**Sava**	Denmark	organic	€ 0.54	30-40
	Netherlands	organic	€ 0.40	35-55	**Troll**	Norway	organic	€ 0.69	30-40
Donald	Netherlands	conventional	€ 0.36	35-50			conventional	€ 0.52	35-55
Emeraude	France	conventional	€ 0.43	35-45	**Peik**	Norway	organic	€ 0.49	30-40
Escort	Netherlands	organic	€ 0.40	50-60			conventional	€ 0.68	35-45
Folva	Denmark	organic	€ 0.59	35-45	**Cinja**	Netherlands	organic	€ 0.50	35-55
Granola	Germany	organic	€ 0.57	35-55	**Mandel**	Norway	organic	€ 0.82	25-30
Innovator	Netherlands	conventional	€ 0.32	35-50	**Forelle**	Germany	organic	€ 0.66	35-55
Kestrel	United Kingdom	organic		35-55	**Bettina**	Germany	organic	€ 0.56	35-55
Leyla	Germany	organic	€ 0.43	35-55	**Iroise**	Switzerland	conventional	€ 0.75	35-45
Marabel	Germany	organic	€ 0.61	35-50	**Linda**	Germany	organic	€ 0.59	30-40

Table 4.24. Availability and seed costs of Potato varieties planted on reference plots in 118 organic farms in DK,

		N	Percentage	Euro/kg			N	Percentage	Euro/kg
Denmark	Organic	13	87%	€ 0.49	**Norway**	organic	16	80%	€ 0.71
	conventional	2	13%	€ 0.59		conventional	4	20%	€ 0.57
	total/mean	15		€ 0.51		total/mean	20		€ 0.68
France	Organic	9	60%	€ 0.84	**Switzerland**	organic	13	68%	€ 0.78
	conventional	6	40%	€ 0.52		conventional	6	32%	€ 0.78
	total/mean	15		€ 0.71		total/mean	19		€ 0.78
Germany	Organic	14	93%	€ 0.58	**United Kingdom**	organic	11	73%	€ 0.60
	conventional	1	7%	€ 0.36		conventional	4	27%	€ 0.55
	total/mean	15		€ 0.56		total/mean	15		€ 0.58
Netherlands	Organic	12	63%	€ 0.57	**Total**	organic	88	75%	€ 0.65
	conventional	7	37%	€ 0.38		conventional	30	25%	€ 0.56
	total/mean	19		€ 0.50		total/mean	118		€ 0.62

Table 4.25. Availability and seed costs of Potato varieties planted on reference plots in 118 organic farms in DK,

country	own cultivation	domestic production	imported
Denmark	70	23	7
France	15	55	30
Germany	47	46	7
Netherlands	31	64	5
Norway	69	31	0
Switzerland	24	76	0
United Kingdom	3	83	13
Total	38	54	8

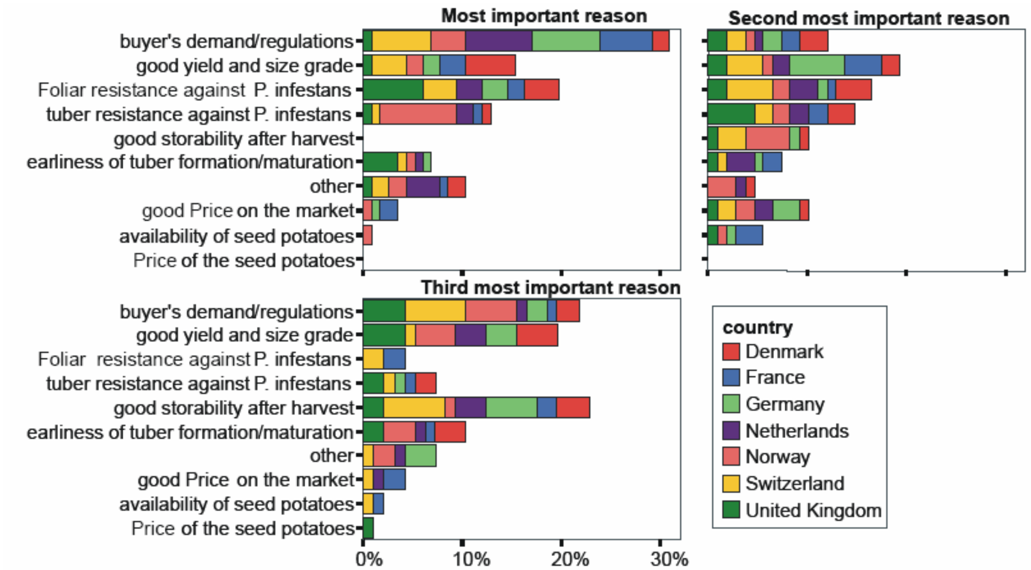

Figure 4.15. Motivation of farmers for the selection of varieties

Table 4.26. Pre-planting treatments of seeds planted on reference plots in 118 organic farms in DK, D, F, NL, N,

		DK	F	D	NL	N	CH	UK	All
Storage	not stored on farm	33	53	47	63	20	16	47	39
	in shed without storage facilities	0	27	27	5	5	0	33	13
	in storage place; cooling with ambient air	27	0	20	11	55	68	7	29
	in storage place with active cooling	20	13	7	21	5	16	13	14
	other	20	7	0	0	15	0	0	6
	Total	100	100	100	100	100	100	100	100
Chitting	not chitted	33	13	60	44	25	11	60	34
	in chitting trays	33	47	27	33	60	74	33	45
	in hanging bags	20	33	0	17	10	11	7	14
	other	13	7	13	6	5	5	0	7
	Total	100	100	100	100	100	100	100	100
Heat treatment	no heat treatment	53	87	60	79	60	63	100	71
	heat treatment applied	47	13	40	21	40	37	0	29
	Total	100	100	100	100	100	100	100	100

Table 4.27. Quality assessment of seed potato planted on reference plots in 118 organic

	Not chitted	Chitted	All
Firm chits	44	58	55
Moderately firm	28	32	31
Weak chits	28	9	14
Total	100	100	100
Average length of chits (cm)	2.07	1.32	

The seed bed preparation techniques are highly diverse on the organic farms. However, there were only 2 farms where no ploughing occurred as a first step in seed bed preparation (figure 4.16). The farmers
prepared the seed beds in 3-7 steps. The most common technique is to plough once and to harrow (pulled or driven) once or twice. There is no technique typical for individual countries, suggesting that the farmers decide very individually on necessary activities, depending on precrop, soil properties, available machinery, and climate.

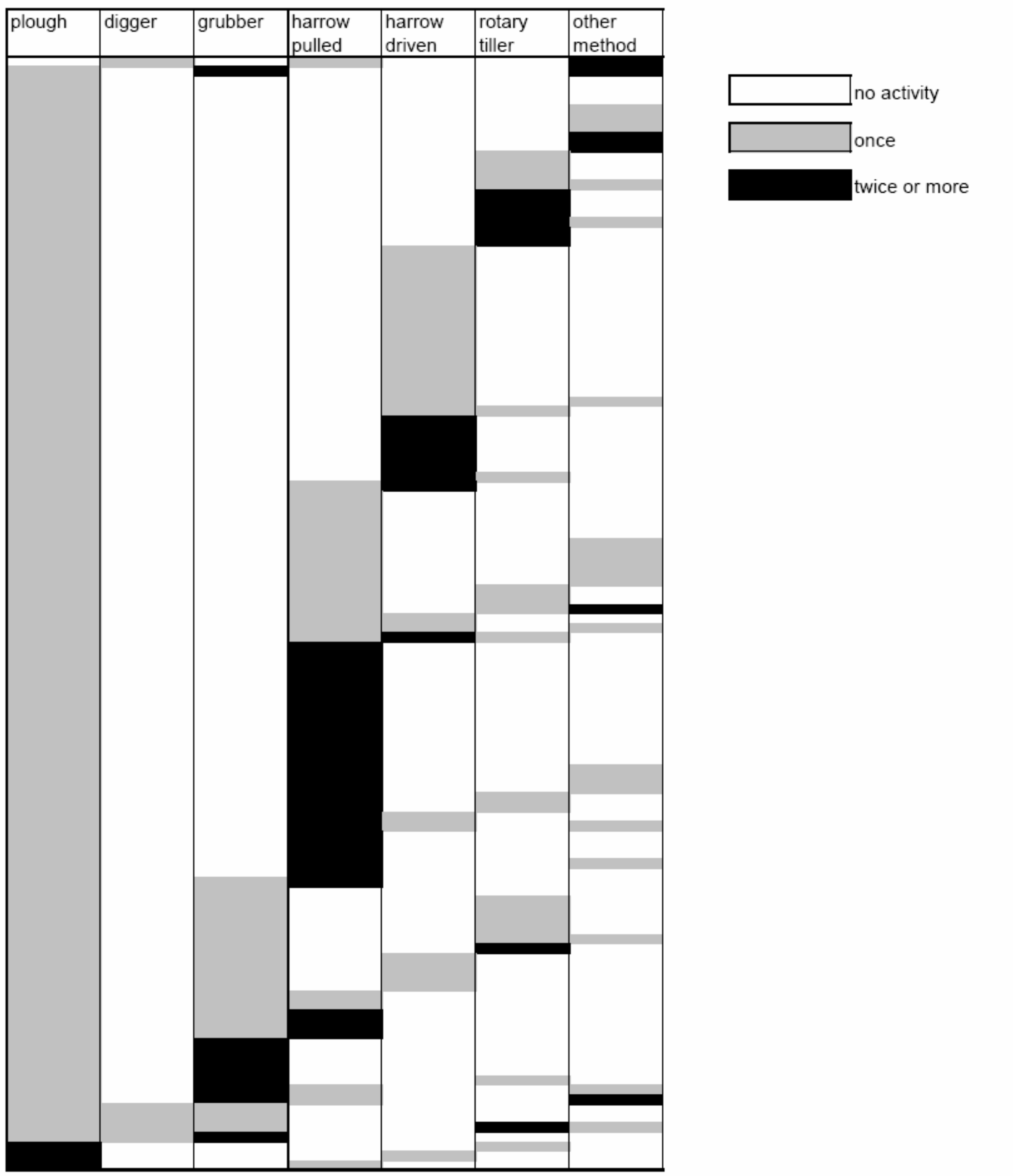

Figure 4.16. Seed bed preparation techniques used by 118 farmers 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

Among the cultivation systems, ridge cultivation is the predominant technique, followed by row and bed cultivation (table 4.28). The most common planting equipment is the 'common' planting machine, followed by novel 'belt-equipped' machines. Most of the farmers own their own equipment, suggesting that the optimum planting date can be freely chosen (table 4.29).

Table 4.28. Potato cultivation systems on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

Cultivation system	N		Rows per bed	Distance between rows, bed width (cm)	Distance in rows (cm)	Planting depth (cm)
row cultivation	33	Minimum	0	65	20	1
		Maximum	0	80	35	20
		Median	0	75	28	9
ridge cultivation	81	Minimum	0	25	0	0
		Maximum	0	91	50	35
		Median	0	75	30	8.25
bed cultivation	4	Minimum	2	150	23	4
		Maximum	3	165	40	14
		Median	2	155	25	9.5

Table 4.29. Potato planting techniques on reference plots in 118 organic DK, D, F, NL, N, CH, UK farms in DK,D, F, NL, N, CH, UK in 2000

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom	Total
By hand		7			5			2
With planting machinery	7	13				32	13	9
With belt-type planter	33	20	53	42	30	11	7	28
With common planter	60	60	47	53	60	53	80	58
Other				5	5	5		3
	100	100	100	100	100	100	100	100
No machinery		7			5			2
Contractor	20	13	20	42	15	21	13	21
Own machinery	80	80	80	58	80	79	87	77
	100	100	100	100	100	100	100	100

The farmers were satisfied with the planting quality (table 4.30) as only few farmers assessed the planting quality as ‘poor’. However, ridge formation proved to be more demanding, as approximately 10% of the farmers complained about poor quality. Problems due to insufficient weed control were mentioned by 10 to 20% of the farmers. There is no specific weed which causes problems in all cases (figure 4.17). However, weeds that are notorious include *Chenopodium album*, *Stellaria media*, and *Cirsium arvense*. Post planting activities include weed control and ridge formation which is usually a combined activity. The cultivation techniques used on the farms are listed in table 4.31. The majority of the farmers managed the ridge formation and weed control in 4 or less management activities and only 25% of the farmers need up to 6 activities. Intervention by costly hand weeding was very rare. Irrigation depends very much on regional aspects and climate (table 4.32). More than 90% of the Danish farmers irrigated the reference plot, followed by approximately 50% of the French farmers. In other countries, irrigation is less common or almost unknown. Only a total of six farmers did not irrigate in order not to promote a late blight epidemic.

Table 4.30. Quality assessment of potato planting on reference plots in 118 organic DK, D, F, NL, N, CH, UK farms in DK, D, F, NL, N, CH, UK in 2000

		DK	F	D	NL	N	CH	UK	Total
planting quality	good	71	53	93	84	80	95	60	78
	moderate	21	47	7	11	20	5	33	20
	poor	7			5			7	3
	Total	100	100	100	100	100	100	100	100
ridge quality	not applicable		7				5	20	4
	good	73	67	53	68	65	68	47	64
	moderate	27	20	40	32	25	21	20	26
	poor		7	7		10	5	13	6
	Total	100	100	100	100	100	100	100	100
weed control	almost free of weeds	67	7	20	5	10	5	13	17
	low	27	67	73	95	70	95	73	73
	high	7	27	7		20		13	10
	Total	100	100	100	100	100	100	100	100

Figure 4.17. Occurrence and relative importance of weeds in potato crop on 118 organic DK, D, F, NL, N, CH, UK farms in DK, D, F, NL, N, CH, UK in 2000

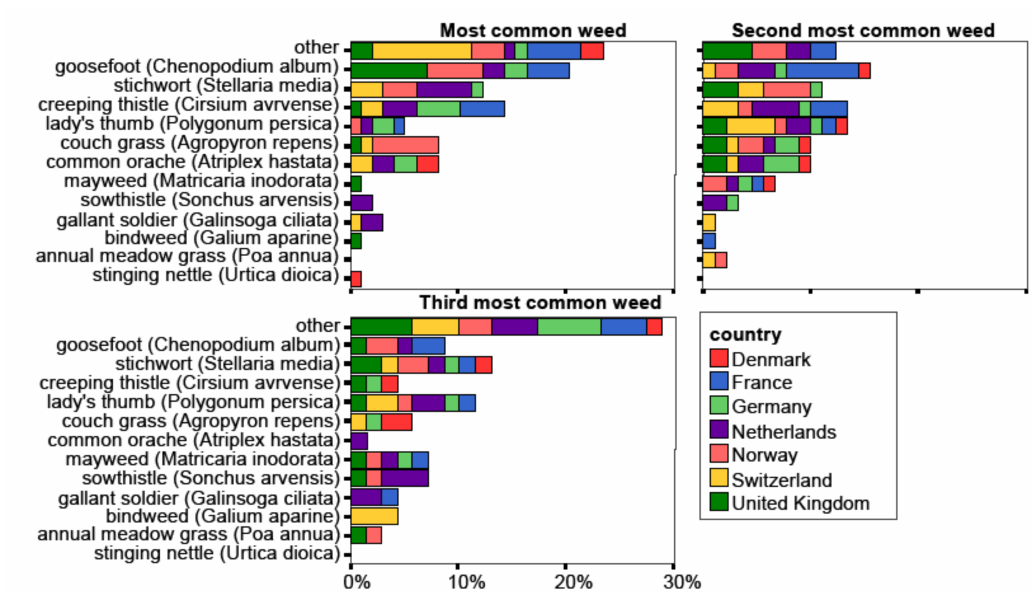

Table 4.31. Potato cultivation techniques after planting on reference plots in 118 organic Farms in DK, D, F, NL, N, CH, UK in 2000.

Cultivation 1	Den-mark	France	Ger-many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No activity								
(Weed) harrowing/ drag-ging/spring tines /combing	53	47	20	37	20	42	20	34
Hoeing			13					2
(Knife or plow or disc) ridge /earth up	27	40	60	32	75	16	13	38
Inter-row rotary cultivation / mill /power ridger			7	26			27	8
Scuffle / loosening				5		5		2
Planter						37	33	10
Rolling cultivator	13							2
Stone separator							7	1
Weed burning	7	13						3
Riding / rolling					5			1
Total	100	100	100	100	100	100	100	100

Cultivation 2	Den-mark	France	Ger-many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No activity		7		16			20	6
(Weed) harrowing/ drag-ging/ spring tines/combing	40	27	80	47	40	26	13	39
(Knife or plow or disc) ridge /earth up	40	67	13	21	60	58	47	44
Inter-row rotary culti-vation / mill /power ridger	7		7	5			7	3
Hand weeding				5				1
Scuffle / loosening				5		16		3
Planter							7	1
Rolling cultivator	7							1
Stone separator							7	1
Riding / rolling	7							1
Total	100	100	100	100	100	100	100	100

Cultivation 3	Den-mark	France	Ger many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No activity		27		32	10	5	33	15
(Weed) harrowing /dragging/ spring tines/combing	33	7	13	16	15	32	7	18
Hoeing							7	1
(Knife or plow or disc) ridge /earth up	47	67	67	32	65	58	40	53
Inter-row rotary cultivation / mill /power ridger	7		13		5		13	5
Hand weeding			7		5			2
Scuffle / loosening				21		5		4
Rolling cultivator	13							2
Total	100	100	100	100	100	100	100	100

Cultivation 4	Den-mark	France	Ger-many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No activity	13	67	20	47	25	26	47	35
(Weed) harrowing/ dragging/spring tines/combing	20		33	5	15	16		13
(Knife or plow or disc) ridge /earth up	47	27	47	42	55	32	53	43
Inter-row rotary cultivation / mill /power ridger	7							1
Hand weeding		7			5	5		3
Scuffle / loosening				5		21		4
Rolling cultivator	13							2
Total	100	100	100	100	100	100	100	100

Cultivation 5	Den-mark	France	Ger-many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No activity	40	87	47	79	45	26	87	58
(Weed) harrowing/drag-ging/springtines/combing	13		13	5	10	5		7
(Knife or plow or disc) ridge /earth up	33	7	33	16	35	42	13	26
Inter-row rotary cultivation / mill /power ridger	7					5		2
Hand weeding		7	7		5	5		3
Scuffle / loosening						16		3
Weeding by geese					5			1
Riding / rolling	7							1
Total	100	100	100	100	100	100	100	100

Cultivation 6	Den-mark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No activity	67	100	60	95	70	42	100	75
(Weed) Harrowing/drag-ging/ spring tines/combing	7		7					2
(Knife or plow or disc) ridge /earth up	27		33	5	25	53		21
Hand weeding					5	5		2
Total	100	100	100	100	100	100	100	100

	Den mark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Total
No	7	47	73	89	65	89	87	67
Yes	93	53	27	11	35	11	13	33
	100	100	100	100	100	100	100	100
Not applied	7	47	73	89	65	89	87	67
Maintain crop growth	73	53	27	5	20	11	7	26
Limit risk of potato scab	20	0	0	0	15	0	7	6
Other	0	0	0	5	0	0	0	1
	100	100	100	100	100	100	100	100
Irrigation applied	93	53	29	11	35	11	13	33
No water available	0	0	43	5	0	53	53	21
Crop had no water shortage	7	47	29	58	50	37	13	36
Afraid of Phytophthora spreading	0	0	0	5	0	0	0	1
No sprinkler system available	0	0	0	5	5	0	20	4
Other	0	0	0	16	10	0	0	4
	100	100	100	100	100	100	100	100

4.3.3.5 Crop protection management 2000

Epidemics due to *Phytophthora infestans* were observed in all countries in the season 2000 (Figure 4.17). The extent of the epidemic was particularly serious in the Netherlands, United Kingdom and Germany, whereas in Norway, Switzerland, France and Denmark, crop losses were reported by less farmers. As a rough estimate of the disease pressure in 2000, the number of sprays applied on conventional farms is given in figure 4.18 (Schepers H.T.A.M., 2001 The development and control of *Phytophthora infestans* in Europe in 2000 in: PAV-Special Report no. 7, Feb. 2001, pp. 9-18). These background data suggest that the disease pressure in 2000 was very high in the Netherlands, France and United Kingdom, and less severe in Denmark, Norway, Switzerland, and Germany. On more than 80% of the organic reference plots *P. infestans* was observed in 2000 although yield losses were not reported in all cases (Table 4.33).

When compared to other years, the season 2000 was assessed as less severe by Danish farmers, whereas French farmers observed a more severe epidemic. The first infection was observed at all phonological stages of the potato crop (table 4.34). However, in the Netherlands late blight broke out very early, indicating particularly heavy infection pressure at a very early stage.

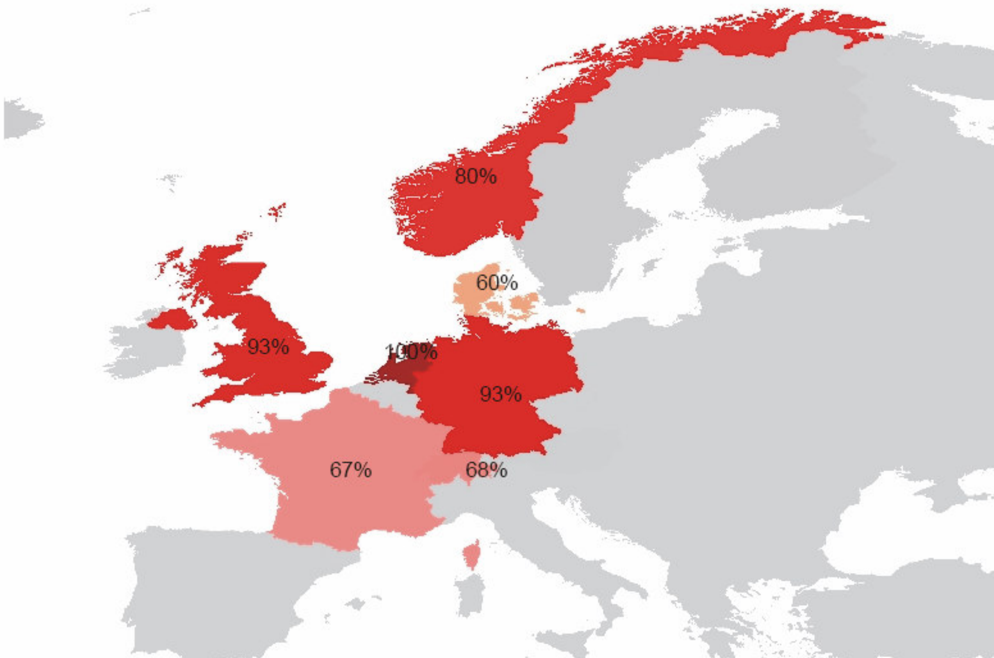

Figure 4.17. Percentage of farms with epidemics of *Phytophthora infestans* causing yield losses on 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

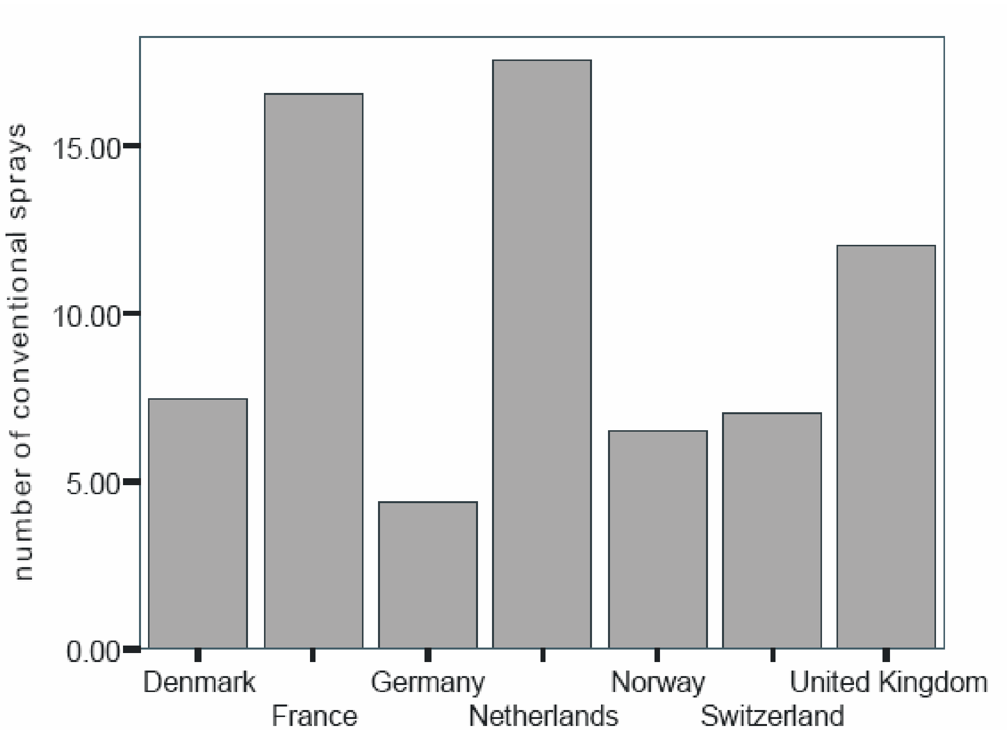

Figure 4.18. Number of sprays applied on conventional farms in European countries in 2000 (Schepers H.T.A.M.,2001. The development and control of *Phytophthora infestans* in Europe in 2000 in: PAV-Special Report no. 7, Feb. 2001, pp. 9-18)

Table 4.33. Occurrence characteristics of epidemics of *Phytophthora infestans* on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

		DK	F	D	NL	N	CH	UK	Total
Phytopthora infestans	No		13			20	21	7	9
observed in 2000	Yes	100	87	100	100	80	79	93	91
		100	100	100	100	100	100	100	100
Assessement of epidemic 2000	comparable with other years	7	29	16	30	53	21	23	0
	first outbreak came earlier than in other years	13		7	47	35	5	21	20
	first outbreak came later than in other years	40	13	36	5	5	0	0	13
	Phytophthora outbreak, more serious than in previous years	7	60		16	25	11	43	22
	Phytophthora outbreak, less serious than in previous years	40		29		5	26	7	15
	need for haulm destruction was earlier than previous years	7		11				3	
	need for haulm destruction was later than in previous years			7	1				
	other		13		5		5		3
		100	100	100	100	100	100	100	100

Table 4.34. Phenological stage at first occurrence of *P. infestans* on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

First infection stage	First infection stage code	DK	F	D	NL	NO	CH	UK	Total
	No occurrence		15			20	22	7	10
First leaves	15				6				1
	30		15	13	6				5
	35			13	6				3
	39	7			6				2
	40		15				6		3
	42				6				1
	45	7		7	6				3
Canopy closed	49				19				3
	50			7					1
	55						6	7	2
Flowering	60	14		7	19	35	17	7	15
	61							7	1
	62						6		1
	63							7	1
	65	7	8	7	6	10			5
	69	7	8						2
Berry growth	70	21	15	33		15	17	33	19
	75	7		13		5	11	20	8
Senescence	80	29	15		13	15	17	13	14
	81		8		6				2
		100	100	100	100	100	100	100	100

The observations of the farmers reveal the influence of weather conditions and give some indications on the development of the late blight epidemics. The weather conditions at the first occurrence and shortly before were usually wet according to the farmers (4.35). However, up to 33% of the farmers did relate the time of first occurrence to dry weather. Reports on the spatial pattern of the symptoms when first observed shows that the symptoms were more often equally spread than sparsely scattered. This probably suggests that the first symptoms are only detected when the epidemic has already proliferated within the plot to some extent.

The source of the inoculum was often identified, in the UK by 40% of the farmers. The farmers who had
identified sources of inoculum reported as most important source long distance distribution, infected seed
tubers, and spread from susceptible varieties from conventional farms (Figure 4.19).

Table 4.35. Observations at first occurrence of *P. infestans* on reference plots in 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

Climate conditions prior to first infection	DK	F	D	NL	NO	CH	UK	Total
No infection	.	13	.	.	20	25	7	10
dry	7	20	33	8	20	25	27	20
wet	93	53	40	77	45	19	60	54
alternating dry and wet	.	13	27	15	15	31	7	16
	100	100	100	100	100	100	100	100
Spatial pattern of first symptoms	DK	F	D	NL	NO	CH	UK	Total
No infection	.	13	.	.	20	22	7	9
Equally spread	73	20	33	63	30	28	27	39
A few infection points	27	40	53	32	20	44	47	37
Certain parts of the plot	.	27	13	5	30	6	20	15
	100	100	100	100	100	100	100	100
Temporal pattern of epidemic	DK	F	D	NL	NO	CH	UK	Total
No infection		13	.	.	20	21	7	9
Jerky, dependant on the temperature and humidity	.	13	13	32	15	5	7	13
Spot like, dependant on the soil/climate	.	7	7	.	10	.	.	3
Spot like, dependant on the prevailing wind	.	7	7	.	5	.	13	4
Explosive, the outbreak spread like wild fire	27	27	13	21	10	5	7	15
Gradually, the outbreak spread in a slow but sure manner	73	27	53	47	30	63	67	51
Other		7	7	.	10	5		4
	100	100	100	100	100	100	100	100

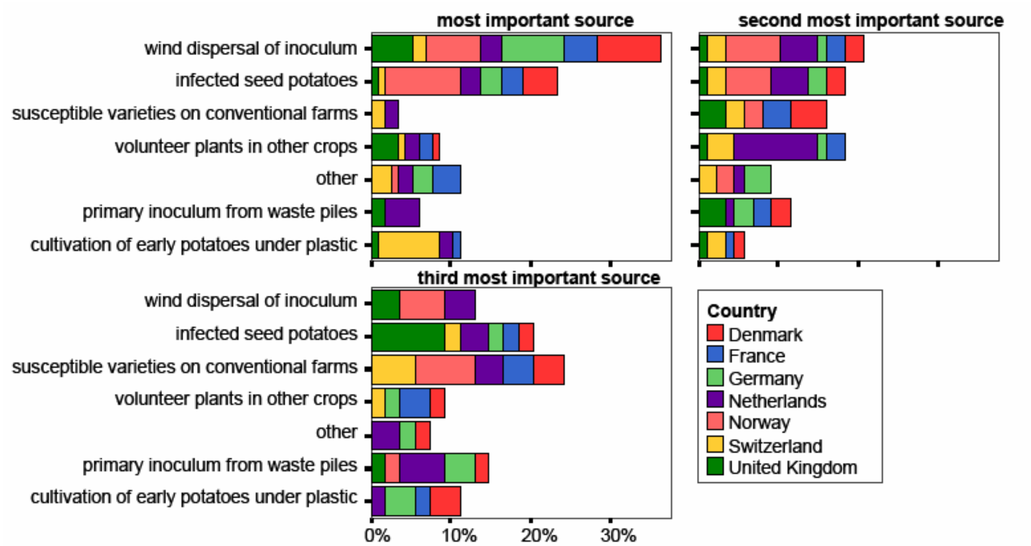

Figure 4.19. Inoculum sources of *Phytophthora infestans* identified by farmers on 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

The organic farmers in this survey apply preventive as well as post-infection strategies to control late blight epidemics. Among the preventive measures, the use of resistant varieties is considered as the most important strategy, followed by usage of good quality seeds and early planting strategies (figure 4.20).

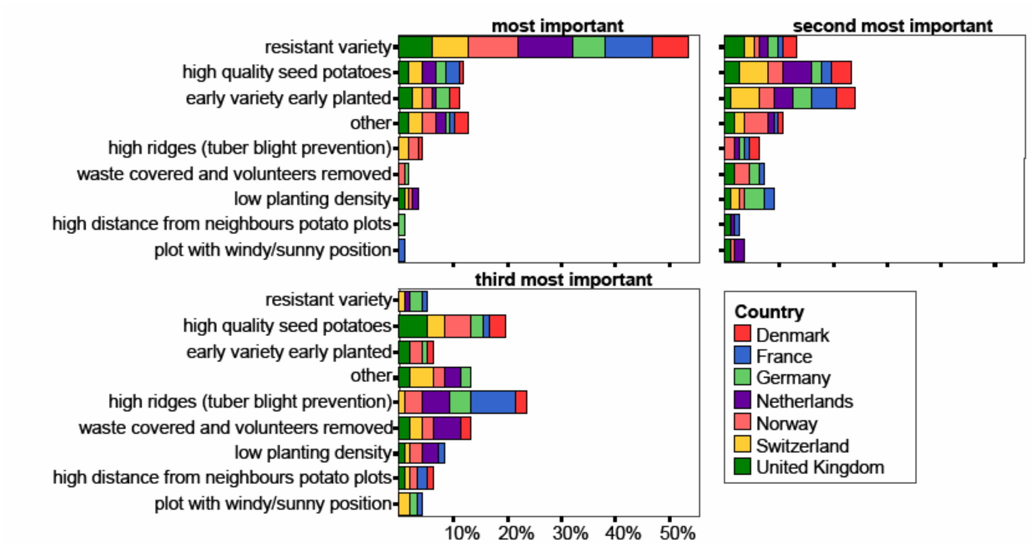

Figure 4.20. Preventive strategies to control *P. infestans* identified by farmers on 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

Strategies to control late blight after outbreak of the epidemic included in 2000 the application of copper fungicides as well as removal of susceptible foliage (figure 4.21), or sprays of plant strengtheners. Labour intensive management strategies such as removal of infected plants were not often carried out.

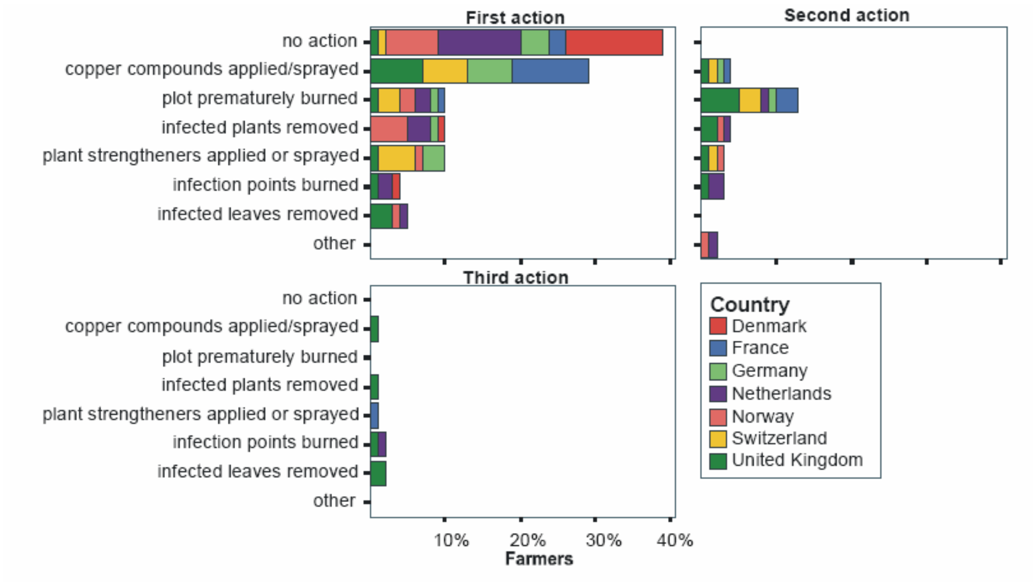

Figure 4.21. Direct control strategies to control *Phytophthora infestans* applied by 118 organic DK, D, F, NL, N, CH, UK farms in DK, D, F, NL, N, CH, UK in 2000

Table 4.36. Decision process for application of copper and alternative agents in 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

First treatment applied, when	DK	F	D	NL	NO	CH	UK	Total
No treatments	100	7	60	95	100	16	27	59
When *P. infestans* not present in region		13	7			42		9
When risk was forecasted (DSS)		13				5	7	3
When my advisor told me			7					1
When I guessed there was a risk		13				11	20	6
When conventional growers reported the first outbreaks						5	13	3
When I discovered the first symptoms on my farm		13	13				13	5
When I discovered the first symptoms on survey plot		33	7				13	7
When the epidemic on my survey plot started			7					1
Other		7		5		21	7	6
	100	100	100	100	100	100	100	100

The timing of sprays of copper or other alternative agents (if applied at all) was usually based on local experience or actual outbreak of the epidemic (Table 4.36). Only few farmers decided on the necessity of the first spray based on information obtained from forecasting systems or advisory services. Follow-up sprays were applied because of loss of activity of the initial spray and/or weather conducive for further spread of the epidemic (figure 4.22).

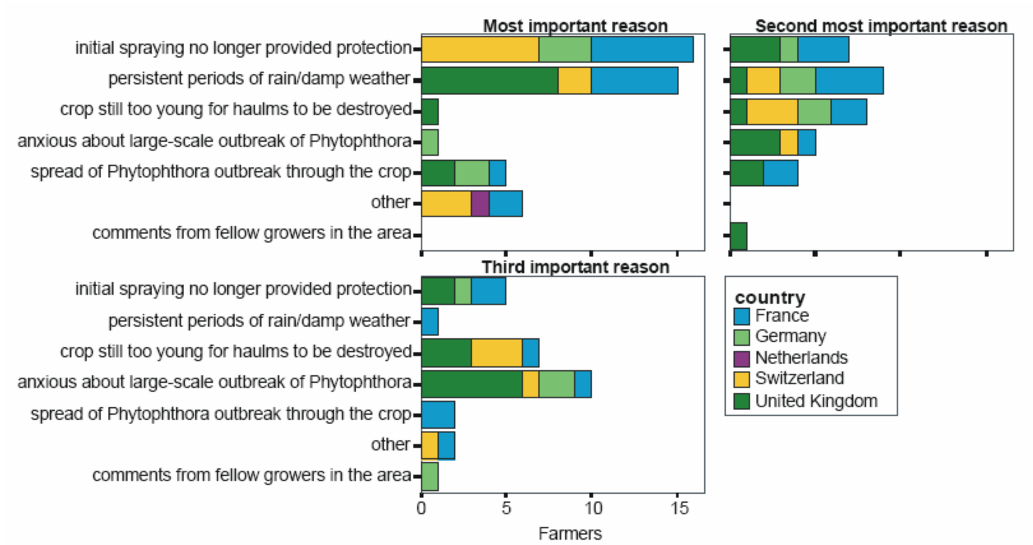

Figure 4.22. Reasons for application of follow-up sprays to control *P. infestans* on 118 organic farms in DK, D, F, NL, N, CH, UK in 2000

Table 4.37. Copper use statistics for control of *P. infestans* in 118 organic farms in DK, D, F, NL, N, CH, UK in 1996-2000

Year	copper use	DK	F	D	NL	N	CH	UK	Total
1996	no	100	33	100	100	100	58	60	80
1996	yes	0	67	0	0	0	42	40	20
1997	no	100	13	100	100	100	42	60	75
1997	yes	0	87	0	0	0	58	40	25
1998	no	100	7	67	53	100	42	47	60
1998	yes	0	93	33	47	0	58	53	40
1999	no	100	13	67	100	100	37	33	66
1999	yes	0	87	33	0	0	63	67	34
2000	no	100	7	47	100	100	42	27	63
2000	yes	0	93	53	0	0	58	73	37

Copper was used between 1996 and 2000 by French, German, Swiss, and UK farmers and, as an exception in 1998, also in the Netherlands. In contrast, in Denmark and Norway copper is banned and therefore not applied (table 4.37). In countries without a copper ban, copper was not used by all farmers. Copper applications were most often applied in France, whereas in Switzerland, UK, and Germany copper was applied by 33 to 73% of the farmers. The most important motivations to abstain from copper use include obviously legal restrictions (Denmark, Norway). However, the as the second most important motive farmers mentioned that 'copper use does not fit with their view of organic farming' (figure 4.27). Lack of necessity was mentioned only by 2 farmers as a reason for not using copper.

Alternative agents were applied by some farmers in all countries (table 4.38) but the use of such treatments is particularly popular in Switzerland. Copper alternatives (table 4.39) applied between 1996 and 2000 include algae preparations, bio-dynamic preparations, stone dusts, plant extracts and some products which could not be properly identified. Most of these agents are believed to strengthen the potato plant, and/or to decrease susceptibility to late blight. Agents such as bio-dynamic preparations, stone meal, or algal extracts are well accepted, whereas agents such as ‘effective micro organisms’ (EM) or ‘Penac’ are controversially discussed in the organic community.

Table 4.38. Statistics on use of alternative agents/preparations for control of *P. infestans* in 118 organic farms in DK, D, F, NL, N, CH, UK in 1996-2000

		DK	F	D	NL	N	CH	UK	Total
1996	no	100	93	93	95	70	53	87	83
1996	yes		7	7	5	30	47	13	17
		100	100	100	100	100	100	100	100
1997	no	100	87	93	89	75	42	87	81
1997	yes		13	7	11	25	58	13	19
		100	100	100	100	100	100	100	100
1998	no	93	93	93	95	75	53	80	82
1998	yes	7	7	7	5	25	47	20	18
		100	100	100	100	100	100	100	100
1999	no	87	87	87	84	75	42	73	75
1999	yes	13	13	13	16	25	58	27	25
		100	100	100	100	100	100	100	100
2000	no	80	87	87	95	75	47	60	75
2000	yes	20	13	13	5	25	53	40	25
		100	100	100	100	100	100	100	100

Table 4.39. Copper alternatives for control of *P. infestans* used between 1996 and 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

Product name	active substance/origin	Product name	active substance/origin
algal extracts	Algae preparation	Citrex (trial)	Plant extract
dried kelp	Algae preparation	Cropset (Yeast extract)	Microbial extract
Hasorgan	Algae preparation	deadnettle preparation	Plant extract
Lithothamne	Algae preparation	plant extract (horsetail)	Plant extract
Seaweed extract	Algae preparation	rhubarb leaves	Plant extract
seaweed marinure	Algae preparation	tea of Equisetum arvense and Rheum raponticum	Plant extract
silica-preparate	Bio-dynamic preparation	valeria preparate	Plant extract
equisetum arvensis	Bio-dynamic preparation	soap	fatty acid
Equisetum Urtica	Bio-dynamic preparation	Caprucin	unidentified
Preparation 500,501	Bio-dynamic preparation	Homisol	unidentified
prepared manure	Bio-dynamic preparation	Ledona	unidentified
preps 500-508	Bio-dynamic preparation	marinure	unidentified
Silica preparate	Bio-dynamic preparation	Milk serum	unidentified
silica preparation	Bio-dynamic preparation	oligosol	unidentified
sodium silicate	Bio-dynamic preparation	Penac (150g/ha)	mineral
Malt extract	plant extract	Protura	unidentified
EM ('effective Microorganisms')	microorganisms		
quartz powder	mineral		
silica	mineral		
siliceous stone	mineral		
silicium (quartz)	mineral		
stone meal	mineral		

Table 4.40. Products (copper and alternatives) and applied quantities in 2000 for control of *P. infestans* in 118 organic farms in DK, D, F, NL, N, CH, UK in 1996-2000

Product name	kg product/application and ha			
	mean	median	minimum	maximum
Copper 50	0.1	0.1	0.0	0.2
Copper 50% + Penac	1.2	0.8	0.0	2.5
Copper hydroxyde (12%)	50.0	50.0	50.0	50.0
Copper hydroxyde (50%)	7.5	7.5	7.5	7.5
Copper oxichloride (50% copper metal)	2.7	1.7	0.0	15.0
Copper sulfate (20% copper)	5.0	2.2	0.0	25.0
Copper sulfate (20% copper) + oligoelements	0.7	0.7	0.7	0.7
Cuprokylte	1.9	2.5	0.0	2.5
Cuproxat	0.2	0.2	0.0	0.2
Kupfer 50	3.3	2.6	1.3	6.7
Questuran (50% copper metal)	0.2	0.2	0.1	0.3
Wetcol- Bordeaux Mixture	0.8	1.0	0.0	1.0
Hornkiesel-preparation	770.8	770.8	555.0	986.7
Hornmist-preparation	853.8	853.8	853.8	853.8
500, 501	15.1	15.0	15.0	15.3
501	16.7	25.0	0.1	25.0
Caprucin	0.1	0.1	0.1	0.1
Cropset	1.0	1.0	1.0	1.0
Lithothamne	125.0	125.0	125.0	125.0
Malt extract	1.1	1.1	0.9	1.3
Marimure (seaweed)	0.5	0.5	0.5	0.5
Marinure	0.9	0.9	0.9	0.9
Novodor (b.t.) (Colorado beetle control only)	5.9	1.8	0.0	16.0
Oligosol (stimulator)	0.5	0.5	0.5	0.6
Penac	0.2	0.2	0.2	0.2
Protura	328.9	328.9	328.9	328.9
Stone meal	303.4	200.0	0.0	1000.0

Table 4.40 gives an overview on all products and the quantities that have been applied in 2000. Several products indicated by farmers in different countries appear to be identical. However, all mentioned products are listed if a straight identification was not possible.
The total copper use per ha in the season 2000 in France, Germany, Switzerland and United Kingdom varied between 0.2 and 15 kg/ha copper metal (figure 4.23). Typically, farmers used less than 5 kg/ha even in France and UK where the input was not limited in 2000. The total copper amount was applied in one to up to seven individual sprays, typically in 2 to 4 sprays (figure 4.24).

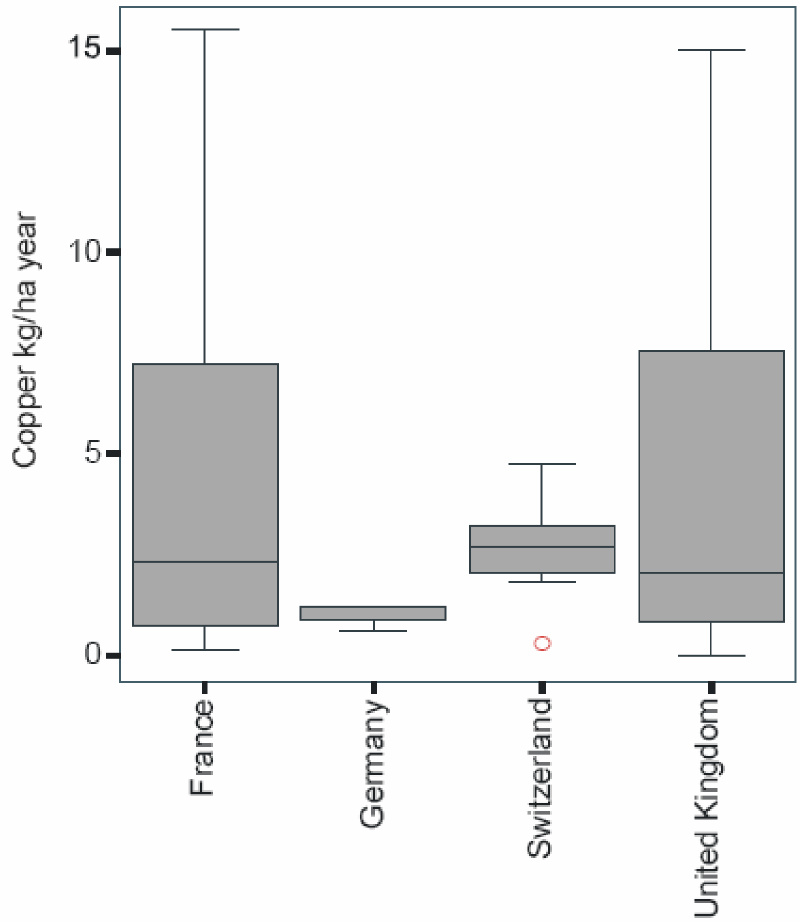

Figure 4.23. Copper use (total Cu/ha and year) for control of *P. infestans* on reference plots in France, Germany, Switzerland and United Kingdom in 2000

The farmers who applied copper or alternative products were asked to give an estimate on the efficacy in late blight control. The farmers suggest that most of the crop protection effect was due to the copper application and only minor efficacy rates were attributed to alternative products (figure 4.25). The farmers were also asked to estimate the number of additional growth days (due to delayed destruction of foliage) and the yield gain associated with the extended growth period. The farmers estimated that the yield increase was approximately 5 t/ha per 10 additional growth days (figure 4.26).

A vast majority of the farmers did observe differences in occurrence and spread of late blight epidemics between and within potato fields (table 4.41). Varietal resistance and local microclimate are believed to be the most important reasons for local differences.

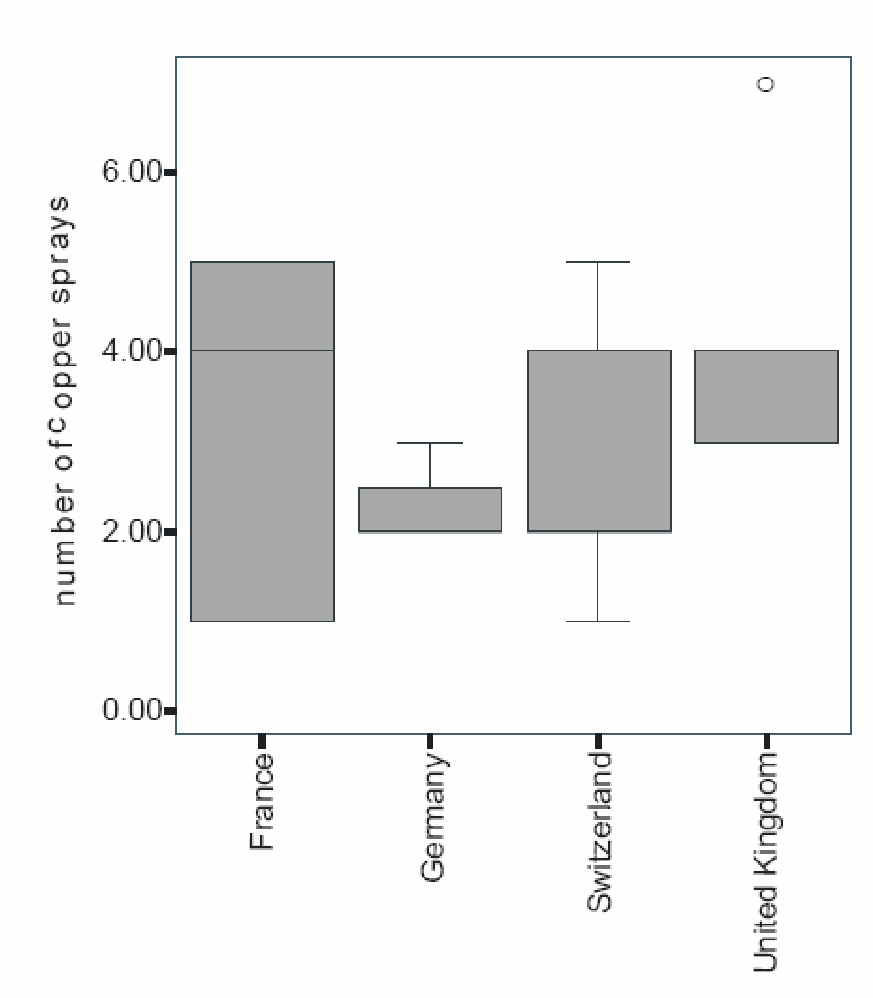

Figure 4.24. Frequency of copper applications for control of *P. infestans* on reference plots in France, Germany, Switzerland and United Kingdom in 2000; reference plots in DK, D, F, NL, N, CH, UK in 2000

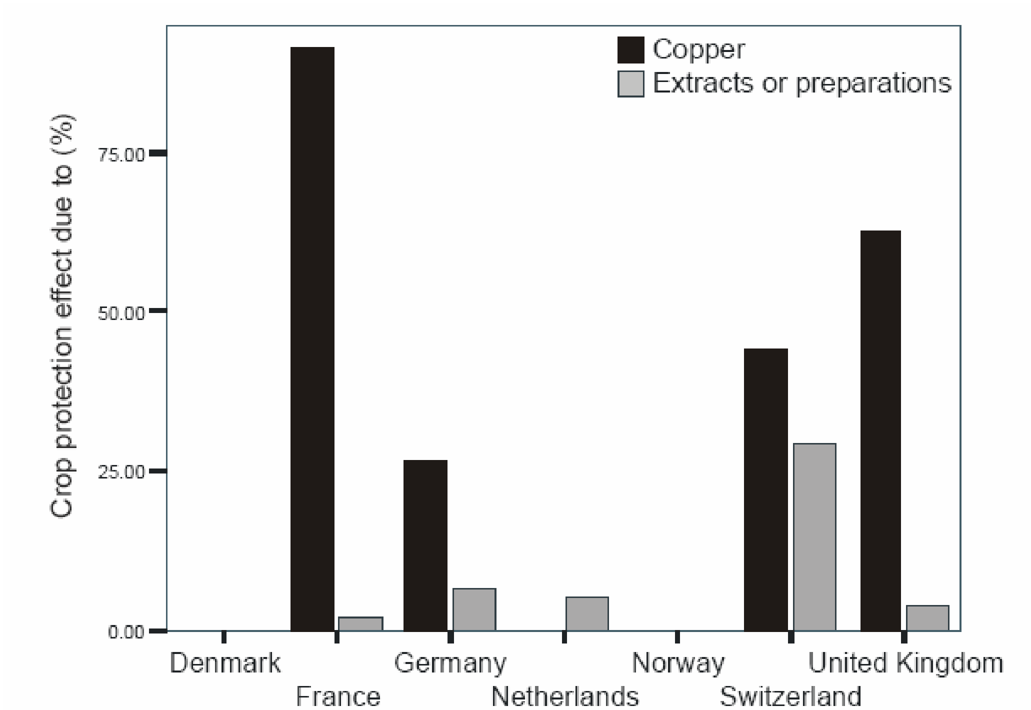

Figure 4.25. Assessment by farmers on efficacy of crop protection treatments for control of *P. infestans* on reference plots in DK, D, F, NL, N, CH, UK in 2000

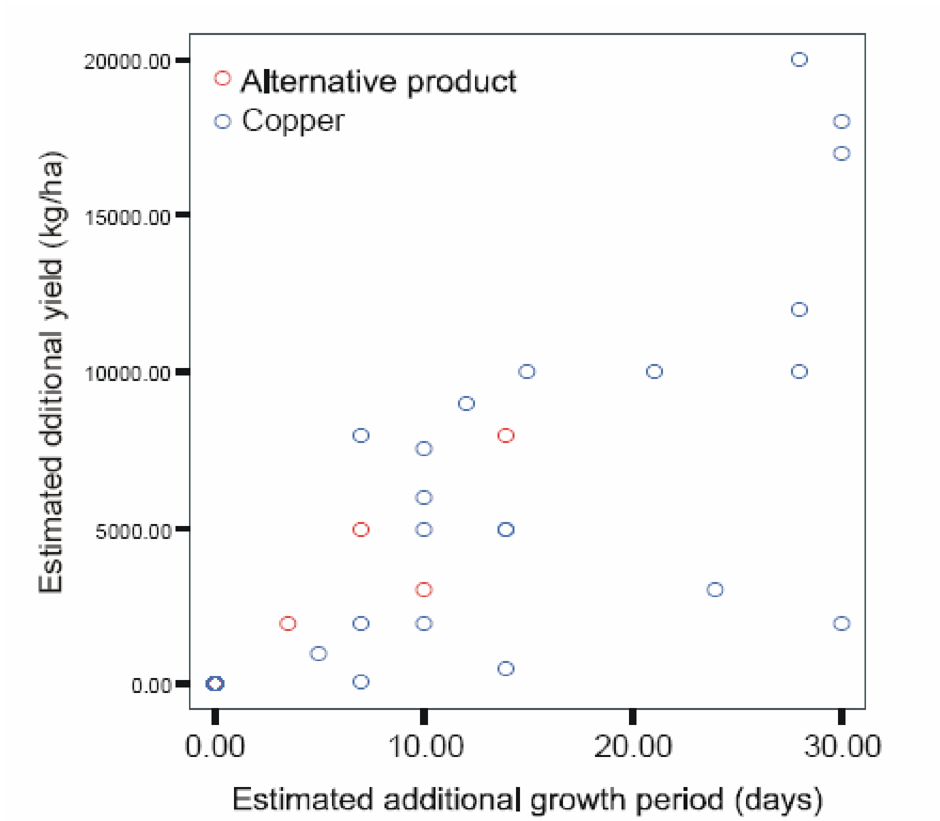

Figure 4.26. Estimated gain in growth period and yield increase due to crop protection applications: Assessment by farmers on efficacy of crop protection treatments for control of *P. infestans* on reference plots in DK, D, F,NL, N, CH, UK in 2000

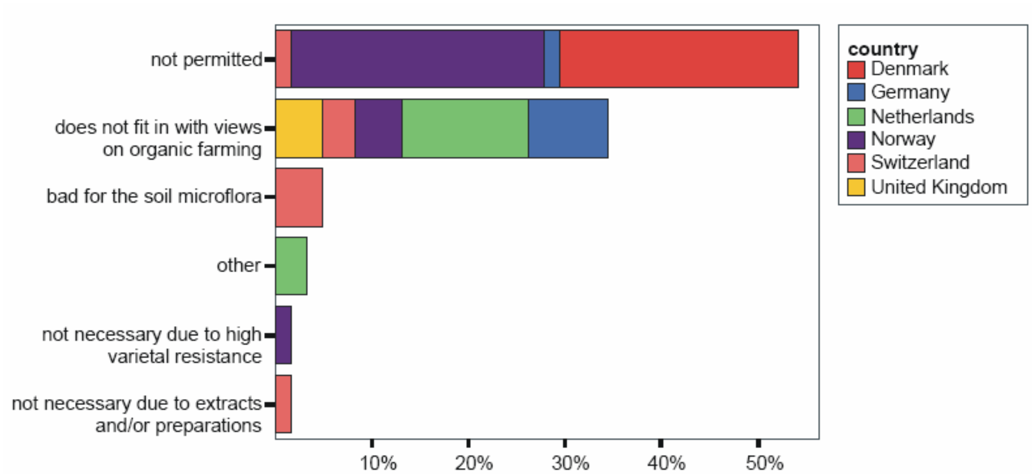

**Figure 4.27. Motivations for not applying copper for control of *Phytophthora infestans* on reference plots in DK,
D, F, NL, N, CH, UK in 2000**
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Table 4.41. Observations associated with differences in outbreak and spread of the late blight epidemic in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

Differences observed (%)	DK	F	DE	NL	N	CH	UK	Total
No	13	53	40	37	60	21	20	36
Yes	87	47	60	63	40	79	80	64
Total	100	100	100	100	100	100	100	100
Susceptibility associated with								
Susceptible variety	73	33	47	21	20	26	73	40
Little sun and wind	60	7	33	16	10		7	18
Other	7	7	20	37	20	26		18
Luxuriant crop growth	13	7	13	5	5	21	33	14
Poor drainage	13	7	13			26		8
Poor soil structure	13	7	13	11		11		8
Poor crop growth	13			5	5	11	13	7
Water moisture shortage		7						1
Inappropriate previous crop				5				1

4.3.3.6 Pre harvest, post harvest and storage management

Pre-harvest management

Haulm destruction is a common procedure to prevent tuber infection by *Phytophthora infestans*, to ensure skin firmness of the tubers at harvest, to reduce tuber maturation and to ensure that tubers keep within optimum size limits and quality parameters such as starch content. Active haulm destruction was not used by all farmers in 2000. Whereas haulm destruction was performed by more than 90% of the Dutch, Norwegian, Swiss, and UK farmers, less than 50% of the Danish and German farmers performed any activities (Table 4.42). Mechanical haulm destruction was popular, preferred to haulm burning in all countries but Norway, where 75% of the farmers destroyed haulms by burning. Most farmers destroyed

the haulms in 1 to 2 activities, more activities were only rarely necessary. The activities started typically at stage 'first leaves yellow' and later. However, haulm destruction was necessary in some cases as early as at full bloom (Table 4.43). The single most important motive for the timing of haulm destruction was prevention of tuber infection by *P. infestans* (figure 4.28). Further important reasons included quality requirements such as starch content, size etc (sub summarized under 'other reasons'). Farmers who did not destroy haulms mentioned as a most important motive that haulm destruction was not necessary as the foliage had already died back sufficiently (figure 4.28). Based on the data, no conclusion can be drawn whether the foliage had died back due to senescence, nutrient deficiency, or late blight. Farmers, who destroy haulms by burning, use usually propane or butane equipment. The energy consumption reaches typically 200 to 400 kg L/ha (figure 4.30).
The activities for haulm destruction led to acceptable results on most farms as re-growth was observed only rarely (table 4.44). However, weather conditions during haulm destruction were favourable for the majority of cases as the weather was mostly dry (table 4.45)

Table 4.42. Haulm destruction activities in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK.

		DK	F	D	NL	NO	CH	UK	Average
Activity 1	no activity	53	20	67	5	10	5	7	22
	Flailing	47	67	33	21	75	74	60	54
	haulm burning	0	13	0	74	5	21	33	22
	(hand) scythe	0	0	0	0	10	0	0	2
	Total	100	100	100	100	100	100	100	100
Activity 2	no activity	73	93	100	47	90	100	73	82
	Flailing	0	0	0	26	0	0	13	6
	haulm burning	27	7	0	26	10	0	13	12
	Total	100	100	100	100	100	100	100	100
Activity 3	no activity	100	100	100	89	100	100	100	98
	haulm burning	0	0	0	5	0	0	0	1
	root cutting	0	0	0	5	0	0	0	1
	Total	100	100	100	100	100	100	100	100
Activity 4	no activity	100	100	100	95	100	100	100	99
	Flailing	0	0	0	5	0	0	0	1
	Total	100	100	100	100	100	100	100	100

Table 4.43. Timing of haulm destruction in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK.

	DK	F	D	NL	NO	CH	UK	Total
No haulm destruction (%)	53	20	67	5	11	5	7	22
Crop in full bloom (%)	0	0	0	5	0	5	0	2
Crop had finished flowering (%)	0	0	0	5	11	5	27	7
Completely green crop (%)	7	13	7	16	26	5	20	14
First leaves yellow (%)	13	33	13	37	5	11	27	20
Half of the leaves yellow (%)	20	20	0	21	21	16	0	15
Most leaves yellow (%)	0	13	13	11	26	53	13	20
All leaves dead (%)	7	0	0	0	0	0	7	2
Total (%)	100	100	100	100	100	100	100	100

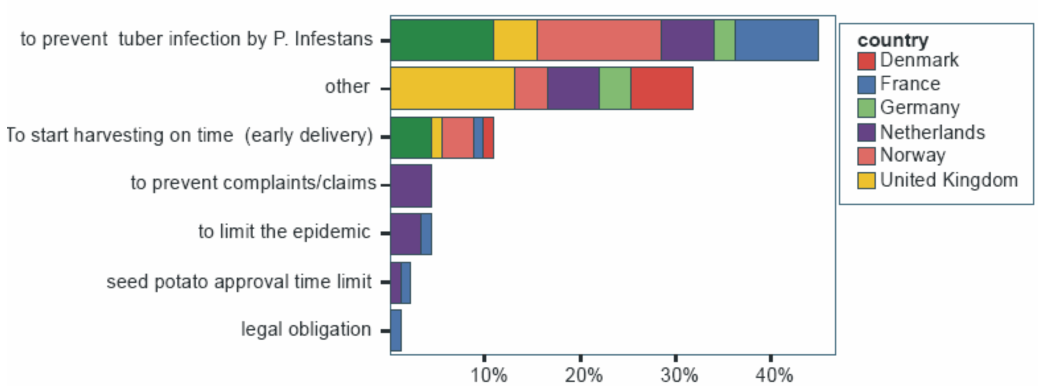

Figure 4.28. Motivations for haulm destruction on reference plots in DK, D, F, NL, N, CH, UK in 2000

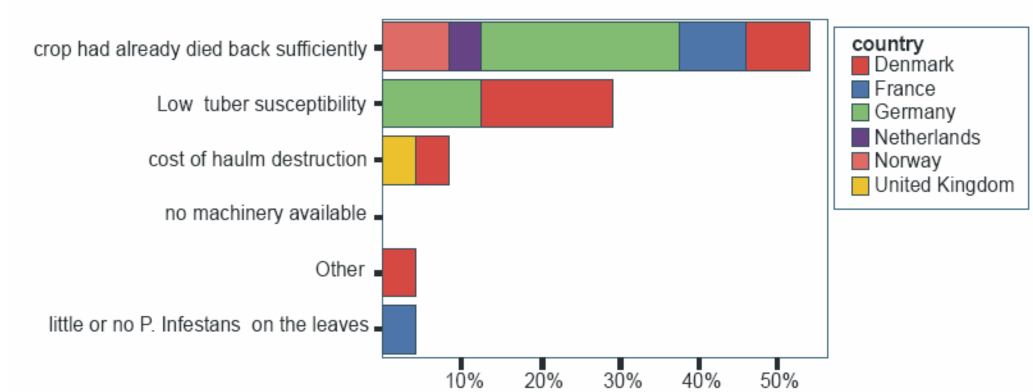

Figure 4.29. Motivations for not destroying haulms on reference plots in DK, D, F, NL, N, CH, UK in 2000

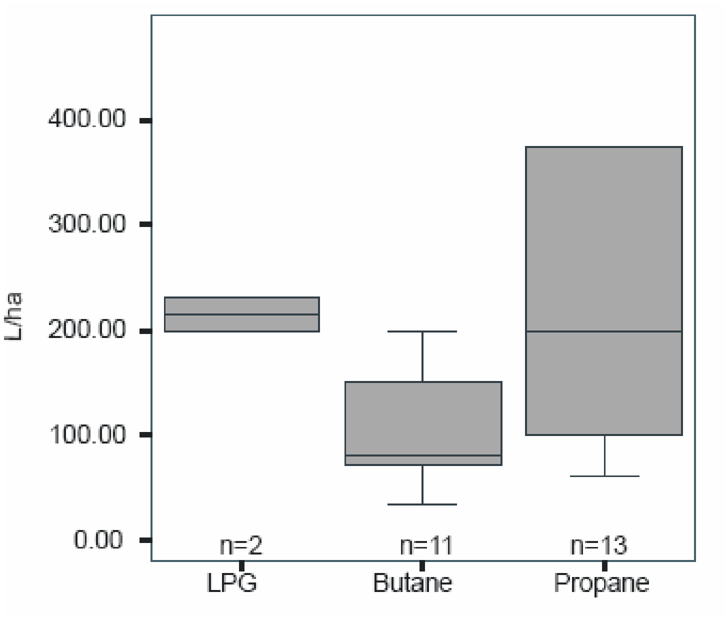

Figure 4.30. Fossil energy consumption for haulm destruction by burning equipment on reference plots in DK, D, F, NL, N, CH, UK in 2000

Table 4.44. Assessment of success in haulm destruction activities in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Average
No action	53	20	67	5	10	5	7	22
Successful, little re-growth	40	67	33	89	80	89	87	71
Moderately successful	7	13		5	10	5	7	7
Total	100	100	100	100	100	100	100	100

Table 4.45. Climatic conditions during haulm destruction in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Average
No action	53	20	67	6	10	6	7	22
Wet soil and damp weather	0	0	0	6	0	11	7	3
Wet soil and dry weather	0	0	0	0	0	0	7	1
Damp soil and damp weather	0	0	0	28	10	0	0	6
Damp soil and dry weather	13	7	0	33	20	17	20	16
Dry soil and damp weather	0	7	0	0	0	0	0	1
Dry soil and dry weather	33	67	33	28	60	67	60	50
Total	100	100	100	100	100	100	100	100

Harvest

The 2000 season was rather normal (table 4.48). In most countries, weather conditions before harvest were not too humid. However, 47% of the UK farmers reported heavy rainfall before harvest began (table 4.42) and also complained that many tubers were not harvested clean (table 4.43). Farmers in the other countries found harvesting and tuber quality favourable. Most of the potato was harvested in full harvesters and transported either by crate or trailer (table 4.50).
The quality assurance during harvest varied considerably between countries. Sorting out of tubers infected by *P. infestans* during harvest seems to be routine practice in Denmark, Germany, and United Kingdom but much less in other countries (table 4.51). Tuber infection by *P. infestans* was assessed as light to normal (as compared to previous years) in most cases. However, 7 to 21% of the Danish, Dutch, Swiss, and UK farmers reported heavy infection rates (table 4.52).

Table 4.46. Assessment of harvest time in 2000 as compared to previous years in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switze-rland	United Kingdom	Total
Early	7	20	33	21	15	26	29	21
Normal	93	53	67	63	75	68	36	66
Late		27		16	10	5	36	13
	100	100	100	100	100	100	100	100

Table 4.47 Weather conditions before harvest in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom
Heavy rain (>20 mm/occasion)	13	20	7	11	5	6	47
Changeable (5-20 mm/week)	47	13	27	11	30	50	7
Dry (< 5 mm/week)	40	67	67	79	65	44	47
	100	100	100	100	100	100	100

Table 4.48. Assessment of conditions during harvest in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Den-mark	France	Ger-many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
very dry, tuber came out of the ground very clean	53	47	60	63	55	42	40	52
damp, tuber came out of the ground fairly clean	40	53	40	21	35	47	27	37
very wet, tuber came out of the ground very dirty	7	0	0	11	5	11	33	9
other	0	0	0	5	5	0	0	2
	100	100	100	100	100	100	100	100

Table 4.49. Observations on relationship between climate and harvest conditions in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	heavy rain (>20 mm/occasion)	changeable (5-20 mm/week)	dry (< 5 mm/week)
Very dry, tuber came out of the ground very clean	0	26	77
damp, tuber came out of the ground fairly clean	47	65	22
very wet, tuber came out of the ground very dirty	53	6	0
Other	0	3	1
	100	100	100

Table 4.50. Harvest equipment used in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Ger-many	Nether-lands	Norway	Switzer-land	United Kingdom	Total
Potato lifter + collected in crates/sacks	0	33	7	0	35	0	7	12
Potato harvester + transport in crates/sacks	60	33	20	16	50	32	57	38
Potato harvester + transport with tipper trailer	40	33	73	58	5	63	36	44
Other	0	0	0	26	10	5	0	7
	100	100	100	100	100	100	100	100

Table 4.51. Quality assurance methods during harvest in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Averag e
No selection needed	13	73	20	37	45	21	15	32
No selection during harvest	7	7	0	5	40	0	15	11
Infected tubers not harvested	0	13	20	21	10	47	9	17
Infected tubers sorted out during lifting	80	7	60	37	5	32	61	40
Other	0	0	0	0	0	0	0	0

Table 4.52. Assessment of tuber infections by *Phytophthora infestans* during harvest in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Total
Light	60	80	85	21	65	65	71	62
Normal	33	20	15	58	35	24	21	31
Heavy	7			21		12	7	7
	100	100	100	100	100	100	100	100

Storage
A large proportion of potatoes from the reference plots were sold directly from the field in NL, CH, Norway and France (table 4.53). In Denmark, Germany, Norway and Switzerland storage on farm is a common practice. Most storage facilities are cooled by ambient air. Only in France and the United Kingdom more than 30 % of the harvest were stored on farm in actively cooled facilities. Potatoes sold from the field are mostly sold in crates but also in bulk (table 4.54).

The quality insurance practice for prevention of infection by *P. infestans* included sorting during harvest, and sorting prior to storage (figure 4.31). However, more than 10% of the farmers stated that they had no active quality control prior to storage. Before and during storage, proliferation of late blight was hindered by careful selection of tubers and removal of haulms, stones and clods, removal of infected tubers, and control of temperature and humidity (table 4.55).

Table 4.53. Storage facilities used in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Netherlands	Norway	Switzerland	United Kingdom
Sold from the field	13	33	7	53	35	47	27
shed outdoors	7	47	20	11	20	16	27
storage facility, cooling ambient air	47	0	67	21	70	53	0
In storage facility, active cooling %	20	33	13	11	5	5	33
Rented storage facility	0	7	0	11	0	0	0
Other	27	0	7	5	5	0	7

Table 4.54. Sales of the harvest in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Total
Sold from the field	13	33	7	53	35	37	27	31
Crate	47	36	60	32	70	37	50	47
Bag		7	7	5	10	11	0	6
Pile/bulk	47	33	27	11	5	16	7	19

Figure 4.31. Prevention of proliferation of tuber rot by *Phytophthora infestans* during storage on reference plots in DK, D, F, NL, N, CH, UK in 2000

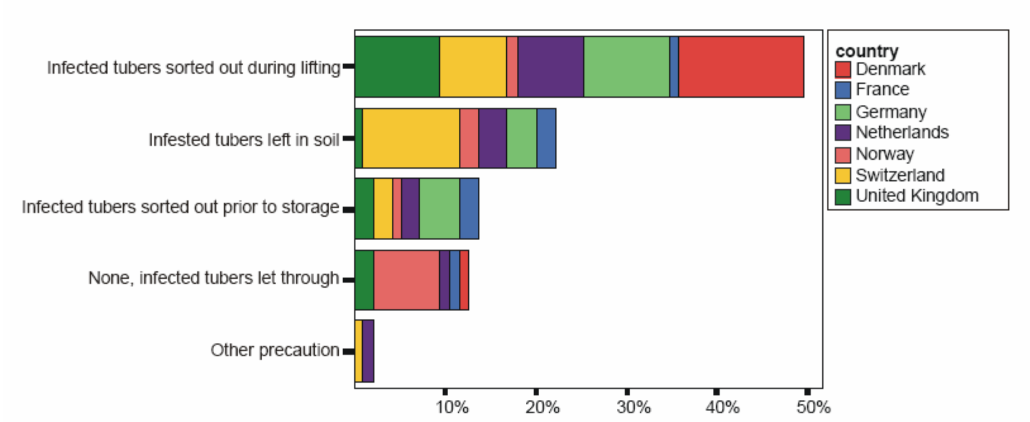

Table 4.55. Quality assurance methods before and during storage in 2000 in 118 organic farms in DK, D, F, NL, N, CH, UK

	DK	F	D	NL	N	CH	UK	Average
no activities	13	43	29	40	60	37	25	35
Haulm, clods, stones removed	73	13	27	18	20	26	22	29
Intensive ventilation	47	7	47	27	20	11	22	26
Unhealthy tubers removed	0	27	13	0	10	5	11	9
Temperature and humidity checked	27	0	47	18	10	5	33	20
Other preventative measures	7	0	13	0	5	16	22	9

4.3.3.7 Assessment of the farmers of the 2000 season

The farmers provided an overall assessment of the potato production on the reference plots in comparison with previous years. The assessment included the parameters 'farm gate price, yield, quality, and profitability of the crop. Depending on country, the assessments vary substantially. The farm gate price was considered normal to high in most countries. However, the Danish and the Dutch farmers reported that farm gate prices were low to very low (see also table 4.9) The yield was assessed as much better than in other years in Germany and Switzerland, whereas the 2000 harvest was lower than usual in the other countries. In contrast, the quality of the 2000 harvest was found to be better than in average years in all countries. As a combination of yield, quality, and farm gate prices the farmers were asked to give an overall assessment of the profitability of organic potato production in 2000. The Danish, Dutch, and Norwegian farmers found the profitability low to very low. In contrast, the French, German and the Swiss farmers assessed the potato crop as relatively profitable (Figure 4.32).

Figure 4.32. Assessment of the growing season 2000 on reference plots in DK, D, F, NL, N, CH, UK

5. Identification of important agronomic factors and production strategies *L. Tamm, A.B. Smit, S. Philips, M. Hospers*

5.1 Introduction Late blight (caused by *Phytophthora infestans*) is the most devastating disease affecting organic (and conventional) potato production in Europe. Under suitable environmental conditions the disease can spread very rapidly and can cause complete crop losses. The extent of economic damage varies considerably between European regions. This depends on several factors. However, in organic production systems factors such as climatic conditions, variety choice, soil management strategy or use of crop protection agents are thought to be important. Based on the detailed inventory of the potato production strategies used by 118 farmers in 7 European countries in the year 2000 an in-depth analysis of the management techniques that contribute to success can be attempted. The aim of this study is to identify management techniques and which are important for successful organic potato production. Apart from 'hard' factors such as agronomic practices we also attempt to include 'soft', farmer-specific factors such as education, information gathering patterns or personal perception.

5.2 Methods

In this study data were used obtained by means of detailed interviews with organic growers as well as expert inquiries (see chapters 3 and 4) conducted in Denmark (DK), Netherlands (NL), Germany (D), France (F), Great Britain (UK), Norway (N), and Switzerland (CH). These data were amended by use of background information such as dynamics of late blight epidemics or varietal susceptibility data from literature sources. In each of the seven countries 15 to 20 organic farmers were interviewed in detail about structure of the farm, economy, and potato production technology. In addition, the farmers were asked about their education, information gathering habits and use of training opportunities. Emphasis was placed to access the practical experience of the farmer. Furthermore, each farmer was asked for an assessment of his own motivations, the development of the market and social and political tendencies.

The farmers were selected in order to obtain a broad spectrum of type of production (organic and dynamic) techniques, time period since conversion, and regional distribution. Farms included in this survey were for at least 2 years in organic agriculture.

The success in potato production of individual farms was related by means of a multiple linear regression model to (i) agronomic activities of the farmers and (ii) the socio-economic background of the farmers. In order to adapt for regional differences, data of regional occurrence of *Phytophthora infestans* were included. In order to identify relevant parameters, a step-wise approach was chosen where irrelevant factors were excluded from the model based on significance levels. Some of the independent variables such as soil fertility parameters (e.g. amount of N, P, and K in the soil) are likely to be intercorrelated and may therefore cause conflicts with basic assumptions of the linear model. Therefore, groups of intercorrelating variables were combined into a single variable prior to regression analysis by means of principal component analysis. The 'soft' parameters which represent the farmer's education and assessments were also combined by PCA in order to obtain groupings of similar characteristics.

As the dependent variable two different variables were selected. On the one hand, success was simply defined by gross yield/ha. As a second approach to describe success, a principal component was calculated ld/ha, fertilizer use efficiency, and profitability (assessed by the farmer).

The linear model can be written as

Success = A1 + A2 + …+ An + F1 + F2 + … + Fn + E1 + E2 + … + En

Where 'Success' denotes the dependent variable (gross yield/ha, or principal component of yield, fertilizer use efficiency, and profitability), variables A1-An denote the agronomic activities, variables F1-Fn denote characteristics of the farmer, and variables E1-En denote regional factors. Some variables were omitted from the analysis since empirical evidence suggests that their influence is either not important or variability between individual farmers was virtually absent. The quantitative and qualitative variables are summarized in table 5.1. In the final stage of data analysis, a total of 22 selected variables on nutrient availability, crop management, crop protection techniques, variety and regional epidemic was included in the analysis.

Table 5.1. Independent and dependent variables included in step-wise multiple linear regression for identification of key factors for success in organic potato production. Variables A1-An denote the agronomic variables, variables F1-Fn denote characteristics of the farmer, and variables E1-En denote regional factors

	Variable name	Variable description		Type of variable
Region	Country		qualitative	E
Soil fertility	organic management since		qualitative	A
	% income from animal husbandry	indicates availability of manure	quantitative	A
	1999 main crop		qualitative	A
	1999 green manuring		qualitative	A
	2000 green manuring		qualitative	A
	type manure		qualitative	A
	soil cultivation intensity	number of soil cultivation activities	quantitative	A
	manuring strategy	Detailed manuring strategy	qualitative	A
	manuring principal strategy	top manuring after planting applied	qualitative	A
	manuring intensity (N total)		quantitative	A
	manuring intensity (N available total)		quantitative	A
	manuring intensity (P total)		quantitative	A
	manuring intensity (K total)		quantitative	A
	principal component for soil parameters	includes physical and chemical soil characteristics	principal component	A

	Variable name	Variable description		Type of variable
	principal component for manuring intensity	includes precrop and fertilizer inputs	principal component	A
Seed and planting	seed produced on farm		qualitative	A
	chitting		qualitative	A
	Planting week		quantitative	A
	Weed coverage	describes competition	quantitative	A
	Irrigation		qualitative	A
	Haulm destruction		qualitative	A
	Harvest week		quantitative	A
variety	varietal foliar resistance		qualitative	A
	varietal tuber resistance		qualitative	A
	varietal maturity		qualitative	A
	Foliar Resistance scale 1-9		quantitative	A
crop protection	Application of copper alternatives		qualitative	A
	Total amount of copper/ha		quantitative	A
	number of copper sprays		quantitative	A
Farmer-specific	clustered groups of idealism		principal component	F
	clustered groups of education		principal component	F
Regional late blight pressure	Climate	potential infection periods after planting	quantitative	E
	distance classes	distance from neighbour plots	quantitative	E
	regional *P. infestans* 2000	first occurrence of *P. infestans*	quantitative	E
	number of conventional sprays	describes regional disease pressure	quantitative	E
	week of first occurrence of *P. infestans*	first occurrence of *P. infestans* within plot	quantitative	E
	weeks without inoculum	weeks between planting and first regional occurrence of *P. infestans*	quantitative	E
	weeks between inoculum and occurrence	delay between first regional occurrence and occurrence within plot	quantitative	E
	First infection week		quantitative	E
Independent variables	gross yield/ha		quantitative	
	Principal component for success	includes yield, fertilizer use efficiency, profitability	principal component	

5.3 Results and discussion

Data analysis by means of multiple linear statistics was performed in a stepwise procedure. Each parameter was checked for plausibility and interpretability of results. The parameters that consist in principal components (which are a derivative of several variables) were very difficult to interpretate. The principal component 'motivation' which should reflect the 'soft' factors such as attitude and education of the farmer proved to be extremely difficult to interpretate as no groupings of behaviour of the farmers could be recognised. Therefore, the independent variable 'motivation' was skipped from further analysis.

Step by step, important and plausible variables were distinguished from irrelevant or, according to the analysis, redundant variables. In the final model, the parameters N intensity, P intensity, K intensity, foliar resistance, chitting, planting week, extracts and preparations, and amount of copper were included (table 5.2 and 5.3).

Table 5.2. Success variable: gross yield/ha. Key independent variables that influence gross yield identified by multiple linear regression

	not standardized coefficients		Standardized coefficients		
	B	SE	Beta	T	Significance
Cconstant	33.73	8.16		4.13	0.000
Manuring intensity (N total) (kg/ha)	0.02	0.01	0.26	1.75	0.083
P manuring intensity (P total)	-0.04	0.02	-0.35	-2.35	0.021
K manuring intensity (K total)	0.00	0.01	0.03	0.32	0.753
Foliar resistance (scale 1-9)	1.62	0.55	0.28	2.97	0.004
Chitting (yes/no)	-1.45	1.69	-0.08	-0.85	0.395
Planting week (week number)	-0.74	0.31	-0.24	-2.38	0.020
Extracts and preparations (yes/no)	-2.72	1.69	-0.15	-1.61	0.110
Copper (kg/ha)	0.73	0.32	0.22	2.28	0.025

The data analysis indicates that some of the parameters have a strong impact on the overall success of the potato production. The variables 'fertilizer input', 'planting date' (the earlier the better), 'total amount of copper' (the more the better), and 'varietal foliar resistance' (the more resistant the better) correlate significantly and consistently with success if potato 'gross yield' is considered as success variable. If a success variable which includes gross yield, nutrient use efficiency, and profitability is modelled, a very similar pattern is observed. This analysis suggests that some production factors, which can be altered by the producer, are responsible for differences between individual farms. The fact that these factors show up in the analysis indicates also that not all farms fully exploit the available production technology. Obviously, there is still a potential for many farms to stabilize and increase yields by the known production strategies.

Table 5.3. Success variable: Principal component of gross yield/ha, Nutrient use efficiency & profitability. Key independent variables that influence gross yield identified by multiple linear regression

	Not standardized coefficients		Standardized coefficients		
	B	SE	Beta	T	Significance
Constant	-1.65	0.83		-1.99	0.049
Manuring intensity (N total) (kg/ha)	0.00	0.00	-0.13	-0.99	0.325
P manuring intensity (P total)	0.01	0.00	0.58	4.43	0.000
K manuring intensity (K total)	0.00	0.00	0.25	2.58	0.011
Foliar resistance (scale 1-9)	-0.11	0.06	-0.17	-2.05	0.043
Chitting (yes/no)	-0.11	0.17	-0.05	-0.66	0.510
Planting week (week number)	0.07	0.03	0.20	2.26	0.026
Extracts and preparations (yes/no)	0.24	0.17	0.11	1.43	0.156
Copper (kg/ha)	-0.07	0.03	-0.18	-2.11	0.038

The farmers' experiences expressed in the interviews correspond in many aspects with this data analysis. However, reality often limits the extent to which these strategies can be implemented on farm level. For instance, choice of resistant varieties (if available on the market) is often limited by acceptance by consumers and wholesalers. In the farmers' experience, the plant nutrition and the soil fertility management are key factors for yields but also for the susceptibility of the potato crop. Farmers find very consistently that a weak crop is much more susceptible than a vigorously growing potato crop. This suggests (mirrored by the data provided in the interviews) that organic potato crops find, in general, suboptimal nutrient availability which leads to physiological imbalances and, as a result, to increased susceptibility to late blight. From these data it may be concluded that key factors for success which should be further exploited include (i) reduction of growing season by early planting and chitting, (ii) use of a soil fertility strategy that leads to sufficient nutrient supply (nutrient supply is in general sub-optimal), (iii) use of resistant or robust varieties (or strategies that lead to the same effect), and (iv) efficient crop protection strategies.

6 Farmers' perceptions of present and future developments of organic potato production and characterization and development of the market demands

L. Tamm, A.B. Smit, M. Hospers

6.1 Motivations and expectations of farmers

A total of 118 organic farmers were asked about their fears and motivations. Despite the difficult economic situation of many farmers in Europe, generation of income was not the most important aim of the farmers. The most important motivation was to produce food which is 'healthy and safe' (figure 6.1). However, the second most important aim is the generation of a sufficient income.

The farmers identified as important trends which will promote organic farming the increasing public concern about food safety issues and the demand for socially responsible agriculture (figure 6.2). However, the farmers also expect decreasing prices for organic food which may pose substantial problems for the farmers. Further trends include the general up-scaling of organic production which was considered as positive. However, many farmers were also concerned that the rapid growth of organic agriculture may bring economical problems for pioneer farms.

When asked about the strengths and weaknesses of the enterprise the farmers mentioned strengths more often than weaknesses (figure 6.3). A good relationship to clients was considered a most important strength by a majority of the farmers, followed by a positive assessment of the pest and disease control on farm. As weaknesses of the farms, lack of good pest and disease control and small income were mentioned most often.

Strategies to improve the overall performance of the farm were dominated by improvements of the production technology (better soil fertility, better pest and disease control) (figure 6.4). Classical economical approaches such as increase of farm area or decrease of labour intensity were mentioned less often.

Organic potato production was assessed as an attractive crop as compared to other commodities (figure 6.5). Good income was mentioned most often as a motive for potato production. Next to profitability, farmers found potato production attractive as there is demand from the market and additionally, potato is considered a valuable crop in a crop rotation because of the good weed control. Potato is also attractive for many farmers as they have developed a personal affinity for this crop.

Farmers were also asked to assess the impact of a complete copper ban on organic potato production (table 6.1). On an average, more than 30% of he farmers thought that the organic potato production will decrease, whereas more than 66% of the farmers expected no change. Only a small fraction of the farmers believed that the potato production will increase. However, there the assessment differs substantially between countries where copper use is allowed and countries where copper is banned. In France, Switzerland and UK a majority of the farmers expect a decrease of production. Interestingly, some Dutch farmers expect an increase as they hope for better market opportunities in the Netherlands when copper becomes banned in all countries.

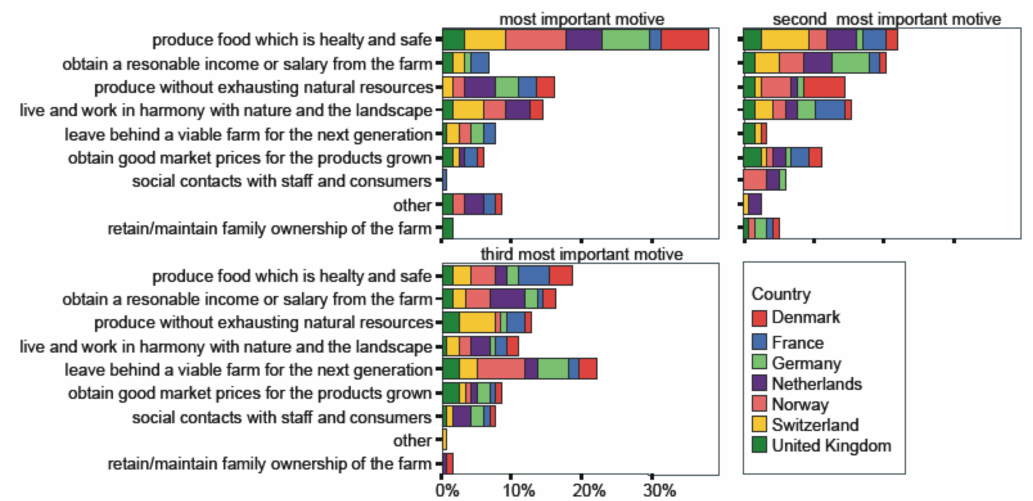

Figure 6.1. Motivations of 118 organic farmers in DK, D, F, NL, N, CH, UK to produce organic

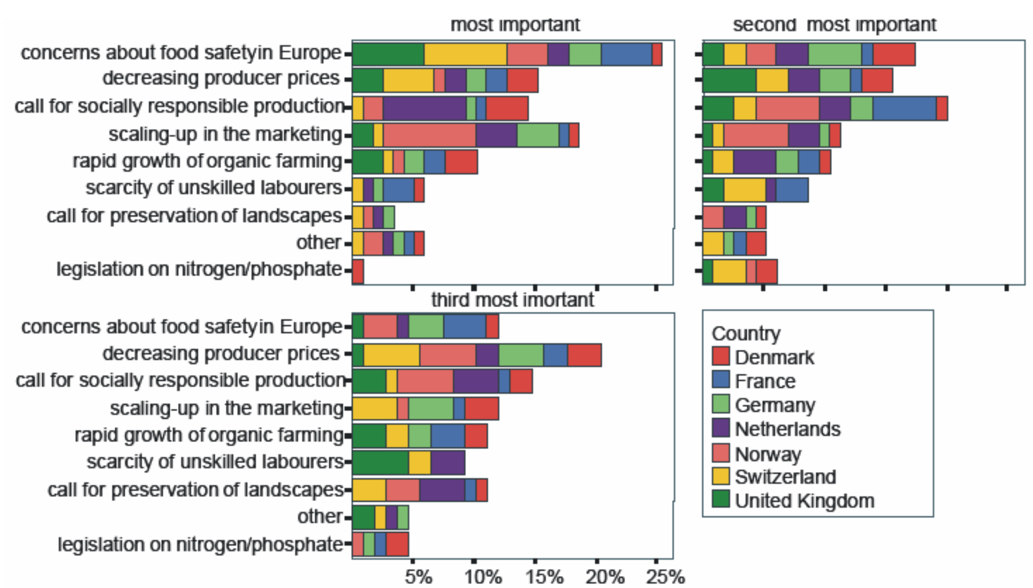

Figure 6.2. Major threats, challenges and opportunities for European organic farming perceived by 118 organic farmers in DK, D, F, NL, N, CH, UK

pests and diseases cause much crop damage

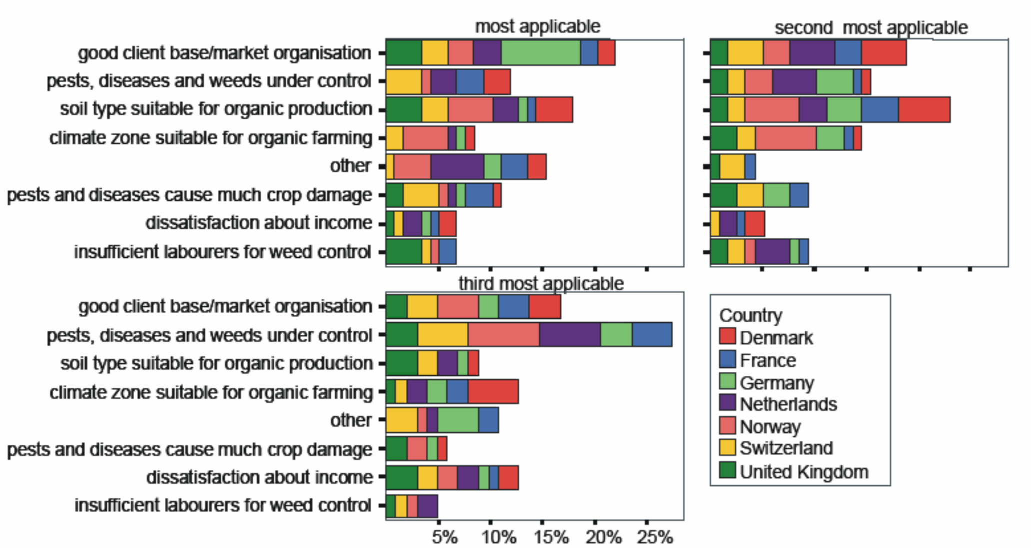

Figure 6.3. Strengths and weaknesses of farms of 118 organic farmers in DK, D, F, NL, N, CH, UK

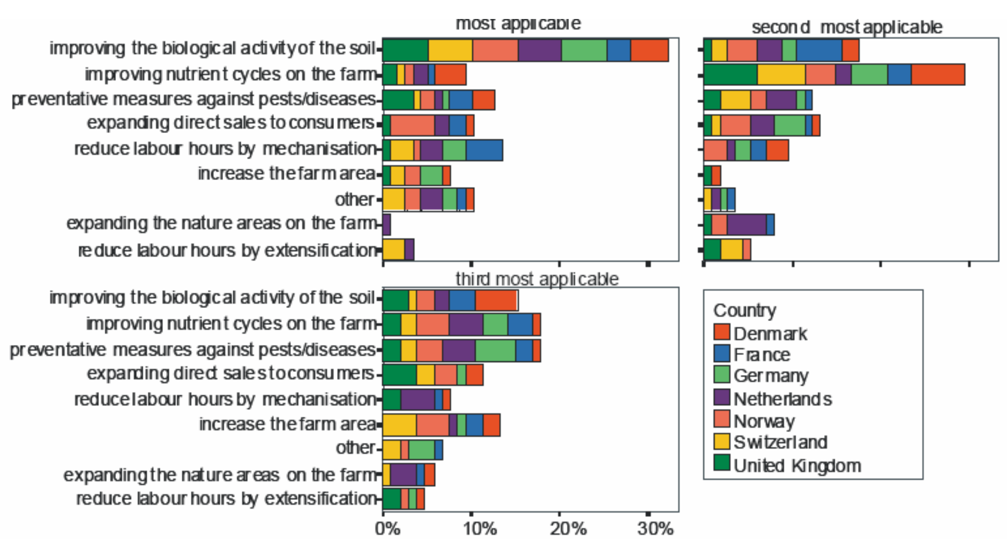

Figure 6.4. Strategies to ensure economic viability of the farms of farms of 118 organic farmers in DK, D, F, NL, N, CH, UK

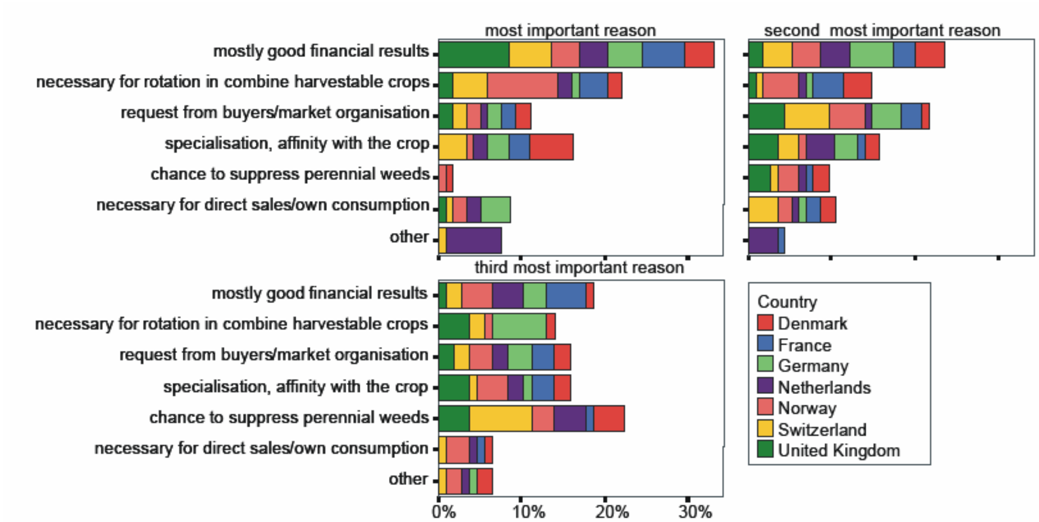

Figure 6.5. Reasons to grow potato of farms of 118 organic farmers in DK, D, F, NL, N, CH, UK

Table 6.1. Expected impact of copper ban on organic potato production 118 organic farms in DK, D, F, NL, N,CH, UK

	Denmark	France	Germany	Nether-lands	Norway	Switzer-land	United Kingdom	Total
Reduction	0	71.4	35.7	5.6	0	61.1	57.1	31
Neutral	100	21.4	64.3	83.3	100	38.9	42.9	66.3
Increase	0	7.2	0	11.1	0	0	0	2.7

6.2 Education and information gathering

The farmers interviewed in this survey are generally well trained. In most countries, more than 80% of the farmers have a specialized education or a higher education at technical college or university (figure 6.6). In UK, Germany and Norway almost 50% of the farmers have a degree from technical college or university. In Switzerland 30% and in France more than 50% of the farmers have not passed any formal education. However, more than 20% of the farmers in Norway and Denmark with some professional education claim that they are not trained in agriculture (figure 6.7). There is an obvious lack in specialized training in organic agriculture. The proportion of farmers with an additional formal training in organic agriculture reaches 25% in best cases, and nil in the worst cases.

The farmers use several information sources to improve their professional knowledge. Specialized journals are most popular, but other information sources such as advisory services and study groups are regularly consulted. More recent technologies such as internet or disease forecasting systems were used in 2000 by up to 50% of the farmers, depending on country. However, there is some discrepancy between these responses and the responses on what information sources were contacted during the 2000 potato campaign (see also table 4.36).

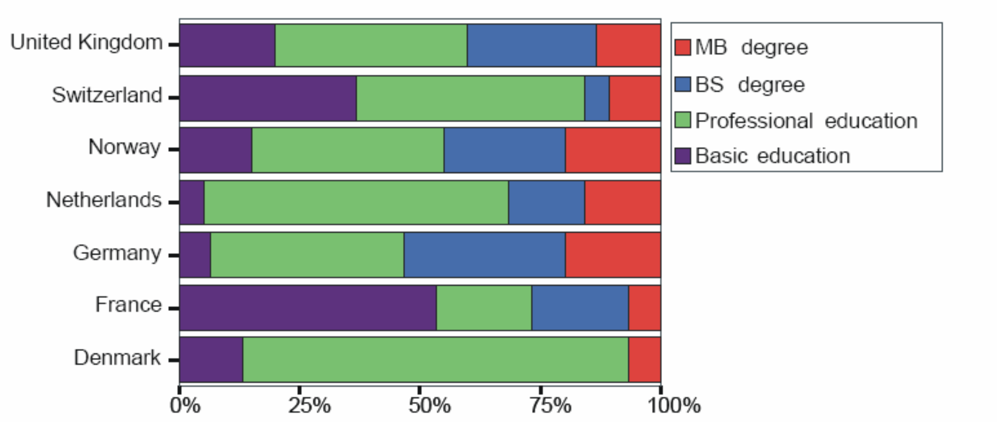

Figure 6.6. Educational level of 118 organic farmers in DK, D, F, NL, N, CH, UK (B.S.: Bachelor of Science, M.S.: Master of science)

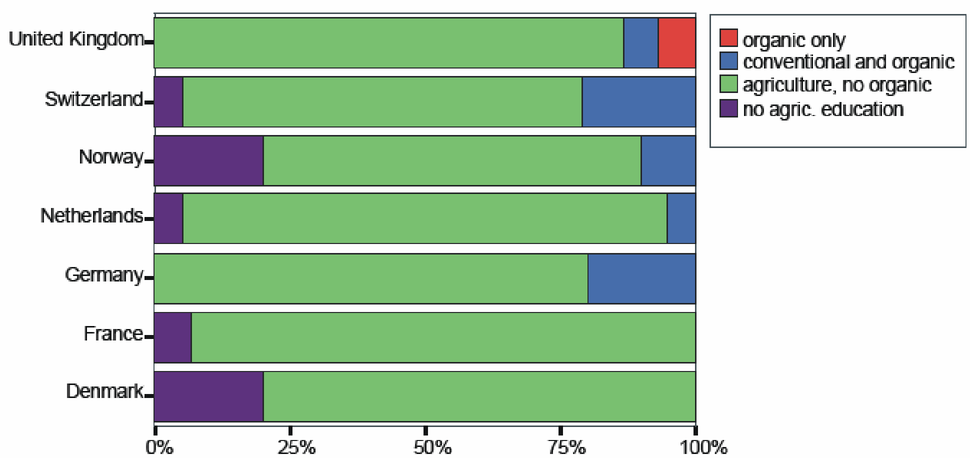

Figure 6.7. Type of agricultural education of 118 organic farmers in DK, D, F, NL, N, CH, UK

Table 6.2. Information sources consulted for potato growing by 118 organic farmers in DK, D, F, NL, N, CH, UK. (% of farmers using information source)

	DK	F	D	NL	N	CH	UK	Total
Agricultural Journals	100	93	100	89	95	100	100	97
Internet	40	20	40	37	30	21	53	34
Disease forecasting systems	7	47	47	26	10	42	20	28
Advisory service	73	27	73	74	85	26	60	60
study groups, conferences	53	67	80	84	40	42	73	62
detailed records of crop management	33	73	73	89	75	74	93	74

There is a broad range of agricultural journals available in each country. Between 15 and 28 different journals were regularly read in each country. Table 6.3 gives an overview of the most popular journals in each country. Those media that are specialized on organic farming are contacted by up to 100% of the farmers.

Table 6.3. Most important print media read by 118 organic farms in DK, D, F, NL, N, CH, UK. (n=number of farmers)

	DK	F	D	NL	N	CH	UK	Total
Okologisk landbruk	.	.	.	.	17	.	.	17
Ekoland	.	.	.	16	.	.	.	16
Oogst	.	.	.	16	.	.	.	16
Bio Aktuell	.	.	.	.	.	15	.	15
Bioland	1	.	12	1	.	1	.	15
Bondebladet	.	.	.	.	14	.	.	14
Farmers weekly	.	.	.	.	.	.	14	14
Organic farming	.	.	.	.	.	.	14	14
Lebendige Erde	1	.	8	.	2	1	1	13
Bauernzeitung	.	.	.	.	.	12	.	12
Boerderij	.	.	.	12	.	.	.	12
norsk landbruk	.	.	.	.	12	.	.	12
Schweizer Bauer	.	.	.	.	.	11	.	11
Agrarisch dagblad	.	.	.	10	.	.	.	10
Jordvett	.	.	.	.	10	.	.	10
Top agrar	.	.	8	.	.	2	.	10
Landsbladet	9	.	.	.	.	.	.	9
Okologisk Jordbrug	8	.	.	.	1	.	.	9
Landfreund	.	.	.	.	.	7	.	7
Log ecological farming	6	.	.	.	.	.	.	6
Okologie & Landbau	.	.	5	.	.	1	.	6
Biofil	.	5	.	.	.	.	.	5
Crops	.	.	.	.	.	.	5	5
France agricole	.	4	.	.	.	1	.	5

7 Recommendations for the ongoing research programme

The results of the survey have shown that the approaches chosen in the Blight-MOP research program address the key factors which are obviously crucial for a successful organic potato production such as (i) reduction of growing season by early planting and chitting, (ii) use of a soil fertility strategy that leads to sufficient nutrient supply (nutrient supply is in general sub-optimal), (iii) use of resistant or robust varieties (or strategies that lead to the same effect), and (iv) efficient crop protection strategies. Furthermore, the survey has not revealed any already existing fully successful production technology which would solve all problems, provided it was implemented into current potato management systems. Therefore, all attempts to improve soil fertility management, agronomic management, varietal resistance or diversification strategies, and crop protection are worthwhile as any improvement will contribute substantially to overall production security and will decrease dependency on copper fungicides.

The survey shows also that there are tremendous differences between farms that produce under similar environmental conditions. Obviously, there is a substantial potential for improvement of current production on farm, just by implementation of current 'state of the art' technology. Therefore, the distribution of existing know-how and novel technologies to the farmers will increase the success of organic production considerably.

The dissemination of know-how and novel techniques will be the next important step in order to fully exploit the benefits of Blight Mop.

Blight-MOP: Development of a systems approach for the management of late blight in EU organic potato production

About the project
Late blight (caused by *Phytophthora infestans*) is the most devastating disease affecting organic (and conventional) potato production in the EU. Under suitable environmental conditions the disease can spread very rapidly and can cause complete crop losses. Protective copper fungicides are currently used to control the disease in most organic production systems. However, copper fungicides will be restricted for the use in organic farming from the year 2002 (EU Regulation No 2092/91).

The income loss due to unhindered spread of late blight is expected to threaten the economic viability of organic potato production in many areas of the EU. Since EU policies are aimed at supporting an expansion of organic production, a replacement for copper containing and other chemical fungicides is urgently required. Increased late blight incidence on organic farms may also influence blight epidemics in neighbouring conventional farms and threaten conventional production systems.

In order to overcome pending production problems, the EU project 'Blight-MOP' (QLRT 31065) started in 2001: It evaluates a wide range of potentially copper-independent control strategies. The overall aim of Blight-MOP is to develop a systems approach which allows commercially viable production of potato crops without the use of copper.

The project includes
(i) an assessment of the socio-economic impact of late blight and ‚state of the art' blight management practices in EU organic production systems
(ii) the evaluation of varieties and within field diversification strategies as well as their impact on fungal populations
(iii) the optimisation of agronomic strategies, and
(iv) the development and evaluation of alternate control treatments and adapted application strategies. The integration of optimized resistance management, diversification, agronomic and treatment strategies into existing organic potato systems will help in the development of regionally adapted and economically viable potato production systems.

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- Plant Research International B.V. (Plant RI), 16 Droevendaalsesteeg 1, 6700 AA, Wageningen, The Netherlands

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In Europe, late blight, caused by *Phytophthora infestans*,is the most devastating disease affecting organic(and conventional) potato production. Under suitable environmental conditions the disease can spread rapidly and it can cause complete crop loss. The extent of damage due to late blight depends on several factors: inorganic production systems these factors include climate, choice of variety, soil management and use of crop protection agents such as copper. Therefore, the extent of economic damage varies between European regions. Council Regulation (EEC) No 2092/91, amended by Commission Regulation (EC) No 473/2002 of 15 March 2002 regulates the use of copper in organic agriculture. Copper has been the single most important control agent in organic late blight control. Therefore, the reduction or an eventual phasing out of copper use will have varying impacts in different regions.

This report presents the results of a detailed survey that has been conducted in 7 European countries in the year 2001. It is a subproject of the EU-funded project Blight-MOP (QLRT 31065). The survey investigates legislative, socio-economic and production parameters. The aim of this study was: (i) to obtain an inventory of the current organic potato production techniques, (ii) to assess the impact of a potential ban of copper on yields and viability of organic potato production and (iii) to identify alternative plant protection strategies that are used by organic farmers.

This report includes: (i) statistics on yields, farm gate prices, and production techniques, (ii) an analysis of farmer observations and experiences on the extent and impact of late blight epidemics, (iii) an analysis of the farmer's motivations, expectations and their assessment of the potential impact of a copper ban. Using multiple linear regression we identified production factors which appear to consistently contribute to production success.