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Deliverable 5.1: Report on seed born diseases in organic seed and propagation material

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Foreword

This draft report contains the work carried out in the EU-funded project within the 6th Framework Research Programme "EEC 2092/91 (organic) Revision" (No. SSPE-CT-2004-502397) in the work-package 5, Task 1, which deals with the "Importance and impact of seed-born diseases on organic seed production".

The main objective of this task has been to identify key problems related to seed born diseases that may hamper organic seed production and the legal background that defines acceptable thresholds for diseases in seeds. Moreover, an overview on available methods for seed treatment potentially acceptable in organic farming has been carried out.

Acknowledgements

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Executive Summary

The key questions which will be addressed in this report are:

- Are seed born diseases an important factor that prevents seed companies from producing organic seeds and organic farmers from using them?
- Which seed treatments are available in organic farming? Which treatments are or will be acceptable? To which degree are they effective?
- Are the thresholds for seed born diseases different among Member States? Can this cause unfair competition among farmers and seed producers?
- How did the health status of organic seed change in the last years?

The main answers may be synthesized as follows:

- Seed born diseases are an important factor influencing seed production and seed use in organic agriculture, but they are not the only obstacle that exists at the moment.
- Awareness on the importance of seed health has increased considerably; “conventional” organizations such as ISF (International Seed Federation) or ISTA (International Seed Testing Association) give statements on seed health and seed treatments for organic agriculture.
- In the last 5 to 10 years several methods and products of non-synthetic seed treatments (physical, microbiological, plant-based etc.) have been successfully tested on different host-parasite combinations and are potentially available for use in organic farming. However, there are no general treatments available that are effective for all host-pathogen combinations.
- Due to the importance of seed health in organic agriculture, it is important that organically acceptable seed treatments are identified and authorized in organic seed production. This would assure organic producers reliable seeds for their farming operations.
- Besides legal restrictions for quarantine diseases on seeds, most of the Member States have legal thresholds for seed born diseases, which however apply almost exclusively to cereals. For vegetables and legumes, Member States only have general statements on seed health.
- Thresholds for seed born diseases in cereals vary between Member States. This may cause distortion in seed trade and use as one country may allow the import (from another MS) of seeds that do not fulfil certification limits in the importing country, but that are fully certifiable in the MS where they are produced.
- Data on the status of organic seed health is available in few countries only. It would be very helpful if the MS kept annual records of the organic seed-lots’ health status as it would allow to monitor the presence of seed born diseases and risks and act consequently on the seeds and the crops. In general, available data for cereals does not show a clear trend of seed health development but rather highlights the influence of climatic condition. There also appears to be a general spreading of Tilletia caries, which may increase with lower control levels, especially with of-farm seed production. Spreading of seed-born diseases is greater in organic farming since few control measures are available.

Recommendations for development of the legal basis for organic seed production:

- Seed quality refers not only to purity and germination parameters but also to aspects of seed health.
- Seed health in organic production is of crucial importance as healthy seeds are the basis for successful production, especially in organic farming systems, where less efficient plant protection agents are available for managing plant diseases and prevention is the main key of success.

- There is a need to define and regulate which seed treatments can be permitted in organic farming (methods and products should be listed in the revised EEC/2092/91[1] in annex II B)
- In order to increase the availability of organic seeds and their assortment in terms of varieties, seed treatments (accepted in organic agriculture) should be made possible.
- It would be advisable that all treatments which the seeds are subjected to are declared on the label.
- Thresholds for seed born diseases in organic seeds must be strict and harmonized among Member States in order to avoid the spread of seed born diseases, difficult to manage in organic farming. Such thresholds must be based on sound scientific basis.
- Organic seed-lots' health status should be monitored on a yearly basis by seed health authorities.

[1] EEC/2092/91: COUNCIL REGULATION (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs (OJ L 198, 22.7.1991, p. 1)

1 Scope of the report

The overall objective of project Work-Package 5 is to evaluate the degree of dependence of organic farming from conventional seeds and to identify main obstacles in the use of seeds from organic sources at EU level. Final recommendations will be developed to support the EU Commission in the further development of tools, aimed at facilitating and harmonizing the use of organic seeds.

Within the general scope of the Work-package, the objectives of task 5.1 are:

- identify constraints in the production and use of organic seeds related to seed born diseases;
- provide knowledge in order to overcome problems related to seed born diseases in cereals, legumes and vegetables.

Specifically, the scopes of the task are:

- to summarize the relevance of seed born diseases in organic seed production and use;
- to compile quality requirements for organic seed trade in different EU countries (e.g. purity, germination, health.);
- to give an overview on international standards for seed health and quality (ISTA, AOSA, FIS, etc.) and to identify differences in National seed trading requirements (legal/private), influencing organic seeds;
- to give an overview of currently available seed treatments that may be accepted in organic farming;
- to evaluate available methods to control seed born diseases that may be acceptable in organic farming;
- to analyze potential competitive problems caused by differences in seed quality requirements in Member States;
- to analyze the development of seed quality of certified organic seed in selected countries from reports issued by seed authorities;
- to propose strategies for future actions to overcome problems and facilitate the use of organic seeds.

2 Methodology and sources of information

In order to address the research objective, information has been gathered through:

- an extensive literature review performed in 2005 and up-dated in July 2006, on methods and products to control seed born diseases, potentially acceptable in organic farming;
- A survey based on a questionnaire submitted to experts in production, trade and use (farmers and advisors) of organic seed, as well as researchers. The survey aimed at understanding their experience with seed born diseases and the perception of seed quality characteristics at different stages of seed production and use;
- collection of EU, international, National and private regulations and thresholds concerning seed born diseases on seeds (organic and conventional);
- collection of National reports (where available) on the status of organic seed health for the last 3 years;
- 5 workshops with stakeholders.

Details on each source of information are reported below.

Literature review

A scientific literature review was performed, concerning methods and products of seed treatment that may be acceptable in organic farming. It has been conducted in 2005 and a first draft was circulated in February 2005. However, because a considerable number of important publications became available after the Joint Organic Congress in Odense (DK) in May 2006, the review was up-dated in July 2006. In total, 68 scientific publications have been reviewed and analyzed. They can be grouped in the following clusters:

- Health status
    - Physical treatments (21 references)
    - natural substances (27 references)
    - biological control agents (35 references)
    - health tests (3 references)
- Germination (5 references).

Each paper was classified and its contents summarized in tables (Please see Annex 1 for the Complete review)

Expert survey Questionnaire

A questionnaire on the topic of organic seeds was developed on the basis of the literature review and submitted to experts. Partners identified 54 experts in 13 Member States. Out of these, 20 experts (37%) responded from the following countries: Switzerland, Germany, Austria, Italy, the Netherlands, Denmark, France and Hungary. The table below indicates the category of experts who participated in the survey:

Table 2.1 Description of the sample of experts who responded to the questionnaire on seed health issues

Category	Number of experts
Researcher	9
Seed producer	2
Advisor	5
Certification body	4

The questionnaire (see Annex II for full text) included questions on the following topics:

- the efficacy of treatments and their acceptability in seed born disease control, including an open list of techniques and products experts may have had experience with, detailed per crop type and details on their application (time length, temperature etc.);
- importance of seed born diseases, severity and frequency of attacks;
- other characteristics of seed quality as perceived by the experts and compared to conventional and organic seeds;
- an additional question on experiences with on-farm seed production.

The information gathered from the questionnaires was elaborated as qualitative data. When additional clarifications were requested, in-depth interviews were conducted with the experts.

Review of regulations, guidelines and thresholds on seed born diseases in Member States

To evaluate points of potential conflict and unfair competition among seed producers and users in different Member States, available regulations and guidelines, establishing or recommending threshold levels of acceptability for seed born diseases on specific seed types (both conventional and organic) have been collected and compared. These included the EU Regulation, EC/1452/2003[2], International standards, National (Austrian, Swiss, Spanish Czech, Finnish, Hungarian, Dutch, German and Latvian) and private regulations.

The collected regulations were compared with the scope of highlighting the main differences which may hamper fair trade of organic seeds in the EU.

National reports on organic seed health status

In few EU countries seed health authorities keep a record of the status of organic seed health. Where available, those records have been collected and compared over 3 years (2004, 2005 and 2006).

In some countries where the reports are not available, unofficial data has been collected (Netherlands and Switzerland).

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[2] COMMISSION REGULATION (EC) No 1452/2003 of 14 August 2003 maintaining the derogation provided for in Article 6(3)(a) of Council Regulation (EEC) No 2092/91 with regard to certain species of seed and vegetative propagating material and laying down procedural rules and criteria relating to that derogation (OJ L206 15/08/2003 p.17)

Stakeholders workshops

In order to gather stakeholders' opinions on a very important issue, influencing the organic seed derogation regime, the authors were involved in 5 international stakeholder workshops, some of which were organized jointly with other organizations :

- the First World Conference on Organic Seed, organized by FAO, IFOAM and ISF in Rome on July 2004;
- a workshop in November 2005, with the participants of the EU project STOVE (QLK5-2002-02239-Quality of life and Management of Living Resources - Full Title: Seed Treatments for Organic Vegetable Production);
- a joint workshop in Vienna on December 2005, with the EU consortium ECO-PB (Ecological Plant Breeding);
- a workshop in Odense, during the Joint Organic Congress that took place in May 2006;
- a workshop in the Netherlands in September 2006 organized with ECO-PB and the Danish Advisory Service, during a Bejo open day.

The first, second and fourth workshops were aimed at gathering the points of view of the researchers. The third and fifth workshops were aimed at policy makers and organic seed database managers. Finally, the last workshop was an opportunity to meet seed producers and traders, certification authorities and bodies, farmers and advisors experienced in organic farming.

3 Results

Results and outcomes are reported in the following four sections:

3.1 **Organic seed quality** reporting the feedback of seed experts (outcome of questionnaires). The contents aim at answering the question “are seed born diseases a serious limitation to production and use of organic seeds?”

3.2 **Seed treatments potentially useful for organic agriculture,** based on the literature review and consultations with experts, aims at answering the question “which seed treatments may be used in organic seed production and with which degree of success?”

3.3 **Private thresholds for seed born diseases in organic agriculture**, based on regulations and guideline comparisons, aims at answering the question “do differences in seed born diseases and legal or private thresholds influence fair trading of organic seed in the EU?”

3.4 **Health status of organic seeds in selected countries**, based on annual reports on organic seed lots health status from few Member States, aims at answering the question “in the last three years which was the development of the organic seed health status?”.

3.1 Organic seed quality in the view of seed experts

3.1.1 Introduction

The aim of submitting a questionnaire to experts of the seed business was to understand how the theme “seed born diseases” is perceived or practically experienced. Such a questionnaire allowed gathering of information and evaluations directly from the experts. The work focused on identifying key practical problems related to seed born diseases, namely the influence of seed born diseases on the production and use of organic seeds. Also, it intended to give an overview of the organically acceptable methods identified by the experts in controlling seed born diseases. The experts contacted belong to various sectors of the organic seed business, such as breeding, multiplication, research, etc.

The questionnaire included two parts: the first was dedicated to the impact of diseases on seed production (including the efficacy of treatments in disease control), while the second part dealt with the impact of diseases on seed production and use.

3.1.2 Overview of the treatments identified by the experts (this relates to 3.2 treatments)

The treatments mentioned by the experts can be classified as follows: agricultural (preventive) means, physical treatments (mechanical, thermal, radiation), natural substances of plant and animal origin, bio-control organisms, chemicals and minerals. Table 3.1 shows an overview of these treatments. The column “Experts’ comments” includes only the most relevant remarks advanced by the experts.

Table 3.1: Possible means to overcome or avoid seed born diseases listed by questionnaire answers

Type	Treatment name	Short description	Experts' comment on treatment
Agricultural (Preventive)	Prevention strategies	Critical control points during seed production and multiplication	• This type of control requires knowledge on the epidemiology of the diseases and potential vectors of disease transmission. • Prevention strategies are the most successful and important measures
Mineral	Copper	Copper oxychloride and copper hydroxide	• Minimal amounts/ha have good effects, release of copper to the field is less than copper content of the crop harvested. • Copper hydroxide on cereal seeds. 200g Cu/100kg seeds
Biological control (micro-organisms)	Biological control agents BCA	Microbiological	• There is a great potential to develop BCA's against almost all diseases • There is a problem with the pesticide legislation, (e.g. in some MS all biological agents need to go through the EU-pesticide procedure, which takes decades and millions of Euro. key points: mechanisms of action of the micro-organisms, application technique, large scale production (fermentation), establishment of the micro-organisms on the host, patenting • Some products, like 'Cedemon' are ready to use in cereals. • Products on the basis of e.g. *Trichoderma* sp., *Bacillus* sp., *Lactobacillus*, *Pseudomonas* or other micro-organisms are developed and available on the market as seed dressings in some countries.
Natural substances of plant origin	Plant extracts	Plant extracts	• Plant extracts include all plant- based agents used to control diseases. Some seem to be interesting for the future. • Several plant-extracts are not registered as PPP in EU but some are allowed under national legislative frameworks, causing un-fear situations among MS. • The main problem is the high amount of liquid necessary (4 – 5 l per 100 kg) and the need of drying afterwards • Examples: Milsana, Thyme oil, Lebermoos
		Thyme oil	• Thyme oil is under broader investigation at Plant Research International, University of Wageningen. • The treatment can be phyto-toxic if not used in a correct way. • Key points: composition, application technique
		Tillecur Tillecur + acetic acid	• Tillecur (84.8% yellow mustard seed powder): 60ml/kg; 1.3 kg/6l Water for 100 kg seed • Slight toxicity (LD50: 2000-5000 mg/kg); regular use, but small market in Germany • The main problem is the high amount of liquid necessary (4 – 5 l per 100 kg)
Natural substances of animal origin	Milk powder treatment, skim milk powder	Skim milk powder; 80g/kg	• Sometimes delay in plant emergence but without effect on number of neither ears nor yield. (The amount is 60 times higher than tillecur; the price is therefore higher than for tillecur and it is difficult to have milk powder attached on seeds)
Chemical	Osmopriming	Osmopriming	• The osmotic pressure obtained by different salts can assure a good external pathogens control and a better germination (increasing the germination rate and reducing the total time of germination) • This method requires the use of a salt solution for some hours (lettuce, chicory) or some days (celery, leek etc.). Immediately after the end of the treatment the seeds must be washed and dried. If the seeds are stored in a cool and dry cell, the treatment effects (in terms of seed stimulation) persist for four-six months.

	Ozone	Ozone	• Ozone is not widely accepted by the organic farming community. However, it is a natural component, although potentially toxic to the persons who are treating. Ozone is also fytotoxic, so pre-testing of samples is needed.
	Ethanol	Concentration 70%	• Interesting new results. Ethanol should be listed in annex of EU-regulations for organic agriculture. The main problem is the high amount of liquid necessary (4 – 5 l per 100 kg)
	Various organic acids	Acetic acid lactic acid	
Physical (Mechanical)	Brushing		• Commercialized e.g. by the company Westrup, Denmark
	Seed rinsing		• Removing infected seed, fungal spores or sclerotia
	Seed dressing	Seed dressing with organic coatings (e.g. Cellulose)	
	Ultrasound	Ultrasound combined with steam or hot air	• Ultrasound has no effect in itself, but will increase the energy of hot air or steam. This makes a very effective surface sterilization, but has no effects on diseases which are deeper in the seed.
Physical (Thermal)	Hot water/ Warm water	Treatment of seeds with water at different temperature (warm/hot)	• One expert believes that hot water treatment can control, or at least minimize ALL seed born diseases in all plant species. It is just a question of the right combination between temperature and duration. • Suitable for many different diseases, including fungi, bacteria viruses on a wide range of crops. But: tests for each lot in order to find optimal combinations between time and temperature are necessary. • The sensitivity of high temperature differs between seed lots even within the same variety. Therefore a seed vigor analysis is normally required for each treatment, which makes the treatment difficult to implement. • Seed lots (from a single crop) may differ in sensitivity to the treatment and it may harm the vitality of the seeds too much. Weakening of the pathogen, without killing the pathogen may give false promise to the grower. It should be clear that the pathogen is killed. • High potential, sometimes delay in plant emergence but without effect on number of ears nor yield; technological constraints (costs); effect of variety to be tested • The seed do get wet. Therefore, it is economically optimal to combine the treatment either with wet sowing or with priming following the treatment. • Hot water: soaking in cold water before hot water treatment might be necessary • Industrial hot water treatment: information about treatments details is proprietary by companies. • high temperature for a short time (50 °C to 55 °C, 30 to 10 min) or lower temperature for a longer time (42 °C to 45 °C, up to 2 h) • The right machine to be used on large scale has not been developed • High potential, sometimes delay in plant emergence but without effect on number of ears nor yield; technological constraints (costs); effect of variety to be tested • Key points: temperature, time, drying

	Steam Hot humid air	Steaming of dry seed; Aerated Steam; Steam/hot air Hot humid air, below 100 degrees (typically 60-80° C)	• Thermoseed (http://www.acanova.se) is a recently patented method developed in Sweden, which exploits aerated steam for seed treatment on a large scale. The method has now been acknowledged by SUK (the Swedish Seed Testing and Certification Institute), and approved as an equivalently effective commercial alternative to chemical seed dressing of cereal seed. • Key points: temperature, time, humidity • Steaming dry seed will only have effect on surface related diseases. One expert reports that: “I cannot think of any plant-pathogen combination, where I would choose this treatment”. "Steam" and "Hot air"" cannot be separated! Hot air contains always humidity and the success of heat treatment is depending on the temperature AND the vapour pressure. • Heat treatment in general is only sanitation of the seeds. Therefore a combination with antagonistic micro-organism is recommended. • Aerated steam only affects the outer side of the seed. By careful control of temperature and duration too much heating of the embryo is avoided. However, the treatment only kills the micro-organisms on the outside of the seed. Seed lots may differ in sensitivity to the treatment, so pre-testing is needed. • With a pre-soaking, it is just as broad ranged as hot water treatment. However, germ-infecting diseases like loose smut take about 2-3 hours, which makes the treatment expensive with this method.
	Hot air	Dry hot air	• Key points: temperature, time • high temperature and long exposures, energy demanding, fire hazard
Physical (Radiation)	electrons	Electron seed treatment	• Electrons (treatment of seed performed in Germany, source: Agrarforschung 4(11+12), 449-451, 1997)
		Electron beam	• Electron beam treatment only affects the outer side of the seed. By careful control of electron acceleration and duration damage to the embryo is avoided. However, the treatment only kills the micro-organisms on the outside of the seed. Pre-testing of seed lots is needed, to evaluate efficacy. • Companies: e-ventus: cereals - seed treatment (e-ventus ®); Schmidt-Seeger AG, Germany
	Micro-waves	Micro-waves	• University of Göttingen tested it; at present, no machine for practical use available
Physical (others)	Vacuum		• With simple home equipments
	Closed in glass		• Using pots (5 lt to 50lt) in traditional practices no scientific basis
Combinations	Various combinations		Examples mentioned by the experts: • Warm water + skim milk powder • Mild hot water treatment with a mild thyme-oil treatment.

3.1.3 Efficacy of Treatments and Acceptability in Seed Born Diseases Control

The experts were asked to rate efficacy and acceptability of the treatments. The answers have been summarized in a qualitative way. The structure of the questionnaire and the number and quality of the answers were not suitable for statistical analysis but are valuable if treated as qualitative data.

According to the experts, suitability and acceptability for organic farming is given for most of the treatments mentioned above. However, this should be considered exclusively an “expert’s opinion” useful in defining common criteria in the future, jointly with legal constraints (EU and National), compulsory for the evaluation of any plant protection product.

According to the answers given by the experts, thermal methods are suitable and effective against most pathogens, on and in seed. However, further development is necessary for many of the treatments mentioned in the list. Some are considered as ready for practical use, in large as well as small scale systems, other treatments are in the primary phase of development and others are well established for some crops but not yet adapted for others.

Costs of treatments are considered an important factor and may vary greatly, according to the product or method used.

Figure 3. 1 shows an overview of the ratings of the experts on the topics “Suitability for organic farming”, “Costs” and “Necessity of further development” for groups of treatments.

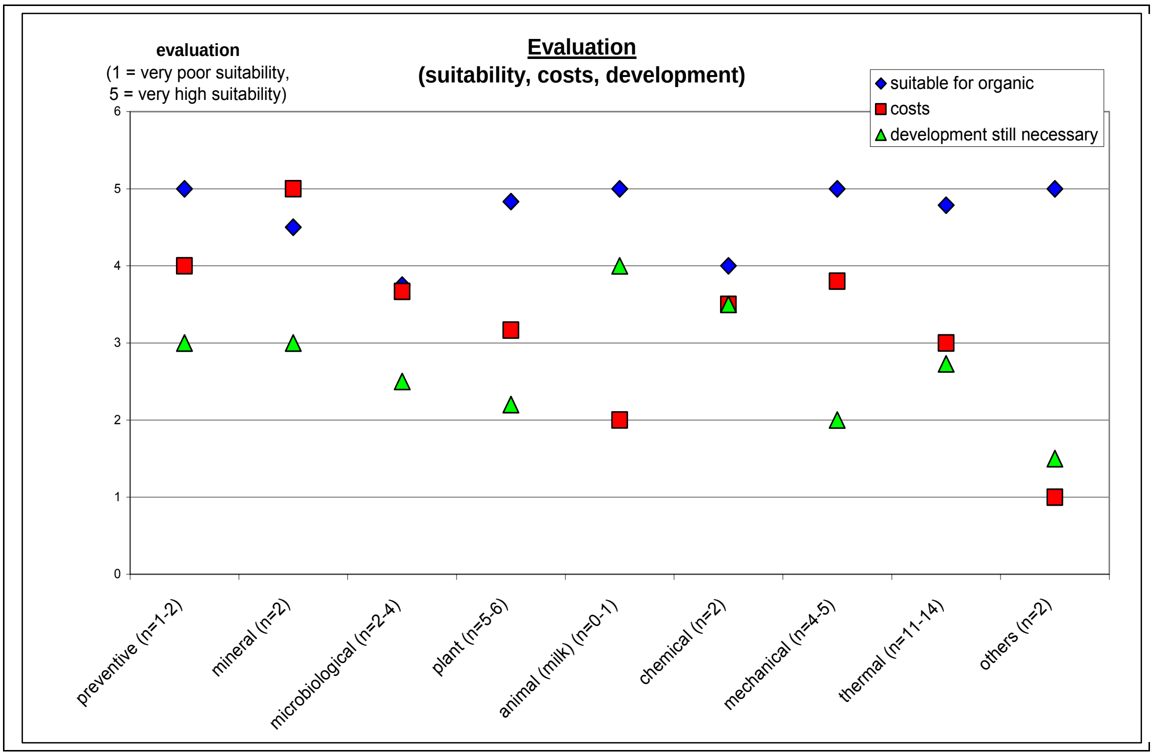

Figure 3.1 Experts answers’ on the topics “Suitability for organic farming”, “Costs” and “Necessity of further development” for groups of seed treatments. Grouping of treatments is the same as that used in table 3.1. Numbers in brackets () represent number of answers

3.1.4 Importance of Seed Born Diseases

Respondents to the survey were subsequently asked to give their opinion on the importance (severity and frequency of attack) of several seed born diseases and their impact on organic seed production. Results of this for wheat are shown in figure 3.2.

It is clear that the experts' rating varies widely, from unimportant to very important. Generally, most of the diseases and pathogens listed were rated as important, e.g. that their impact on organic seed production is considerable. The results obtained for other cereals are very similar to those registered for wheat, which is considered significant and representative for all species.

With regards to vegetables seeds, an even wider range of evaluation was expressed.

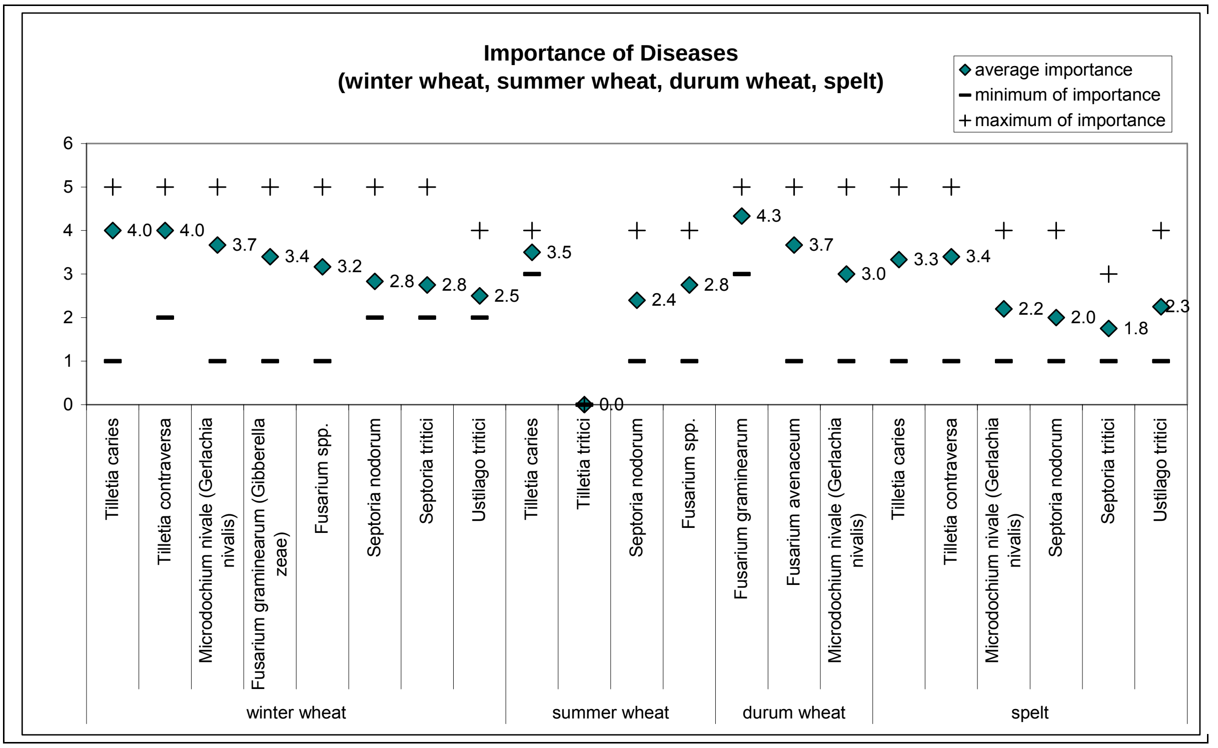

Figure 3.2: Experts rating of the importance of seed born diseases for wheat and spelt. Experts were asked to rate the importance from 0 (no importance) to 5 (very high importance) and the figure reports the statistical elaboration of the answers.

3.1.5 Seed Born Diseases and Seed Use

This part of the questionnaire aimed at assessing other characteristics of seeds that may affect their global quality, especially from the users' point of view. These characteristics may be due to breeding methods, multiplication operations etc. The objective at this stage was to assess existing problems and identify, when possible, which quality parameters are more sensitive and whether they are specific for organic seeds or common with conventional seeds.

In general, the answers of the experts indicated that there is no difference between organic and conventional cereal seed in terms of seed quality. However, some observations were made, such as:

- The lower nitrogen fertilization in the production of organic seed results in lower seed vigour (germination speed) that is likely to be caused by lower lysine content in the protein fraction.

- Differences between organic and conventional seeds depend on genetics as well as on production methods (organic and conventional) especially due to the seed-born pressure on the multiplication site (often lower in organic fields).
- Appearance of seed born diseases has to be judged not only on small and large scale but also on different stages of production, such as:
  - Organic breeding or on-farm seed production (minimum period for evaluation: several years)
  - Organic certified or basic seed production (minimum period for evaluation: 1 or 2 years)
  - Relevance for non-seed use (yield losses, market losses, mycotoxin content)

3.1.6 Experience with on-farm seed production

The additional question on experience and use of on-farm produced seeds obtained very few replies that suggest that on-farm seeds should be analysed for seed born diseases. If the infection is lower than the accepted/recommended thresholds, such seeds could be recommended for use but there should be an analysis prior to use. Such analysis cannot be too expensive nor complex otherwise on-farm seed production has no potentialities for development and spreading. However, a new EU-project will work on questions related to this subject (EU-project Farm seed opportunities SSP-CT-2006-044345).

3.1.7 Conclusions and recommendations

The answer to the research question "Are seed born diseases a serious limitation to production and use of organic seeds?" is summarized below.

Seed health is an important quality factor in organic production. It is important for breeders and multipliers in order to provide the best quality products to farmers and have a potential advantage on their competitors. A great deal of detailed information concerning seed treatments is held by experts from the seed business (private companies). This information is kept confidential due to competition advantages. For the farmers, seed health is an important factor because seed is the starting point of the cultivation and the healthier a crop starts, the better it may develop.

Presently, both seed producers and users believe that seed born diseases are a limiting factor in organic seed use and production, even if the severity of the problem widely varies among crops and countries/regions. Prevention and avoidance strategies are the primary means of improving seed health in organic agriculture. However, research in this very important area is in the initial stage and only limited results are available for practitioners. There is the need to establish common criteria for evaluation of seed treatments to be allowed in organic seed production. Finally, the results of the consultation show that legislation has to take into account the following points:

- For the EEC/2092/91 revision it might be necessary to state criteria for evaluation of organic seed treatments and list allowed substances.
- In the EEC/2092/91 revision it is recommended to include rules on organic seed labelling, compelling seed producers to state all treatments that a seed lot has undergone. The goal of this is to allow seed users to evaluate seed quality and potential detrimental side effects of seed treatments (especially physical ones). Currently, seed producers are only requested to state if a seed lot is treated with plant protection products (depending on the law in a specific member state, e.g. the Germany "Saatgutverkehrsgesetz" asks for statements of physical treatments). However, it is important to know if treatments have been applied (i.e. also heat treatments or enhancement treatments) in order to provide complete information about the seed lot to the user.

3.2 Potentially useful seed treatments in organic agriculture

3.2.1 Background and introduction

Seed born diseases are the cause of serious problems in the cultivation of cereals, vegetables and legumes. This is a broadly accepted fact, also illustrated by a statement of the International Seed Federation (FIS): “The seed industry, united in the FIS, is aware of the fact that in some cases infected seed may cause serious crop depressions and depredations and supports legitimate regulations which prevent the introduction and spread of economically important pathogens through seed.” (FIS Homepage: http://www.worldseed.org/Position_papers/pos_fise.htm#Dise, last access: January 2007).
In conventional agriculture, these diseases are kept under control through chemical seed treatments. Since this is not allowed in organic farming, the availability of some organic seed species and varieties is very limited. Moreover, some farmers fear that seed born diseases will become more difficult to manage in the future, when a greater number of organic seeds will be produced and traded in Europe. However, there are also some seed born diseases that might be less problematic in organic cultivation because they are prevented by rotation systems or by alternative treatments allowed in organic farming.

To evaluate the availability of acceptable methods in the control of seed born diseases, a literature review was performed, targeting alternative control methods and treatments that could suit organic farming requirements. Scientific activities and results dealing with the topic, especially those reporting direct experimentation results and methods, were summarized in order to assess available possibilities and solutions. Finally, some strategies to overcome seed born diseases in organic farming are highlighted along with further research needs.

Alternative methods for seed born disease control have been progressively developed during the last 10 years but their efficacy and applicability has still to be fully evaluated. Important inputs have come from joint meetings with participants of the STOVE project (QLK5-2002-02239-Quality of life and Management of Living Resources - Full Title: Seed Treatments for Organic Vegetable Production) and from three important opportunities for stakeholders consultations. These were: the first World Conference on Organic Seed, organized by FAO, IFOAM and ISF in Rome on July 2004; the European Joint Organic Congress held in Odense on May 2006, and the “Organic seed on the move” meeting, organized by the European Consortium ECO-PB jointly with the Organic Revision Project and the Danish Agriculture Advisory Service in The Netherlands in September 2006. These meetings offered the project partners the chance to gather new scientific information as well as receive direct feedback from seed companies, farmers, consultants and policy makers.

Seed treatments are not only carried out against seed born diseases. In fact, some are also aimed at improving the performance of seeds (e.g. faster and more uniform germination) or treatments that change characteristics and quality of seeds (e.g. physical sorting, pelleting, etc.). All these treatments are covered by the term “seed technology”. The overall objectives of seed technology are:

- Improve seed quality
- Improve reliability of stand establishment
- Increase uniformity
- Reduce seeding rates and thinning costs
- Precision planting (with use of technological equipments)
- Overcome dormancy or stressful conditions

Seed technology is a critical component of agriculture, particularly in the high-value horticultural crops. In order to utilize the genetic potential of crops, the plants must be propagated and established in the field. This is primarily accomplished through seeds. In many horticultural crops, the ultimate profitability of the crop can be determined by how the seeds perform to establish the plants in the field. Not only are the final number and spacing of plants important, as in lettuce,

carrot or Brassica production, but also the speed and uniformity of emergence can have a major impact on the crop. For example, a difference of only two days in the time of seedling emergence in lettuce or broccoli can result in the need for additional harvest operations. Looking at the economic pressure that also organic farmers are faced with this can be a very important point in cultivation and production.
Many aspects of crop management are also timed according to plant growth stage. As an example, the need for delayed emergence of the seedlings until weeds have germinated and can be destroyed with heat or mechanical measures can be mentioned. Non-uniform development of the crop leads to less than optimal results from such management practices. Many horticultural crops are germinated in greenhouses prior to transplanting. The efficiency of production of transplants is affected greatly by the quality of the seeds used. All of these factors have brought increasing attention to the vigour and quality of seeds. Therefore, some technological approaches to enhance the performance of seeds are also shortly described or mentioned within this report. Since some of these techniques are rather expensive, they are used thus far primarily in the high-value horticultural crops, although their spread into agronomic crops can be anticipated as seed value increases due to high costs of seeds produced under organic conditions or limited availability of old varieties or landraces.

3.2.2 Overview on seed treatments

The collected material in the literature review was clustered into several categories, representing different aspects of seed technology and seed quality. The main groups are: i) Managing seed born pathogens (enhancement of seed health) and ii) enhancement of seed quality (functional seed treatments). Another important group of literature findings can be summarized under the title "seed health testing". However, the main focus of the study was on treatments (and other means) to improve seed health. Therefore, only a short overview is given on functional seed treatments and the part on seed health testing is not covered here. The group "enhancement of seed health" was then divided into subgroups according to main experimental similarities. Studies that covered more than one aspect were included in each pertinent group and/or subgroup. Results of the survey are summarized; tables for easier consultation and the quotation list are added in Annex I of this deliverable. Due to the actual dynamic of the theme "seed treatments to enhance seed health" it was not possible to collect all the literature on the topic and the review does not aim to be fully complete. However, it covers the most important aspects of seed health treatments.

Managing seed born pathogens (enhancement of seed health)

This group of seed technology is subdivided into 1) Agricultural and preventive measures; 2) Physical treatments; 3) Natural substances of plant or animal origin; 4) Biological control (bio-control organisms; microbial); 5) other products, substances or methods.

A) Agricultural and preventive measures

As already mentioned by experts in their answers to the questionnaire, avoidance strategies for seed born diseases should be favoured compared to treatments that aim to improve the health status of seeds after infestation of the seed. This is also illustrated in a comment given by one of the experts consulted to answer the questionnaire: "This questionnaire is focusing at the end of pipe technologies".

Agronomic and preventive means to reduce the impact of or the infestation with seed born diseases are:

- Seed production in disease-free production areas
- Isolation of seed fields
- Crop sanitation and rotation
- Cultural practices

- Irrigation practices
- Preventative treatments
- Rouging (e.g. Lettuce Mosaic Virus)
- Elimination of alternative hosts
- Control insect vectors
- Use of resistant cultivars
- Disease-free stock seed
- Seed certification programs and field inspections

To produce high standard quality seeds, it is of vital importance in seed production and multiplication to incorporate these points in order to avoid infestation of seed with pathogens. There are critical control points (CCP) during the production and multiplication of seeds on which the mother plants must be kept free of specific diseases in order to avoid seed infestation. Transmission of diseases from the mother plant to the seed must be avoided in order to produce healthy, vigorous seeds. If this transmission is avoided, seed treatments at later stages are not necessary. For many seed crops it is of vital importance to find these CCP's. Research to find these CCP's, especially for vegetable crops, must be intensified and the results must find way into seed multiplication.

B) Physical treatments

Physical treatments are among to oldest known treatments to enhance seed health. Due to the success of chemical products for seed treatments these methods became somehow forgotten. However, they are newly re-evaluated within the actual increase of needs to treat organic seed. Several papers and projects within the last decade focused on testing of physical treatments for their capacity of controlling seed born pathogen infections. The traditional methods are hot and warm water baths, diversified by methods incorporating steam, ultra-sound, vacuum or various combinations of hot water, steam, ultra-sound, vacuum and hot air. More modern methods such as infra-red treatments, electron treatment (e-ventus) or micro-wave treatments were tested, some of them, however, with limited success. Another traditional method, smoke treatment, needs further evaluation, a mechanical-physical method, seed brushing, has proven to be successful for specific host-pathogen combinations (i.e. Wheat-Tilletia).

C) Natural substances of plant and animal origin

There are many studies on the use of natural substances and commercial compounds which have been tested as direct treatments or sometimes used for seed dressing/coating. Plant extracts such as essential oils are the largest group within this category. Differently from physical methods, most of these substances will require registration as plant protection agents. This might complicate their use since registration is a timely and costly process.

D) Biological control (biocontrol organisms; microbial)

In this subgroup we considered papers and studies reporting biological control experiments, based on pathogens antagonists, such as fungi and bacteria, for coating and/or seed treatments.
Problems faced when applying bio-control organisms were: legal issues (registration, bio-safety), formulation (the organism must remain alive during application and storage), recovery and re-colonization (the organism must be able to multiply and colonize the seed and its surrounding after sowing).

E) Other products, substances or methods

In this group various substances or procedures are summarized. Some of them, such as copper, are traditionally used in organic agriculture. Others, such as ozone, belong to the category “chemicals”. However, whether ozone is classified as a natural or as a chemical substance is irrelevant since it is a substance that can disinfect a seed surface.

Enhancement of seed quality (functional seed treatments)

In general the term "organic" does not include “non essential” treatments which induce use of external inputs and/or energy. However, in some cases, subsequent treatments may contribute to organic seed quality.

There are physical and technological methods and tools available to improve seed lot quality. **Lot refinement** (physical grading of seed), e.g sorting and/or separation by size, colour, density (gravity) etc) is of common use in seed production.
Seed pelleting is often used for seeds that are either small or irregularly shaped, making it difficult to singulate them for planting. Seed pelleting addresses both problems by coating seeds with clay or other materials. This gives them a uniform shape and size and increases their size and density to allow more precise placement in the soil.
Seed coating is an optimized technique to bring various kinds of substances on seeds. Polymer film coating allows optimized addition of additives such as fertilizers, (micro-) nutrients, or seed protectants (e.g. essential oils, beneficial microorganisms (e.g., Trichoderma, Rhizobium) biocontrol organisms, biocides, etc) to the seed. Some new applications have also been developed using the film coating method. For example, artificial polymers have been developed that exhibit temperature-sensitive permeability to water (Landec Corporation, Menlo Park, California). These Intelimers® are permeable to water at warm temperatures, but not at cool temperatures. Modifying the composition of the polymer can set the temperature at which the permeability changes. Seeds coated with these polymers will not imbibe water if the temperature is below the set point of the polymer, potentially protecting the seed from imbibitional chilling injury. The coatings are also used to delay germination after sowing, such as for timing the emergence of male parent lines at different times for hybrid seed production. A starch-based bio-polymer is also used in film coating to slow water uptake and alleviate chilling injury (SeedBiotics SB2000™)
Physiological enhancement treatments are **Seed Priming** and **Pre-Germination**. In seed priming, the seeds are imbibed to a water content below that required for radicle emergence, but sufficient to allow germinative metabolism to proceed. Priming can be achieved in several ways, including imbibition in an osmotic solution that controls water uptake by the seeds (osmopriming), slow addition of measured amounts of water to bring the seeds to a specific water content (drum or hydropriming) or combining seeds, clay particles and water to allow the seeds to imbibe to a specific water content (matripriming).

The processes and the materials used for all of these enhancement treatments may influence their acceptability for organic farming. Details concerning standard processes for dressing, slurry application, dusting, pelleting, priming etc. are often kept confidential by seed companies. However, organic pellets or coatings have been developed and are certified in the USA (NOP).
If such treatments are accepted in organic production they probably have to undergo an evaluation for possible Certified Organic Processing certification

Definition of Treated Seed

The term "treated" refers to the application of pesticide or to processes which reduce, control or repel disease organisms, insects, or other pests that attack seed or seedlings grown from treated seed. (see http://ohioline.osu.edu/b638/638_1.html
and http://www.ams.usda.gov/LSG/seed/treated.pdf)

The addition “This includes control of pests while seed is in storage and after sowing” is also mentioned.

The term "treated" indicates that the seed has been subjected to an application of a substance or has undergone a process which reduces, controls or repels certain disease organisms, insects, or other pests attacking seeds or seedlings, and which can change the appearance, growth pattern, or performance of the seed(see
http://www.in.gov/legislative/ic/code/title15/ar4/ch1.html)
This definition includes all seed enhancement treatments such as pelleting, coating or priming.

Chemically treated signifies “treated with (registered) plant protection product”, including bio-control organism (VAM, for nutrient efficiency stand establishment, disease suppression)

The definition should clarify what is the aim of the treatment: a) seed disinfection (on and in the seed, embryo, etc.) – elimination of pathogen that has penetrated into living cells of seed (e.g. smut or bunt); b) seed disinfection (mainly surface) - killing of spores, mycelia, or propagules of micro-organisms on seed surface; c) seed protection (against soil inhabiting fungi) – application to protect seed from pathogens in the soil (damping-off).
A systemic fungicide may provide post-emergence protection (powdery mildew).

Aside from the need to define which seed treatments may be allowed in organic farming it is also important to differentiate between types of treatments, according to who can apply them: 1) treatments which can be used by everyone 2) treatments which farmers can apply on-farm, with little or no difficulty and risks 3) treatments for which professional plants are necessary, or for which special safety installations are required.

3.2.3 Conclusions on seed treatments

Firstly, it is possible to affirm that unlike with chemical control, it appears that for alternative treatments a single solution, suitable for a wide range of pathogens on many different crop species does not exist. Alternative treatments are apparently effective in specific situations, influenced by pathogen nature (fungi, bacteria, etc), agro-climatic conditions, crop species, and the application protocol adopted in each case.

Physical treatments such as hot or warm water, seed brushing or others, seem to have the advantage of being unspecific, and thus express their effectiveness against different pathogens which are sensible to high temperatures or which are mechanically removed from the seed. Efficacy of treatments differs greatly depending on the level of infection and on the type of pathogen and crop species, and could have a negative correlation with germination level. Therefore, these methods require specific protocols depending on the variables.

Another option is the use of natural substances. These treatments are based on the interaction between disease-causing pathogens and substances like plant extracts (essential oils, decoctions, organic acids) in different formulations and uses. These methods, along with biological control ones, based on pathogen antagonists, are much more specific and a particular protocol must be followed in order to obtain good results in each specific situation.

Alternative seed treatments can be used in combination to cover a wider range of pathogens, but the interaction between different methods should be carefully evaluated, in this case also, in order to obtain satisfying results and avoid negative influences on seed quality.

Finally, what emerges from studies and from personal communications with experts, is that the interaction between pathogen and crop seed is a very complex system. Until now, this aspect was underestimated in conventional agriculture because of the high effectiveness of chemical treatments and their wide range of action. In organic farming, a lack of information on seed pathogens physiology is strongly perceived and this needs to be addressed through a thorough study in order to achieve satisfying results.

3.2.4 Recommendation on seed treatments

1. To define the meaning of “treated/untreated seeds”. This actually applies only to chemical treatments, but should also consider physical and other mentioned treatments not only related to seed health.
2. To define which treatments must be declared on the seed label
3. To define the list of organically acceptable treatments for organic seeds (health treatments and others)
4. To establish and support research projects exploring avoidance of seeds infection during seed multiplication phases.

3.3 Report on inspection limits and thresholds for seed born diseases

In general, the trend is to increase the use of organic seeds in organic farming, assuring that available organic seeds are marketable. Therefore, the EC/1452/2003 lays down the establishment of national databases of organic seed. This instrument allows farmers/seed users to have access to information on the availability of organic seed. The exceptional use of conventional seed is regulated by a restrictive approval process (see D 5.3). For a wider and total use of organic seed, factors limiting the use of organic seed must be identified and acted upon.

Concerning seed health, the role of the different national seed regulations on the exchange mechanisms of seed among Member States must be considered. Could there be competitive disadvantages for some seed producers because of different national regulations? Could organic farmers, as a consequence of the EC/1452/2003 be forced to use organic seed of another Member State which might be internationally traded but which does not fulfil the national regulations for seed produced within their country? We attempted to respond to these questions for the most important seed born diseases of winter grain in selected countries.

3.3.1 Seed regulations in the EU-legislation, limits for seed health and general remarks on the seed quality regulations in the EU and in Member States

In the EU, the seed market is regulated by guidelines of the Council Directive 66/402/EEC[3] on the marketing of cereal seed. The minimum standards of a EU-wide harmonisation mainly give guidelines on varietal purity, weed contamination and on minimum levels of germination, but they include seed health in a very limited way. Only for *Claviceps purpurea* there are official preconditions seed has to fulfil for marketing and trading (Council Directive 66/402/EEC). Chemical treatments of basic seed and of certified seed must be declared on the label (66/402/EEC, article 12). The implementation of the guidelines is left to the Member States that have the possibility of applying stricter rules. There are no marketing limits for seed within the EU despite the possibility for different requirements for seed certification in different countries. A reason for different requirements for certification and seed health in different Member States may be due to climatic

[3] Council Directive 66/402/EEC of 14 June 1966 on the marketing of cereal seed. (Official Journal 125 , 11/07/1966 P. 2309 – 2319)

conditions that make risk different (e.g. temperature, time of snow cover during wintertime) for the main diseases of cereals in different regions.

The national regulations are more detailed and concern selection and importance of diseases and criteria and methods for field acceptance and for laboratory analysis. In some countries the regulations are part of the national right, in others they are interpreted as rules of official laboratories and certification bodies (ARGE Biolandbau 2003). Therefore the national rules for seed acceptance are difficult to compare.

3.3.2 National Limits (Thresholds for acceptance) of Selected Seed Born Diseases

Wheat: Common Bunt and Dwarf Bunt
Both of the Tilletia diseases are very important in organic farming. Common Bunt, *Tilletia caries,* is seed born, dwarf bunt, *Tilletia controversa,* is mostly soil-born. Seeds and soil become infested during harvest. In case of low temperature during the emergence in autumn and during long covering of snow in winter, even a few spores on seeds can cause high infections in the field. Because of the very small differences between the spores of the two diseases, they are often not distinguished by seed testing methods.

Pre Basic Seed of Wheat: For seed of wheat of the quality level "pre basic seed", *T. caries* is only mentioned in Estonia and Latvia. In Estonia the limit is 0,0% in the field, in Latvia one infested plant per 100m² may occur.
In Spain the limits for *T. caries* and *T. controversa* are among the strictest ones but the two diseases are calculated together.

Basic Seed of Wheat: Czech Republic, Estonia, Finland and Hungary lay down the strictest rules for field acceptance of basic seed of wheat concerning *T. caries* (Table 3.2). No infestation is permitted in the field. On the other hand, these countries do not have rules or limits for laboratory testing or acceptance. Spain, The Netherlands, Switzerland, Austria, Germany, and Latvia allow different levels of field infestation but they are stricter concerning laboratory acceptance.

Table 3.2: Common Bunt / *Tilletia caries* and Dwarf Bunt / *Tilletia contraversa/ brevifaciens* on basic seed of wheat / *Triticum aestivum*

Country	Field inspection			Seed inspection		
	T. caries	*T. controversa*	unit	*T. caries*	*T. controversa*	unit
CZ	0,0		%			
EE (a)	0,0		%			
FI	0,0	no limits	%	no limits	no limits	
HU	0	0	head/100 m²	no limits	no limits	
ES (a)	0,05		plants/100 m²	0,0		%
NL	1		plant/500 m²			
CH	2	2	plants/100 m²	no limits (d)	no limits (d)	
AT	3	1	plants/150 m²	300 (b)	300	spores/kernel
DE	3	1	plants/150 m²	<1 (c)	no limits	spores/grain
LV	5		plants/100 m²	0.002		% of weight

(a) *Tilletia controversa* together with *Tilletia caries*
(b) >10 dressing necessary
(c) Private standard
(d) Not ruled by law. For organic seed (except barley) an official health test is the basis for official recommendation about the use as seed.

A similar problem occurs with *T. controversa* in Hungary, Spain, Czech Republic, Austria, and Germany. In Spain, the limits are among the strictest but they are calculated together for *T. caries* and *T. controversa*. Only Czech Republic, Estonia, Finland, The Netherlands, and Latvia do not have any rules or limits; therefore there is theoretically a possibility that other coutries may import Tilletia controversa-infested basic seed of wheat when buying certified seed from these countries. However, the Swiss legislation states that only seed that fulfils the same requirements as seed produced in Switzerland can be imported.

Certified Seed (1) of Wheat: shows a similar situation for certified (1) seed of wheat like table 3.2 for basic seed: The countries with the strictest regulations for the field acceptance of wheat concerning *T. caries* (Czech Republic, Estonia, Finland, Poland) do not lay down any rules or limits for the laboratory acceptance. Both criteria of acceptance of seed (field, laboratory) for *T. caries* are more or less strict in Hungary, Spain, Austria, Germany, Switzerland and Latvia. The Netherlands has only a strict rule for the field acceptance concerning *T. caries*, and (like Latvia) there is no testing of *T. controversa*. Again, the Spanish limits are calculated together for *T. caries* and *T. controversa*. Denmark and Sweden lay down very strict rules for the laboratory acceptance concerning *T. caries* on certified (1) seed of wheat only.

Table 3.3: Common Bunt / *Tilletia caries* and Dwarf Bunt / *Tilletia contraversa/brevifaciens* on certified (1) seed of wheat / *Triticum aestivum*

country	field inspection			seed inspection		
	T. caries	T. contraversa	unit	T. caries	T. contraversa	unit
CZ	0,0		%			
EE	0,0		%			
FI	0,0	no limits	%	no limits	no limits	
PL	0,0	0,0	%			
DK				0,0 (a)		%
SE				0,0		%
HU	1	1	heads/100 m²	no limits	no limits	
ES	0,5 (b)	(b)	plants/100 m²	0,0 (b)	(b)	%
NL	1		plants/100 m²			
AT	5	1	plants/150 m²	300 >10 spores (c)	300	spores/kernel
DE	5	1	plants/150 m²	20 (d)	no limits	spores/grain
CH	5	5	plants/100 m²	no limits (e)	no limits (e)	
LV	15		plants/100 m²	0.004		% of weight

(a) (conventional) untreated
(b) Tilletia contraversa together with Tilletia caries
(c) dressing necessary
(d) private standard
(e) Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits.

Although seed infection with spores of *Tilletia* is a very important factor for seed health the certified (1) wheat seed from Czech Republic, Estonia, Finland, and Poland can be exported to other member states without any laboratory testing.

Certified Seed (2) of Wheat: For certified 2 seed of wheat there are regulations in Hungary, Spain, United Kingdom, and Austria, and all of them are different (Table 3.4).

Table 3.4: Common Bunt / *Tilletia caries* and Dwarf Bunt / *Tilletia contraversa/brevifaciens* on certified 2 seed of wheat / *Triticum aestivum*

country	field inspection			seed inspection		
	T. caries	T. controversa	unit	T. caries	T. controversa	unit
HU	2	2	heads/100 m²	no limits	no limits	
ES(a)	0,5		plants/100 m²	0,0		%
UK				>= 1 (b)		spore/seed
AT	10	1	plants/150 m²	300; >10 spores (c)	300	spores/kernel

(a) Tilletia controversa together with Tilletia caries
(b) Treatment
(c) Dressing necessary

Organic Seed of Wheat: For organic wheat seeds, regulations exist in Denmark, Finland, Norway, Sweden, Scotland and in Austria and Switzerland (table 3.5). *T. caries* and *T. controversa* are only tested in laboratory. For the quality level “organic” there is an official rule only in AT (Sorten- und Saatgutblatt 2000, 8. Jahrgang, Sonderrnummer 10) identical to that for conventional untreated seed.

Table 3.5: Common Bunt / *Tilletia caries* and Dwarf Bunt / *Tilletia controversa /brevifaciens* on organic seed of wheat / *Triticum aestivum*

country	seed inspection						unit
	T. caries			T. controversa			
	organic	certified 1	certified 2	organic	certified 1	certified 2	
FI		0[i]			0		
SE		0[ii]			0ii		
Scotland		1[iii]			1iii		spores/kernel
DK		10[iv] **)	<= 10 *)		10iv **)	10 **)	*) spores/g **) spores/kernel
AT	10iii	10iv	10iv	10iii	10iv	10iv	spores/kernel
CH (a)		10			10		spores/grain
NO		- N -[v]			- N -i		
(a) Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits							

Most of the rules concern the quality level "certified 1": Finland and Sweden do not allow any threshold on this seed level; Scotland tolerates one spore/kernel. The regulations in Denmark, Switzerland and Austria tolerate higher spore loads (10/kernel).

Organic Seed of Triticale: the *Tilletia* diseases on organic seed of triticale are regulated in a similar way to organic seed of wheat (table 3.6). There are strict rules in Finland and Sweden, comparable rules for "certified 2" in Denmark and Austria and higher tolerances for all seed qualities in Austria.

Table 3.6: Common Bunt / Tilletia caries and Dwarf Bunt / Tilletia controversa /brevifaciens on organic seed of triticale

country	seed inspection						unit
	T. caries			T. controversa			
	organic	certified 1	certified 2	organic	certified 1	certified 2	
FI		0			0		
SE		0			0		spores/kernel
DK		0*)	10*) 10 **)		0*)	10*) 10 **)	*) spores/kernel **) spores/g
AT	10[vi]	10	10	10[vii]	10	10	spores/kernel

For other important seed born diseases of cereals such as root rot (*Fusarium spp, Microdochium nivale*), glume blotch (*Septoria nodorum*) or loose smut of barley (*Ustilago nuda*) the situation is very similar (see Tables 3.7 to 3.19, reported in annex III). Member States or countries have different levels of acceptance and ways of certification (i.e. field control or laboratory examination).

3.3.3 Conclusions and recommendations

From the data reported in the previous chapter, it is obvious that seed lots of a defined quality can harbour different loads of *Tilletia* spores in different European countries. Due to free trade among EU Member States, it is possible that a shortage of seed, e.g. "certified 1"-seed, in a Member State is due to strict regulations for seed born*Tilletia* spores. This country may thus have to accept seed lots of the desired quality "certified-1" from a country with levels of tolerance with lower safety, harbouring more spores than some seed lots that have been discarded in the importing Member States. In Austria for example, organic growers are concerned that different national private standards and their position in national private systems may lead to discrimination between local and foreign organic seed.

Because no chemical-synthetic treatment is allowed in organic farming and because of the low efficacy of planting methods and alternative treatments against most of the seed born cereal diseases, the tolerance of the infection of organic seed should be as low as possible to avoid problems during production and multiplication of seeds. Thresholds and limits for conventional seed, when chemical-synthetic treatment is available, are relatively high and not achievable for organic seed. However, many Member States make a difference in certification, discriminating between “acceptable without further treatment” and “acceptable only with seed treatment”, with no difference for conventional or organic seed.

Another point concerning the difference between conventional and organic seed is that all levels of organic seed of all species and all diseases are tested only in laboratory, never in the field. However, field certification is important and necessary, but must be amended/completed with laboratory analyses.

For laboratory analyses, sound methods of detection are: applicable on a routine basis in laboratories normally equipped for pathology work and analysis of seed; conducted in a relatively short time period; standardized and reproducible within and between laboratories; reliable within specified tolerances; relatively inexpensive; conclusive within specified confidence limits, and must be available and agreed on. Such tests with common methods are evaluated e.g. by ISTA (International seed testing association).

Common standards for thresholds of seed born diseases are necessary. These thresholds must be based on scientific evidence. For each seed born disease, the lowest level of threshold evaluated for one disease under the worst case should be used as minimum standard. However, such agreement among all MS is not simple to reach. It would be advisable to start from few most important crops (for example wheat) with agreements among groups of MS.

3.4 Health status of organic seeds in selected countries

Information on this issue has been analysed with the aim of evaluating the development of organic seed health status in several Member States. Sources of information have been reports of National seed health authorities, publications (scientific and grey literature) and data from private companies.

Unfortunately, the official seed authorities in Members States usually do not keep record of organic seed-lots analysis separately from conventional lots. The reason for not separating the data is that, in the majority of Member States, the thresholds and recommended limits to establish if a seed lot can be used without health treatment is the same in organic and conventional seeds.

Austria provides detailed data on areas of certified varieties through the web page of AGES (Oesterreichische Agentur für Gesundheit und Ernährungsssicherheit; http://www.ages.at).

In Denmark, thanks to the National project ORGSEED (http://www.okoforsk.dk/projekt/vi1/index.html), official data for organic seed lots of cereals, field-pea and lupine are available for the years 1999 to 2005.

In Italy and United Kingdom, recordings of the health status for seed lots is carried out without separating organic from conventional data. Consequently, there is no background data for valuation of organic seed health status in these countries.

In The Netherlands, no official data is available because, as for Italy and United Kingdom, separation of data is not carried out but unofficial information from private companies allows to estimate the trend.

In Switzerland, a scientific paper from Agroscope (Proceedings of First World Conference on Organic Seed, FAO 2004) allows some evaluation jointly with data from official health controls (lab analyses results 2004 and 2005).

3.4.1 Results

In the following tables, the situation in selected countries and mainly on cereals in the last years is reported.

Table 3.19 presents an overview of the Danish situation for cereal and pulses from 2000 to 2005. This data clearly shows a higher susceptibility of pulses compared to cereals, but no clear trend or development is reported on the same crop year after year. It seems that the climatic condition of the specific years act as a basic influence on the seed quality.

Table 3.19: lots of organic cereal and leguminous seed discarded due to seed born diseases in Denmark from 2000 to 2005

Year	Winter wheat	Spring wheat	Winter rye	Winter triticale	Spring barley	Spring oat	Field pea	Field bean	Lupin
2000	21	0	3	63	20	0	50		
2001	25	19	5	17	27	3	69		
2002	0	4	0	12	13	0	90	0	0
2003	38	36	0	8	31	3	47	50	9
2004	11	9	0	18	13	4	88	0	21
2005	18	0	0	0	5	3	65	50	42

In table 3.20, a more in-depth view of Danish data is offered. Again, the effect of the year is obvious, but it is also clear that *Tilletia* should be considered the main seed born disease causing seed losses. The high level of risk induced by the presence of *Tilletia* in soils and seeds should also be considered, as it spreads very rapidly starting even from small inoculum.

Table 3.20: Data from Denmark reporting the presence and severity of Fusarium, Septoria and Tilletia on winter and spring wheat from 2000 to 2005 organic seed lots

	Percentage of lots with more than 15% *Septoria*		**Percentage of lots between 15%-30% *Fusarium* (respectively for winter and spring wheat)**		**Percentage of lots with occurrence of *Tilletia caries.* In brackets percentage with more than 10 spores.**	
Year	***Winter wheat***	***Spring wheat***	***Winter wheat***	***Spring wheat***	***Winter wheat***	***Spring wheat***
2000	5	0	3	0	25 (25)	0
2001	0	0	0	13	29 (25)	19 (6)
2002	0	0	0	0	5 (0)	9 (4)
2003	0	18	0	27	38 (38)	9 (0)
2004	0	0	0	0	11 (11)	9 (9)
2005	0	0	0	0	18 (18)	10 (0)

Specifically on spring barley, the Danish situation shows a high presence of *Pyrenophora* and *Ustilago*, even if the samples with high infestation rate are limited.

Nevertheless, especially in organic farming where prevention is the basis of disease management, starting a crop with seeds having high potentials for infection is not a sound practice and should not be advised.

Table 3.21: Data from Denmark reporting presence and severity of Pyrenophora, Ustilago and Fusarium on spring barley from 2000 to 2005 organic seed lots

Year	**Percentage of lots with occurrence of *Pyrenophora graminea/teres* in brackets percentage with more than 5%**	**Percentage of lots with more than 30% *Fusarium***	**Percentage of lots with occurrence of *Ustilago nuda* In brackets percentage with more than 2%**
2000	61 (14)	1	30 (2)
2001	71 (35)	6	34 (17)
2002	31 (5)	7	43 (7)
2003	76 (38)	33	47 (1)
2004	18 (4)	4	67 (11)
2005	14 (6)	2	9 (0)

From the Dutch partial data on wheat, the situation seems similar (here only "presence" and not "incidence" of the pathogen is reported) and the germination rate of the seed-lots is generally good, except for 2004, due to climatic conditions.

Table 3.22: Informal and partial data on organic wheat seed lots in the Netherlands

Year	Percentage of seed lots affected by *Fusarium*	Percentage of germination of all the seed lots
2002	16	91
2003	7	91
2004	19	76
2005	12	94
2006	2	93

With Austrian data it is possible to compare the situation in organic and conventional seed-lots (table 3.23). The changes in the years and the different pattern between organic and conventional seed-lot do not allow many comments as it is not possible to identify a trend. Austrian experts report that *Tilletia* might become dangerous, because of on farm multiplied/saved seed (not only in organic production) and the infections of *Fusarium* and *Septoria* mainly depend on climatic conditions (*Septoria nodorum* and *Fusarium nivale* mainly spreads in wet years).

Table 3.23: Lots of organic and conventional cereal seeds discarded due to seed born diseases in Austria from 2000 to 2006, in percentage. Data of 2002 and 2004 (*) were reported in percentage of kg of seeds while all other years are expressed as percentage of lots. Main seed born diseases causing rejection of the lots are mentioned only for few years and crops

	Winter wheat		Winter barley		Spelt	
Year	**Organic**	**Conventional**	**Organic**	**Conventional**	**Organic**	**Conventional**
2000	11	4.5	7	36		
2001	8	4.3	18	17		
2002*	10		13		27	
2003	11	2.6	10	12.5	30	40
2004*	18		37 (*Fusarium*)		37 (*Tilletia*)	
2005	18 (*Fusarium*)	12	34 (*Fusarium*)	70	26 (*Tilletia*)	0
2006	18	2	2	44	16	0

In Switzerland, from 1995 to 2003, about 75% of cereal seed-lots where recommended for use without any need for treatment, with a variation from one year to another of 50 to 86%. The results from seed health tests in organic cereals in 2005 show that out of 138 seed-lots tested, 17.4% were discarded due to different reasons. Concerning *Microdochium* and *Septoria* only few seed lots were above threshold values (4% and 8% of discarded lots) while 50% of discarded lots were due to with *Tilletia caries* infestation. For *T. caries*, there is a clear increase of seed lots having a too high number of spores from 2004 to 2005, confirming in Switzerland as well a growing risk linked to this pathogen. However, in the long run no general trend is defined.

3.4.2 Discussion and Conclusions

No general trend is observed and consequently, it is not possible to identify a cause-effect relationship that explains the behaviour of seed born disease in organic seeds. The variation is too wide and many other factors influence the final seed quality. In particular, the climatic conditions of the specific year, the variety susceptibility and specific multiplication conditions. Greater data availability and comparison with conventional seed lots of same area, variety and year would probably allow for a clearer view.

Nevertheless, it is important to consider and record the data on seed born diseases and address all preventive strategies in order to overcome the spread of diseases and also to develop seed treatments acceptable in organic farming and effective against the pathogens.

3.4.3 Recommendation

As it is of basic importance to monitor as much as possible the presence and development of seed born diseases, it is advisable that National Seed Health authorities identify the lots they analyse as “organic”. This would allow to elaborate analytical results separately (conventional from organic) and closely monitor the situation.

This would be important also in order to evaluate risks and developments of prevention strategies.

4 Conclusions and recommendations

The objective of the report was to define if and to which degree seed born diseases are an important factor that prevents seed companies from producing organic seeds and organic farmers from using them. The outcome of the analysis led to the conclusion that seed born diseases are an important factor influencing seed production and seed use in organic agriculture, but they are not the only obstacle. It is also clear that the awareness of the importance of seed health in organic agriculture has increased considerably in the last years and “conventional” organizations such as ISF (International Seed Federation) or ISTA (International Seed Testing Association) presently give statements on seed health and seed treatments for organic agriculture.

Moreover, the report provides an overview of seed treatments that may be acceptable in organic farming as they are in line with organic principles. It must be clear that at present the EEC/2092/91 is not defining any allowed seed treatment. However, organic seed producers are looking forward to solutions which allow them to improve organic seed quality (concerning pathogens but also other seed qualities) and researchers are now offering several solutions which must be considered. In the last 5 to 10 years, several methods and products of non-synthetic origin for seed treatments (physical, microbiological, plant-based etc.) have been successfully tested on different host-parasite combinations and are potentially available for use in organic farming. However, there are no general treatments available that are effective for all host-pathogen combinations and the implementation, after legal definition, needs further applied research. It must also be considered that several physical treatments may have side effects on the germination of the treated seeds. In order to avoid this, specific studies on treatments and seed physiology are required.

Another factor that may affect organic seed production, use and trade among Member States is the fact that besides legal restrictions for quarantine diseases on seeds, most of the Member States have legal thresholds for seed born diseases in general (=conventional), but almost exclusively for cereals. For vegetables and legumes, Member States possess only general statements on seed health. Thresholds for seed born diseases in cereals vary between MS and it may cause distortion in seed trade and use as one country has to allow the import (from another MS) of seed that does not fulfil certification limits in the importing country when it is fully certifiable in the MS where it is produced.

Monitoring of organic seed health in the last 3 years according to the analysis of official and unofficial data on organic seed health status is available only in few countries. For this reason, it would be very helpful if all MS kept annual records of the organic seed-lots health status as it would allow monitoring of seed born diseases and action to be taken on the seeds and crops. In general, available data for cereals does not show a clear trend of seed health development but highlights the influence of climatic condition. There also appears to be a general spreading of *Tilletia caries* which may increase with lower control levels, especially with of-farm seed production. Data supporting this hypothesis however is limited. It should be considered that spreading of seed born diseases is more critical in organic farming since few control measures are available.

Recommendations for development of the legal basis for organic seed production:

Presently, the EEC/2092/91 (amended by EC/1452/2003) calls for the use of organic seed and propagation materials when possible and gives authority to MS to manage the derogation system for using conventional non treated seed (see D5.3 for more details).

However, it is not clear which seed treatments are allowed in organic farming nor what are the labelling rules for organic seed. At present, as organic seed production is developing, there is a need to define and regulate which seed treatments can be permitted in organic farming. Therefore it is recommended to list methods and products in the revised EEC/2092/91, annex II B, also in order to increase the availability of organic seeds and their assortment in terms of species and varieties, and seed treatments (accepted in organic agriculture) should be allowed.

Concerning labelling it would be advisable that all treatments the seeds undergo are declared on the label as they may affect seed quality also in term of the ability to germinate.

Besides recommendation for revision of EEC/2092/91, it is advisable to revise general regulations on seed born diseases thresholds. In particular, organic farming thresholds for seed born diseases must be strict and harmonized among Member States in order to avoid the spread of seed born diseases. Such thresholds must be based on sound scientific basis and the harmonization process, clearly difficult to implement, could begin with the most common (and largely traded) species such as wheat.

Finally, it would be extremely helpful if seed health authorities monitored the organic seed-lots' health on a yearly basis. This does not require additional work as seed health authorities are running annual analysis on seed lots and they should just report the organic lots results separately, to use them for further development of this sector, for prediction and advice.

[i] ARGE Biolandbau (2003: 165)
[ii] ARGE Biolandbau (2003: 164)
[iii] ARGE Biolandbau (2003: 166)
[iv] ARGE Biolandbau (2003: 162)
[v] ARGE Biolandbau (2003: 167)
[vi] ARGE Biolandbau (2003: 164, 165)
[vii] ARGE Biolandbau (2003: 164, 165, 166, 167)

APPENDIX I: Bibliographic references

1 HEALTH STATUS

This appears to be the widest category, having most of the studies concerned mainly sanitary aspects or alternative seed treatments. It contains four subgroups: *physical treatments*, *natural substances*, *biological control* and *health tests*.

1. PHYSICAL TREATMENTS

Several papers concerned testing of physical treatments for their capacity of preventing and/or controlling seed pathogens infections.

Treatment	Host species	Diseases and pathogens controlled	Researcher	Notes
Warm and hot water (45° and 55°C)	Barley	*Pyrenophora graminea, Ustilago nuda*	Nielsen *et al*., 2000	Pre-treatment soaking seeds in water; acetic acid was used as well
Hot water (53° and 55°C)	Barley, wheat	*Ustilago nuda, Pyrenophora teres, Fusarium nivale*	Rodriguez, 2000	Also organic substances were tested
Dry heat (50°-70°C x 14 days)	Barley, wheat	*Cochliobolus sativus, Pyrenophora teres, P. tritici-repentis.*	Clear *et al*., 2002.	Seed viability after treatment was assessed
Hot water (40°-55°C x 10'-30')	Carrot, cabbage, celery, parsley, lamb's lettuce	*Alternaria spp., Phoma spp., Septoria spp., Peronospora valerianellae, Xanthomonas spp.*	Nega *et al*., 2003.	Germination effect was assessed
Aerated steam	Cereals (i.e. rice)	*Fusarium moniliforme [Gibberella moniliformis], Tilletia caries, Drechslera graminea [Pyrenophora graminea], Septoria nodorum*	Tinivella *et al*., 2003.	Included in the STOVE project
Heat treatments by drum-dryer, steam and ultrasound	Cereals, vegetables	*Pyrenophora teres, Tilletia tritici, Ascochyta pisi, Fusarium* spp.*, Alternaria radicina, A. petroselini, Cladosporium* sp.*, Septoria petro, Stemphylium* spp.*, Phoma lingam, Botrytis* spp.*, Xantomonas campestris.*	Borgen, 2004a	Organic substances as well
Hot and warm water (55°C x 10' and 43°C x 1 h)	Potato	*Phytophtora infestans*	Forrer H.R. *et al*., 2000	Objective was to verify negative effects of the treatment on growth and yield

Treatment	Host species	Diseases and pathogens controlled	Researcher	Notes
Hot water (60°C x 10'; 58°C x 15')	Rice	Seedling diseases *(i.e. Burkholderia plantarii)*	Shirai *et al*., 2003.	
Hot water (50°-60°C)	Rice paddy	*Gerlachia oryzae*	Krishnamurthy *et al*., 2000.	Biological control and natural substances were studied as well
Advantage® (proprietary priming method based on water steeping, and incubation)	Sugar beet	*Phoma betae*	Halmer *et al*., 2004	Also a sugar beet pellet was tested (organic substance)
Hot water, hot air, electron treatment	Vegetables	*Alternaria radicina, A. dauci, Septoria petroselini, Phoma lingam, Xanthomonas campestris, Phoma valerianellae, Fusarium spp., Colletotrichum lindemuthianum*	Jahn *et al*., 2004	
Seed rinsing	Wheat	*Tilletia caries*	Plakolm and Söllinger, 2000	Organic substances as well
Warm water	Wheat, barley	*B.sorokiniana, Fusarium* spp.	Batura *et al*., 2004	Also biological control, organic substances were used
Warm and hot water (45°C x 2h, 52°C x 10 mins)	Wheat, barley, oat	Fungal pathogens (*Tilletia* spp., *Ustilago* spp., *Microdochium nivale*, *Stagonospora nodorum*)	Schachermayr *et al*., 2000	
Hot water (55°C x 3') and dry physical cleaning (brushing machine)	Wheat, barley, rye	*Tilletia caries, Pyrenophera graminea, Ustilago nuda, Urocystis occulta*	Borgen and Kristensen, 2000	Organic substances as well; surveys were realized
Hot humid air	Winter wheat	*Tilletia tritici*	Kristensen and Forsberg, 2000	
Hot water (44°-59°C)	Carrot	*Alternaria dauci*	Hermansen *et al*., 1999	Experiments with biological control and fungicides were included.
Electronic treatment	Carrot	*Alternaria spp., Xanthomonas campestris*	Jahn and Puls, 1998.	Biological control treatment was tested, and also combination of the two.
Hot water, hot air, electron bombardment	*carrot*	*Xanthomonas spp.*	Roberts *et al*., 2006	BCA tested as well. All physical treatments reduced transmission from seed to seedling.
Hot water, humid hot air and electron treatment	*Carrot, cabbage, celery, parsley and lamb's lettuce*	Alternaria dauci, Phoma lingam, Septoria apicola, Septoria petroselini, Phoma valerianella, Alternaria radicina, Alternaria brassicola, Phoma apiicola	Jahn *et al*., 2006	It identifies specific temperatures and treatments times for each plant-pathogen binomia

Treatment	Host species	Diseases and pathogens controlled	Researcher	Notes
Hot water treatment, electron treatment and vacuum steam treatment	Parsley, caraway, coriander, fennel	*Mycocentrospora acerina, Pseudomonas syringae* pv. *coriandricora, Alternaria radicina, Mycosphaerella anethi* and *Verticillium* spp.	Blum *et al.* 2006	Several attempts to optimize host-parasite management on herbs
Hot air, hot water, electron treatment	parsley	*Septoria Petroselini*	Amein *et al*., 2006	Effect of thyme oil consedered too; Effects on germination evaluated too

2. NATURAL SUBSTANCES

In this section, studies on the use of natural substances and commercial compounds (tested as direct treatments or used for seed dressing/coating) were included.

Treatment	Host species	Diseases and pathogens controlled	Researcher	Notes
Advantage® (proprietary priming method based on water steeping, and incubation)	Sugar beet	*Phoma betae*	Halmer *et al*., 2004	Also a sugar beet pellet was tested (organic substance)
Skimmed milk powder, whey powder, ground yellow mustard seed	Wheat, barley, oat	*Tilletia caries*	Schachermayr *et al*., 2000	
Plant-based compound	Carrot	*Alternaria* spp.	van der Bulk *et al*., 2004	Nature of compound not reported
Proprietary natural compositions	9 Vegetables, 5 field and several ornamental crops.	Not reported	Vasilenko and Carrier, 2004	Nature of cited composition is not reported
Plant extracts, smoke, natural substances	Cereals	*Ustilago nuda, Pyrenophora graminea, P. teres, T. tritici, Fusarium* spp.	Borgen, 2004a	Substances used not specified
SBM (horseradish seed dressing agent); milk powder, wheat flour, cattle manure + lime	Wheat	*Tilletia caries*	Plakolm and Söllinger, 2000	Control plots were treated with copper; some varietal resistance was tested

Treatment	Host species	Diseases and pathogens controlled	Researcher	Notes
Mustard flour, acetic acid	Wheat, barley, rye	*Tilletia caries, Pyrenophora graminea, Ustilago nuda, Urocystis occulta*	Borgen and Kristensen, 2000	Physical treatments as well; surveys were realized
ProBio® (seed pellet)	Sugar beet	*Phoma betae*	Halmer *et al*., 2004	Physical priming treatment as well
44 plant extracts	Not specified	*Fusarium culmorum, Microdochium nivale*	Kuhn *et al*., 2004	Nature of plant extracts not reported
Lime+basalt powder, Biochikol 020PC (Chitosan), Biosept 33SL (grapefruit seed extract)	Wheat, barley	*B.sorokiniana, Fusarium* spp.	Batura *et al*., 2004	Also biological control, physical treatments and CuSO4, KmnO4
Plant extracts from *Cannabis sativa, Eucalyptus globules, Thuja sinensis, Datura stramonium.*	Wheat	*Tilletia tritici*	Borgen, 2004b	Comparison with *Thuja* leaves, lime and salty brine treatments
Vinegar	Wheat	*Tilletia tritici, Pyrenophora graminea*	Borgen and Nielsen, 2001	
Essential oils (e.g. thyme), organic acids (e.g. ascorbic acid)	In vitro test	*Xanthomonas campestris, Clavibacter michiganensis, Botrytis aclada, Alternaria dauci*	Groot *et al*., 2004	Used in combination with physical treatments (not reported)
Vinegar, oligo-elements, cinnamon essential oil	Carrot	*Alternaria dauci*	Lizot *et al*., 2002	Different combinations of substances were tested
Garlic extract, horsetail decoction and waterglass, sea weed extract, sulphur powder	Barley, wheat	*Ustilago nuda, Pyrenophora teres, Fusarium nivale*	Rodriguez, 2000	Also thermotherapy was tested
Microalgal extract (*Calothrix* sp.)	Corn, sorghum, mung bean	*Macrophomina phaseolina*	Mahakant *et al*., 1998	
Concentrated lactic acid	Carrot	*Alternaria dauci*	Heller, 2002	
Acetic acid	Barley	*Pyrenophora graminea, Ustilago nuda*	Nielsen *et al*., 2000	Thermotherapy was used as well
Organic acids (e.g.,jasmonic, salicylic, lactic); commercial compounds (e.g. ComCat, Chitoplant); essential oils (e.g. clover, oregano thyme)	Vegetables	*Colletotrichum* sp., *Botrytis aclada, Alternaria dauci, Xanthomonas campestris, Clavibacter michiganensis*	Schmitt *et al*., 2004	Biological agents were also tested

Treatment	Host species	Diseases and pathogens controlled	Researcher	Notes
Extracts of garlic bulb and cow, buffalo and sheep urine	Rice	*Aspergillus spp*	Wani and Gincy Devasia Kurucheve, 2004	Comparison with Thiram treatments; germination problems were detected
Neem based pesticides (Bioneem, Neemgold, Neemarin, Nimbicidine, Neemazal and Achook)	Okra		Kumar, 2004.	Effect of Neem based products on germination rate was assessed
Crop straw (non sterilized powdered straw) for coating	Sugar beet	*Pythium*	Bardin *et al*., 2004b	Biological treatments were used as well
Neem products (powdered neem seed, neem seed kernel, neem seed coat, neem cake)	Cowpea	*Heterodera cajani*	Vijayalakshmi and Archana, 2003.	No effect on seed germination was observed
Plant extracts from *Azadirachta indica, Thuja orientalis, Catharanthus roseus, Leucas aspera, Tridax procumbens, Coleus aromaticus, Ruta graveolens, Clerodendron inermae*	Rice paddy	*Gerlachia oryzae*	Krishnamurthy *et al*., 2000.	Biological control and physical methods were studied as well
Plant extracts from *Ocimum gratissimum, Acalypha ciliata, Vernonia amygdalina, Mangifera indica, Azadirachta indica*	Corn	*Fusarium moniliforme*	Owolade *et al*., 2000.	Control treatment was done with benomyl.
Thyme oil (BioZell2000B)	Fennel and caraway	*Verticillium dahliae* and *bacteria*	Blum *et al*., 2006	Significant effects shown
Thyme oil	parsley	*Septoria petroselini*	Amein *et al*., 2006	Control with Thiram and comparison with physical treatments

3. BIOLOGICAL CONTROL

In this subgroup we considered papers and studies reporting biological control experiments, based on pathogens antagonists, such as fungi and bacteria, for coating and/or seed treatments.

Biological agent	Host species	Diseases and pathogens controlled	Researcher	Notes
Clonostachys	Carrot	*Alternaria* spp.	van der Bulk *et al*., 2004	
Pseudomonas chlororaphis	Cereals (barley, oat, wheat, rye, triticale)	*Pyrenophora* spp., *Fusarium* spp., *Bipolaris sorokiniana, Tilletia caries, Microdochium nivale, Septoria nodorum*	Widen and Annas, 2004	Commercial compounds Cedomon® and Cerall® were also used
T.viride	Wheat, barley	*B. sorokiniana, Fusarium* spp.	Batura *et al*., 2004	Thermotherapy and organic substances tested ad well
Bacteria *(Streptomyces, Pseudomonas, Bacillus, Enterobacter);* fungi (*Phomopsis, Ectomycorrhizae, Trichoderma, Cladosporium, Gliocladium)*	Cotton, vegetables	Not reported	STEC and FIS, 2000	
Streptomyces spp.	Maize	*Aspergillus* spp., *Curvularia lunata, Drechslera maydis, Fusarium subglutinans, Cephalosporium acremonium*	Bressan, 2003	
Bacillus subtilis, Fusarium oxysporum, Streptomyces sp., *Pseudomonas chlororaphis*	Brassica	*Alternaria* spp.	Schmitt *et al*., 2004	Screening of 87 organisms (bacteria, fungi, streptomycetes and yeasts) was carried out. Natural substances were tested as well
R. leguminosarum bv. viceae	*Pisum sativum* (host), *Beta vulgaris* (non host)	*Pythium sp.* "group G"	Bardin *et al*., 2004a	Several strains showed very good responses in field experiments
Fungi and bacteria*: Trichoderma harzianum, T. pseudokoningii, Aspergillus niger, A. candidus, Penicillium sp., Bacillus cereus, Pseudomonas aeruginosa*	Rice	*Alternaria alternata, Curvularia lunata [Cochliobolus lunatus], Fusarium solani*	Sarhan and Shibly, 2004.	No negative effects on germination, except for *Penicillium* sp.

Biological agent	Host species	Diseases and pathogens controlled	Researcher	Notes
Clonostachys rosea	Carrot	*Alternaria dauci, A. radicina*	Jensen *et al*., 2004.	
Trichoderma spp.	Tomato	*Rhizoctonia solani*	Kövics *et al*., 2001.	
Antagonistic bacterial isolates (i.e. *Bacillus* spp, *Pseudomonas fluorescens*)	Onion	*Fusarium oxysporum*	Tehrani and Ramezani, 2003	120 bacteria were isolated from onion rhizosphere; six highly effective strains were used for in vitro and soil and seeds experiments
Bio-agents: Abamectin (fermentation product from *Streptomyces avermitilis*), Nemaless (containing strains of *Serratia marcescens*), and Sincocin-AG	Faba bean	*Meloidogyne incognita*	El-Nagdi and Youssef, 2004.	Treatments mentioned were used for seed soaking
Trichoderma spp.	Groundnut	*Macrophomina phaseolina*	Malathi, 2004.	Treatment also improved seedling vigour and dry matter production, and prevented loss of oil content
Pseudomonas fluorescens	Sugar beet	*Pythium*	Bardin *et al*., 2004b	Natural treatments were used as well
Seed dressing with *P. fluorenscens*	Sorghum	Fungal infections	Baig and Baig, 2003.	Assessed seed emergence and germination rates as well
Trichoderma harzianum	Cowpea	*Macrophomina phaseolina*	Braga *et al*., 2003	Comparison with chemical treatments
Trichoderma viride	Raddish, dill, onion, parsley, carrot, red beet	Several but not stated	Sadowski *et al*., 2006	Effect of coating composition evaluated as side-effect on *Rhizoctonia solani*
Clonostachys rosea	Barley	*Bipolaris sorokiniana*	Jensen *et al*., 2002.	
Trichoderma harzianum, T.pseudokoningii, Pseudmonas fluorescens	Rice paddy	*Gerlachia oryzae*	Krishnamurthy *et al*., 2000.	Natural substances and physical methods were studied as well
Not reported	Rice	*A. tenuis, B. oryzae, F. solani, G. oryzae, Nigrospora, Penicillium, Rhizopus, Fusarium moniliforme, Fusarium semitectum, Phoma sp., Pinatubo oryzae, Cercospora oryzae, Alternaria padurickei, Alternaria longissima, Curvularia sp., Aspergillus sp., Tilletia berclayana, Sarocladium oryzae*	Hossain *et al*., 2000.	One antagonist fungus was used for the tests, and a comparison with two fungicides was done as well. No consequences on seed germination was found.

Biological agent	Host species	Diseases and pathogens controlled	Researcher	Notes
Trichodermin (*Trichoderma lignorun* strain istokskij at 8.0 kg/t), Kaelsi-Micros (*Pseudomonas aureofaciens* strain H16 at 200 ml/t)	Winter wheat, winter rye, spring barley.	*Fusarium spp., Alternaria spp.*	Semaškienė, R, 2000.	Other treatments used were with symbiont (growth stimulant + copper) and a chemical treatment.
*Bacillus megaterium (*and *Bacillus azotoformanis (*1 x 109 CFU/ml) in marigold)	Globe amaranth (*Gomphrena globosa*), pot marigold (*Calendula officinalis*) and marigold (*Tagetes erecta*)	*Nimbya gomphrenae*, *Stemphylium vesicarium, Alternaria tagetica*	Wu *et al*., 2001.	Treatments with 1% NaOCl, 10 ppm pyrifenox, 200 ppm iprodione, mancozeb, were performed as controls.
Bacillus subtilis	Dill (*Anethum graveolens*)	*Alternaria radicina*	Blum *et al*., 2006	Effect on emergence
Conidial suspensions (1 x 108 conidia/ml) of antagonistic fungi *(Trichoderma atroviride 312, T. longibrachiatum 9, T. harzianum 144, Gliocladium roseum 11, Penicillium frequentans)* and talcum powder in the first experiment; talcum + yeast (0.2 %) and *G. roseum* or *T. harzianum* in the second experiment.	Durum winter wheat (cv. Vitron)	*F. culmorum*	Roberti *et al*., 2000.	Treatments with fungicides were performed as controls. All biological treatments gave good results and increased emergence, survival and other parameters.
Trichoderma (T. hamatum, T. harzianum, T. koningii, T. pseudokoningii, T. longibrachiatum, T. viride), *Gliocladium virens, Bacillus subtilis* , *Pseudomonas fluorescens.*	French Bean *(Phaseolus vulgaris)*	*Colletotrichum lindemuthianum*	Ravi *et al*., 1999.	

Biological agent	Host species	Diseases and pathogens controlled	Researcher	Notes
Diffusates from 32 plant species (i.e. *Anethum graveolens, Azadirachta indica, Cannabis sativa, Coriandrum sativum, Melia azedarach, Momordica charantia*)	Sunflower	*Alternaria alternata, Emericellopsis terricola, Fusarium solani, Macrophomina phaseolina, Stemphylium helianthi*	Bhutta *et al*., 1999.	
Trichoderma viride, Chaetomium globosum	Pigeon pea (*Cajanus cajan* (L.) Millsp.)	*Alternaria alternata, Phyllosticta cajani, Rhizoctonia bataticola [Macrophomina phaseolina], R. solani, Curvularia lunata [Cochliobolus lunatus], Cladosporium cladosporioides, Colletotrichum dematium, Alternaria, Trichothecium roseum, Aspergillus flavus, A. niger, Botrytis cinerea, Fusarium moniliforme [Gibberella fujikuroi], F. semitectum [F. pallidoroseum]*	Pradep *et al*., 2000.	The control was a non-treated thesis.
Trichoderma harzianum, Streptomyces griseovirides	Carrot	*Alternaria dauci*	Hermansen *et al*., 1999	Experiments with hot water and fungicides were also included.
More than 20 bacterial strains *(i.e. Pseudomonas, Bacillus)*	Carrot	*Pythium ultimum, Rhizoctonia solani*	Jahn and Puls, 1998.	Electronic treatment was tested, and also combination of the two.
Pseudomonas chlororaphis, strain MA 342	Cereals (wheat, rye, barley, oat)	*Pyrenophora graminea, P. teres, P. avenae, Ustilago avenae [U. segetum var. avenae], U. hordei [U. segetum], Tilletia caries*	Johnsson *et al*., 1998.	A control treatment was performed using guazatine + imazalil. Field tests along 5 years were realized.
Pseudomonas chlororaphis, strain MA 342	Cereals (barley, oat, wheat)	*Drechslera teres [Pyrenophora teres], D. graminea [P. graminea]* and *Ustilago hordei [U. segetum]* in barley; *against D. avenae [P. avenae]* and *U. avenae [U. segetum var. avenae]* in oats; *and Tilletia caries [T. tritici]* in wheat	Hökeberg, 1998.	A formulation based on rapeseed oil is studied.
Conidial suspension (107 spores/ml) of *Trichoderma sp.* isolate TA1; 7 isolates of *Bacillus megaterium*	Turfgrasses	*Bipolaris [Cochliobolus] australiensis, Curvularia [Cochliobolus] pallescens, Exserohilum rostratum [Setosphaeria rostrata]*	Ninq *et al*., 1998	Some fungicides were tested as well.

Biological agent	**Host species**	**Diseases and pathogens controlled**	**Researcher**	**Notes**
[Not reported in the abstract]	Wheat	*Bipolaris sorokiniana [Cochliobolus sativus], Pyricularia oryzae [Magnaporthe grisea], Drechslera [Pyrenophora] tritici-repentis, Stagonospora [Leptosphaeria] nodorum*	Luz, 1998.	Treatments with iprodione + thiram were done as control.
Not identified in the poster but "several"	Carrots and brassicas	*Xanthomonas spp.*	Roberts *et al.*, 2006	Physical methods tested as well. Good results in vitro but not enough in final field trials
Several commercial ones (Streptomices sp., Pseudomonas chlororaphis) and experimental ones (not identified)	cabbage	*Aletrnaria spp.*	Amein *et al.*, 2006	Control: Thiram and Serenade

4. Health tests

Studies in this section regarded the assessment of health status with different approaches and methodologies.

Method	**Species**	**Diseases and pathogens detected**	**Researcher**	**Notes**
Modified ISTA germination ability test , Fluorescence test, Washing filtration test	Wheat, rye, triticale, emmer, spelt, einkorn.	*M. nivale, S. nodorum, Tilletia* spp.	Bänziger *et al.*, 2004	
Image analysis	Carrot	*Alternaria dauci, A. radicina*	Boelt *et al.*, 2004	Experiments conducted under tunnels and in open field. Germination rate and agronomical aspects were assessed as well
Seed separation	Barley	*Ustilago nuda*	Borgen, 2003	Effect of different seed separation techniques on the infection level of loose smut in infected seed lots

B. GERMINATION

Works classified under this group presented experiments assessing organic seed germination rate (compared to conventional seed) or some enhancement treatment.

Method	**Comparison**	**Species**	**Researcher**	**Objectives**
Light emittance		9 Vegetables, 5 field and several ornamental crops	Vasilenko and Carrier, 2004	Increase germination rate and accelerate germination
	With conventional	Melon	Paillán *et al.*, 2004	Assess relation between fruit load and seed quality
Cold germination test		Wheat	Bartl, 2000	Assess cold germination rate (indicator of fungal pathogens presence)
Germination rate	With conventional and between open field and under tunnel cultivation	Carrot	Boelt *et al.*, 2004	
Seed dressing with *P. fluorenscens*		Sorghum	Baig and Baig, 2003.	Assessing seed emergence and germination rates

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Appendix II

Expert consultation about seed borne diseases impact on organic seed production and use

Dear participant of our consultation,

The research project of the EU "Organic Revision" will evaluate critical points of the implementation of the EU regulation 2092/91 in several EU countries. One of the work-packages (WP 5) within this project is dealing with organic seed, especially to some critical points of EEC 1452/03. For more information about the project see www.organic-revision.org.

In the first phase of this project it is planned to investigate the influence of seed borne diseases on the production and use of organic seeds. ***The main focus will be identification of main problems faced in practise and which measures can be taken to reduce them****.*

As you were named to be a specialist in this area, we request your help in our expert consultation: please fill in the questionnaire below, it will take you 30 minutes as a maximum!

The first part of the questionnaire is dedicated to diseases impact on seed production (including treatments efficacy in disease control) while the second one is dealing with diseases impact on seed use. If you have no experience on one of the two parts please just skip it.

Questionnaire part 1: seed born diseases and seed production

1.1 treatments efficacy and acceptability in seed born diseases control

Please fill it in putting the treatment number (from the table below), a short description of the key parameters of the treatments (e.g. in case of "hot water" which temperature, for how long, drying method...). Following the assessment about acceptability, suitability and practice of each treatment. If you want to add treatments you are experienced in you are welcome to add tables.

Scoring ranges from 1(very poor suitability) to 5 (very high suitability).

Tratment numbering:

treatment	***number***
Hot water	1
Steam	2
Hot air	3
Seed rinsing	4
Ultrasound	5
Plant extracts	6
Mineral products	7
Biological control (micro-organisms)	8

Treatment №	
short description	

	assessment	comments
Suitable for organic		
Costs		
friendly to use		
development still necessary		
to be used on small lots		
To be used on large scale		

Seed born disease	species	assessment	comments

General remarks to the treatment:

Treatment №	
short description	

assessment comments

Suitable for organic

Costs

friendly to use

development still necessary

to be used on small areas

to be used on large scale

Seed born disease species assessment comments

General remarks to the treatment:

Treatment №	
short description	

assessment comments

Suitable for organic

Costs

friendly to use

development still necessary

to be used on small lots

to be used on large scale

Seed born disease species assessment comments

General remarks to the treatment:

Treatment №	
short description	

assessment comments

suitable for organic

Costs

friendly to use

development still necessary

to be used on small lots

to used on large scale

Seed born disease species assessment comments

General remarks to the treatment:

If necessary please make more copies of the form above and freely add comments!!!!

1.2: Importance of seed born diseases

Can you give an assessment of the ***importance*** *of following seed born diseases and their influence on organic seed production? Please score the importance of the disease using a range from 1 (very low) to 5 (very high), n.e. (not-experience) in case you have not experience on a specific issue.*

Please use the code (number) you gave above for the identification of ***efficient treatments*** *to different diseases. You can add more information writing in this field, a following line will open up automatically if necessary.*

In case there are other important seed born diseases in your area which are not listed, please, add them with Latin name.

grain

Winter wheat: importance efficient treatments

Tilletia caries

Tilletia contraversa

Microdochium nivale

(Gerlachia nivalis)

Fusarium graminearum

(Gibberella zeae)

Fusarium spp.

Septoria nodorum

Septoria tritici

Ustilago tritici

Summer wheat:

Septoria nodorum

Fusarium spp.

Durum wheat:

Fusarium graminearum

Fusarium avenaceum

Microdochium nivale

(Gerlachia nivalis)

Spelt:

Tilletia caries

Tilletia contraversa

Microdochium nivale

(Gerlachia nivalis)

Septoria nodorum

Septoria tritici

Ustilago tritici

Winter barley

Microdochium nivale

(Gerlachia nivalis)

Ustilago nuda

Ustilago hordei

Pyrenophora graminea

Cochliobulus sativus

Fusarium spp.

Summer barley

Ustilago hordei

Ustilago nuda

Pyrenophora graminea

Cochliobulus sativus

Fusarium spp.

Rye:

Urocystis occulta

Microdochium nivale

(Gerlachia nivalis)

Tilletia contraversa

Fusarium spp.

Oats:

Pyrenophora avenae

Fusarium spp.

Triticale:

Microdochium nivale

(Gerlachia nivalis)

Septoria nodorum

Cochliobulus sativus

Fusarium spp.

Corn:

Ustilago maidis

Fusarium spp.

Ascophyta spp..

General remarks:

Legumes

Faba beans importance efficient treatments
Ascochyta fabae

Botrytis cinerea

Fusarium spp.

Peas

Ascochyta spp.

(Ascochyta pisi, A. pinodes, A. pinodella)

Fusarium spp.

Soja

Diaporthe phaseolorum

(Phomopsis sojae)

Cercospora kikuchii

Fusarium spp.

Lupines

Colletotrichum gloeosporioides

Fusarium spp.

Lucerne, Alfalfa

Alfalva mosaic virus

Clavibacter michiganensis

Red clover

White clover

General remarks:

Vegetables

<u>*Potatoes*</u>	importance	efficient treatments
Phytophthora infestans		
Rhiczoctonia solani		
Phoma foveata		
Fusarium spp.		
Synchytrium endobioticum		
Helminthosporium solani		
Spongospora subterranea		
Streptomyces scabies		
Clavibacter michiganensis		
ssp. sepedonicus		
Erwinia carotovora		
Ralstonia solanacearum		

potato leaf roll virus (PLRV)

potato virus Y (PVY)

potato virus A (PVA)

potato virus X (PVX)

potato virus M (PVM)

potato virus S (PVS)

tobacco rattle virus (TRV)

potato spindle tuber (PSTVd)

Globodera rostochiensis

Globodera pallida

Tomato

Clavibacter michiganensis

Xanthomonas campestris

Pseudomonas syringae

Tobacco mosaik viurs

Tomato mosaik virus

Pepino mosaik virus

Carrots

Alternaria dauci

Alternaria radicina

Xanthomonas campestris

Red beet

Celery

Pseudomonas syringae

Septroia apii

Cabbage

Xanthomonas campestris

Pseudomonas syringae

Phoma lingum

Broccoli

Xanthomonas campestris

Pseudomonas syringae

Phoma lingum

Lettuce

Xanthomonas campestris

Septoria lactucae

Lettuce mosaik virus

Lambs lettuce

Phoma valerianellae

Peronospora valerianellae

Fennel

Onion

Botrytis alli

Pumpkin

Beans

Colletotrichum lindemuthianum

Pseudomonas syringae

Bean common mosaic virus

Peas

Pseudomonas syringae

General remarks:

Questionnaire part 2: seed born diseases and seed use

Following part of the questionnaire is ment to assess other characteristics of seeds that may affect their global quality especially from the users's point of view.Those characteristics may be due to breeding methods, multiplication operations etc. Our intention at this stage is just to assess if problems exist and possibly to identify which quality parameter is more sensitive. If you have no experience on the issue, please, skip this part.

Did you notice any difference between using organically produced seeds and conventional ones? Please indicate in 5 of the most relevant species you have experience in, in which production phase, which kind of difference and to which extent (scoring from 1, very low, to 5, very high) filling in the table below:

species	***Prod.phase***	***emergence rate***	***emergence speed***	***vigour***	***Presence of seed born disease***	***Pest and disease susceptibility***	***Plants homogeneity***	***productivity***
	Seedlings productio							
	Greenhouse							
	Open-field							
	Seedlings productio							
	Greenhouse							
	Open-field							
	Seedlings productio							
	Greenhouse							
	Open-field							
	Seedlings productio							
	Greenhouse							
	Open-field							
	Seedlings productio							
	Greenhouse							
	Open-field							

General remarks:

Extra question

Did you ever use or have experience with on-farm produced seeds?

*In case you did, we would like to know your experience regard the quality of such seeds, in order to understand what can be done in order to improve such production system***.**

On which species did you experience on-farm seed production:

Were they ecotypes, varieties or what?

please fill in the table below scoring (1very bad ;5 very good).

Health status	***Plant homogeneity***	***Presence of seed born disease***	***Pest and disease susceptibility***	***productivity***

Do you know of any scientifically supported project relatd to on-farm seed production in yur country? Please specify:

In case of need, please, add lines in the table. … and here below please add any general remarks:

Few information about you:

Surname: *First name:*

Institution:

Activity (researcher, consultant, seed producer, farmer.....):

Address:

e-mail:

Special expertise in this area:

Would you advise some literature on the topic? Please list.

Please send the questionnaire by August 31st to Gerhard Plakolm at the following e-mail address:

Gerhard.plakolm@bal.bmlfuw.gv.at

Thank you very much for your cooperation! We will send you a copy of the report originated from the questionnaires elaboration.

Appendix III

Further tables reporting differences in thresholds for seed-born diseases in selected countries.

Table 3.7: Root Rot / Fusarium spp, Microdochium nivale etc. on basic seed of wheat, rye, barley and oat

country	field inspection		seed inspection				unit
	rye	barley	wheat	rye	barley	oat	
HU	no limits	barley is not examined		no limits	barley is not examined		
AT			10*) (a)	>10**) (b)			*) % **) % infected seeds
DE			20 (c) (d)				%
NL			25*) or 10**)	25*) or 10**) (e)	25*) or 10**)	25*) or 10**) (e)	*) % total infection **) % of seeds with "internal" infection
CH			no limits	no limitsiii	barley is not examined	no limits (f)	

(a) limit for obligatory treatment
(b) dressing necessary
(c) private standard
(d) cold test
(e) In blottertest one distuinguishes seeds with superficial infections and more severe infections; for calculating the total infection one assigns a weighing factor to the different categories; seeds with superficial are multiplied with a factor 1/3; the rest with a factor 1.
(f) Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits.

Table 3.8: Root Rot / Fusarium spp, Microdochium nivale etc. on certified (1) seed of wheat, rye, barley, and oat

quality	coun-try	field inspection		seed inspection				unit
		rye	barley	wheat	rye	barley	oat	
certified seed	NO			15				%
	DE (a)			20 (b)				%
	SE			0-40 (16-40 sw) (c) > 40 (d)				%
	CH			no limits (e)	no limits (f)		no limits (e)	
	HU	no limits			no limits			
certified seed 1	AT			15*) (g)	>10**) (h)			*) % **) % infected
	DK			15 (i)	15 (i)	15 (wb) (i) 30 (sb) (i)	30 (i)	%
	SE						36-50 (c); > 50 (d)	%
	HU		barley is not examined			barley is not examined		

(a) private standard
(b) cold test
(c) treatment recommended
(d) treatment necessary
(e) Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits.
(f) For hybrids the limit is 4 pieces in 500 grams.
(g) limit for obligatory treatment
(h) dressing necessary
(i) conventional untreated
(sb) spring barley
(wb) winter barley
(sw) spring wheat

Table 3.9: Root Rot / Fusarium spp, Microdochium nivale etc. on certified 2 seed of wheat, rye, barley, and oat

country	field inspection	seed inspection			unit
	barley	wheat	barley	oat	
HU	barley is not examined				
UK		> 5 Microdochium nivale: (a)		> 5 Microdochium nivale: (a) (b)	%
AT		15 (c)			%
SE				36-50 (d) > 50 (e)	%
HU			barley is not examined		

(a) treatment
(b) own seed
(c) limit for obligatory treatment
(d) treatment recommended
(e) treatment necessary

Table 3.10: Root Rot / Fusarium spp, Microdochium nivale etc. on organic seed of wheat, rye, barley, and oat

quality	country	seed inspection					unit
		wheat	rye	barley	oat	triticale (a)	
basic seed	CH				10 (b)		% of grains
organic	AT	10iii			20ii (c)		%
	Scotland	10iii					%
	DK	15iv	15iv	15 (wb)iv 30 (sb)[viii] (d)	30iv	15iv	%
	NO	15i		25i	15i		%
	SE	16 - 40 (e) > 40ii (f)	0 - 40 (e) > 40ii	0 - 20 (e) > 20ii (g)	36 – 50 (e) > 50ii (c)	16 - 40 (e) > 40ii (f)	%
	AT	--[ix]	--[x]		--iv	--iv	
	AT				- N -i	--ii (d)	
certified 1	CH	10**) (b)	10**) (h)		20*) (b)		*) % **) % of grains
certified 2	DK			15% (wb) 30% (sb)		15	%

(a) Fusarium spp.
(b) Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits.
(c) These limits are valid Drechslera avenae and Fusarium spp.
(d) These limits are valid Fusarium spp. and Cochliobolus sativus together.
(e) optional
(f) These limits are valid for Fusarium spp. and Septoria nodorum together.
(g) These limits are valid in addition for Drechlera graminea, Drechselera teres, Fusarium spp., and Cochliobolus sativus.
(h) For hybrids the limit is 4 pieces in 500 grams.
(sb) spring barley
(wb) winter barley

Table 3.11: Root Rot / Fusarium spp, Microdochium nivale etc. on seed of rye, barley, and oat

country	field inspection	seed inspection		Unit
	oat	rye	barley	
NO	15			%
SE		0 - 40 (a) > 40 (b)	0 - 20 (sb 11 - 20) (a) > 20 (b)	%

(a) treatment recommended
(b) treatment necessary
(sb) spring barley
(wb) winter barley

Table 3.12: Loose Smut / Ustilago nuda on basic seed of barley

country	field inspection		seed inspection	
	barley	unit	barley	unit
EE	0,0	%		
UK	0,5 (0,1)	% infected plants	0,5 (0,1)	% infected seeds
CZ	0,8	%		
HU	20	heads/100 m²	no limits	
ES	0,5	plants/100 m²	2	seeds on 500 g
NL	1	plants/100 m²	no limits	
CH	2	plants/100 m²	no limits	
AT	3	plants/150 m²	0,8, >0,1 (a)	% infection
DE	3	plants/150 m²	0,0 (b)	%
LV	5	plants/100 m²	no limits	
FI	no limits (c)		>1 (a) (d)	% infected seeds

(a) dressing necessary
(b) private standard
(c) Diseases are observed in the field. The inspector makes the decision on possible rejection based on his observation, no exact limits.
(d) No limits for rejection, limits are given for dressing necessity.

Table 3.13: Loose Smut / Ustilago nuda on certified (1) seed of barley

quality	country	field inspection		seed inspection	
		barley	unit	barley	unit
certified	EE	0,2	%		
	CZ	2,0	%		
	DE	5	plants/150 m²	0,0 - 20 (c)	%
	CH	5	plants/100 m²	no limits	
	NL	6	plants/100 m²	no limits	
	PL	3	plants/30 m²		
	LV	15	plants/100 m²	no limits	
	UK	0,5 (0,2)	% infected plants	0,5 (0,2)	% infected seeds
	FI	no limits		>1 (b) (d)	% infected seeds
certified 1	AT	5	plants/150 m²	2,0 >0,1 (b)	% infection
	DK			0,0 (a)	%
	HU	50	heads/100 m²	no limits	
	ES	5	plants/100 m²	5	seeds on 500 g

(a) conventional untreated
(b) dressing necessary
(c) private standard
(c) No limits for rejection, limits are given for dressing necessity.

Table 3.14: Loose Smut / Ustilago nuda on certified 2 seed of barley

country	field inspection		seed inspection	
	barley	unit	barley	unit
HU	50	heads/100 m²	no limits	
ES	10	plants/100 m²	10	seeds/500 g
AT	10	plants/150 m²	5,0, >0,5 (a)	% infection
UK			0,5 (b)	%

(a) dressing necessary
(b) own seed

Table 3.15: Loose Smut / Ustilago nuda on organic seed of barley

quality	country	seed inspection			unit
		barley	spring barley	winter barley	
organic	FI			0,3 - 0,9 (a) 1,0 - 3,0 (b) 3,0 (a)	%
certified 1	AT	0,1xi			%
	SE	0,1ii			%
	Scotland	0,2iii			%
	AT	0,2	0,1iv	0,1iv 2,0 (a)	%
	NO	0,3i			%
	DK		0,0iv	0,0iv	%
certified 2	SE	0,1ii			%
	Scotland	0,2iii			%
	NO	0,3i			%
	AT	0,5[xi]	0,5iv	0,5iv 5,0 (c)	%
	DK		2,0iv	2,0iv	%

(a) optional
(b) disinfection
(c) not acceptet

Table 3.16: Loose Smut / Ustilago nuda on seed of barley

country	field inspection	seed inspection	unit
	barley	barley	
NO	0,1		%
SE		0,3	%

Table 3.17: Glume Blotch / Septoria nodorum on basic seed of wheat

country	field inspection		seed inspection	
	wheat	unit	wheat	unit
CZ	20	%		
AT			20 (a)	% infection
CH			no limits	
DE			no limits (b)	

(a) limit for obligatory treatment
(b) private standard

Table 3.18: Glume Blotch / Septoria nodorum on certified seed of wheat

quality	country	field inspection		seed inspection	
		wheat	unit	wheat	unit
certified seed	CZ	20	%		
	SE			0-40 % (16-40 sw) (a) > 40 (b)	%
	NO			5 %	%
	CH			no limits	
	DE			no limits (d)	
certified seed 1	DK			15 % (c)	%
certified seed 2	UK			> 5 (e)	%

(a) treatment recommended
(b) treatment necessary
(c) conventional untreated
(d) private standard
(e) own seed
(sw) spring wheat

Table 3.19: Glume Blotch / Septoria nodorum on organic seed of wheat and triticale

Quality	Country	seed inspection		unit
		Wheat / Triticum aestivum	triticale	
basic seed	CH	40		% of grains
organic seed	SE	16 - 40 (a) > 40ii (b)	16 - 40 (a) > 40ii (b)	%
	AT		--ii (b)	
certified	CH	40 (c)		% of grains
certified 1	NO	5i		%
	DK	15iv	15iv	%
	AT	20[xii]	--iv	%
	Scotland	- N - 10)iii		%
	SE	--ii (d)	--ii (d)	
certified (2)	NO	5i		%
	DK	15iv	15iv	%
	AT	--xii	--iv	
	SE	--ii (d)	--ii (d)	

(a) optional
(b) These limits are valid for Fusarium spp. and Septoria nodorum together.
(c) Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits.
(d) see Fusarium spp.

Aknowledgement

country	Limit-description done by …				
	wheat	rye	barley	oat	triticale
AT	A. Ratzenböck				
CH	H. O. Pinnschmidt from Nielsen & Kristensen 2001	Jens Müller			
CZ					
DE	Aart Osman: In blottertest one distuinguishes seeds with superficial infections and more severe infections; for calculating the total infection one assigns a weighing factor to the different categories; seeds with superficial are multiplied with a factor 1/3; the rest with a factor 1	Karl Josef Müller			
DK	H. O. Pinnschmidt from Nielsen & Kristensen 2001				
EE	Linda Legzdina				
ES	Fernando Martinez				
FI	Marja Jalli				
HU	László Gergely				
LV	Not ruled by law. For organic seed (except barley) there is an official health test as a basis for an official recommendation about the use as seed according to the limits.	Linda Legzdina			
NL	Aart Osman				
NO	H. O. Pinnschmidt from Nielsen & Kristensen 2001				
PL	Pawel Czembor				
Scotland					
SE	H. O. Pinnschmidt from Nielsen & Kristensen 2001				
UK	Steve Hoad	H. O. Pinnschmidt from Nielsen & Kristensen 2001	Steve Hoad, H. O. Pinnschmidt from Nielsen & Kristensen 2001	H. O. Pinnschmidt from Nielsen & Kristensen 2001	

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Table 3.3

viii ARGE Biolandbau (2003: 163)
ix ARGE Biolandbau (2003: 162, 164, 167)
x ARGE Biolandbau (2003: 162, 164)
xi ARGE Biolandbau (2003: 164, 166, 167)
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