# Rapport fra udredningsgruppen

# vedrørende

# Sameksistens mellem genetisk modificerede,

# konventionelle og økologiske afgrøder.

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# Report from the Working Group

# on

# The co-existence of genetically modified crops

# with conventional and organic crops

## Conclusion and Summary

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## Conclusion

- With a limited GM-production in Denmark of the crops maize, beets, potatoes, barley, wheat, oats, triticale, rye, lupine, broad beans and peas, the Working Group finds that co-existence at the proposed threshold values is possible, as long as the measures suggested are adopted.

- If the GM-production of these crops becomes more extensive, further measures and stipulations in terms of segregation may become necessary.

- In order to ensure a GM-content in organic crops of close to 0 (detection level ~ 0.1%), further measures, as suggested, will become necessary.

- For the crops oilseed rape, grass seed, clover seed, and vegetable seed, the problem is so extensive, that further evaluation is required, before production guidelines can be proposed. For oilseed rape, however, the extent of the problem differs between fully fertile varieties, hybrid varieties and varietal associations
- The measures suggested by the Group to ensure compliance with the requested threshold values are based on:

  - The existing Danish regulations on certified seed production
  - Information contained in Danish and foreign reports, and other sources.

- There will be large variations between both crops and individual farms in the expenses incurred in complying with threshold values. Farms that already produce according to a common set of regulations, such as certified seed production, have least difficulties in complying with threshold values.

- Based on the complexity of the subject, the Group suggests that:

  - Their work is continued with a more thorough analysis of (a) the crops oilseed rape, grass seed, and clover seed, (b) the significance of extent of GM crop distribution, and (c) the economic relations.

  - An obligatory course in the cultivation and handling of GM crops is introduced for farmers – possibly as part of the farmer's education.

## Summary

**The Working Group**
The Working Group was established in July 2002 with the remit to "work with the co-existence strategy", which included the following specific tasks:

- To undertake a scientific evaluation of the possible sources of adventitious presence of GM material in conventional and organic productions.
- To evaluate the extent of adventitious presence and the need for control measures.
- To identify and evaluate the measures deemed necessary to ensure co-existence of GM crop production with conventional and organic productions.

**Background/status:**
- Gene technology is a relatively new methodology, which may be used in the breeding of new plant cultivars.
- Only small areas in the EU are grown with GM crops today – mainly in Spain. No GM crops are grown commercially in Denmark, but there are experimental plantings.
- The EU has to approve the marketing of GM crops, but at the moment has a moratorium on new authorisations.
- The scale of GM cropping of soy, cotton, maize and oilseed rape particularly in the United States, Canada, China and Argentina is extensive (19% of the total cropping area of these crops).
- There have been several cases of genetically modified organisms (GMO) appearing in conventional and organic crops and products. Imported seed is now controlled.
- While the Working Group has carried out this evaluation, the EU has been debating a proposal regarding the approval and labelling of GM foods and feed, including a threshold value for the adventitious presence of GMO below which labelling will not be required. The current threshold value for food for the labelling of GMO content is 1%. In November 2002, political agreement was reached in the EU Council for a threshold value of 0.9% for foods and feed. The proposal is now receiving its second reading in the EU Parliament.
- The detection limit for GMOs with the existing analytical methods is about 0.1%.
- The regulations for organic farming state that GMOs must not be used in the production.

The Group has found background material for its report in existing publications, particularly the following:
- The report "The consequences of genetically modified crops for organic farming" published by DARCOF (Kjellsson & Boelt, 2002 )
- The joint European report: "Scenarios for co-existence of genetically modified, conventional and organic crops in European agriculture" (JRC/IPTS, 2002). In this report, groups of experts evaluate the complex problems of co-existence for selected crops, based on e.g. simulation models.

Based on the above, and taking into account the actual range of GM plants and cultivars on offer, the Working Group does not expect that GM crops will be grown extensively in Denmark within the immediate future.

Based on the present experiments with GM crops and the applications for marketing, the Group infers that, initially, the GM crops most likely to be grown in Denmark are oilseed rape, maize and beets. The GM crop characteristic most likely to be used first is herbicide tolerance to facilitate weed control. However, other GM crops and characteristics could also be introduced.

**Threshold values**
The EU is currently debating the threshold values for the labelling of seed of individual crops with adventitious presence of GMO. The Commission has presented a working paper containing threshold values of between 0.3-0.7% for seed, depending on crop. These thresholds are based on the current threshold value of 1% for the labelling of GMO content in foods.

The Working Group is aware that there is political agreement in the EU Council for a threshold value of 0.9% for the labelling of GMOs in foods and feed. The change from 1 to 0.9% is within the margins of error of the estimates of the Group. Accordingly, the change from 1% to 0.9% does not give rise to a change in the Group's conclusions.

The Group's assessment for organic production is based on the assumption that GMO-free seed is used.

For several crops, the Group's evaluations and estimates for the production as far as the first stage of distribution show that co-existence based on the proposed threshold value for the end product is possible. This takes into account the possibility of admixture occurring in the subsequent stages of distribution, which, however, have not been considered in this report.

**Biological background**
Whichever crop is grown, be it conventional, organic or genetically modified, genes will always to some extent be transmitted to other crops of the same species. The extent of transmission depends on, e.g.:

- Crop characteristics including choice of variety
- The size of the area grown with the crop and inter-field distances
- Existence of wild relatives
- Human handling
- Wind conditions
- Pollinating insects

The most important routes of transmission identified by the Group, are via seed, pollen, straw, volunteer seed left in the soil, sowing and harvesting machines, transport equipment and storage facilities.

Various crop-dependent safeguarding measures can, however, be adopted. The most important are:

- Control of seed
- Separation distances and buffer zones
- Cropping interval (years between crops)
- Control of volunteers and possible wild relatives

- Cleaning of sowing, harvesting and transport equipment, as well as storage areas, and the control of the use of straw.

**The evaluation**
In connection with this evaluation, the Group has chosen to prioritise the GM crops most likely to be used in Denmark within the coming years.

The problems presented above are very complex and are affected by many external factors. As existing knowledge in this area is furthermore limited, there are varying degrees of uncertainty associated with the assessments and evaluations of the Group. The Group has endeavoured to take these uncertainties into account in its evaluation of the control measures required.

**The scientific evaluation**
The Group has based its evaluation of each crop on the following scenarios:

- *0% scenario*: No GM varieties of this crop or GM crops with which it can cross-pollinate are grown in Denmark or in a region. However, adventitious presence is possible through cross border pollination or the import of seed from areas where GM crops are grown.

- *10% scenario*: There is a moderate growing of the GM crop.

- *50% scenario*: This corresponds to the very rapid development of GM crop cultivation in countries such as Canada, where GM oilseed rape now constitutes more than 50% of the total area cultivated with oil seed rape.

Where the Group has suggested initiatives to restrict the presence of GM material in conventional or organic crops, these have been based on:

- Existing Danish regulations on certified seed production
- Foreign and Danish reports, and other sources.

The Group assumes that "good farming practice" is used.

The safeguarding measures have been graduated as follows:
- Basic measures (similar to regulations on certified seed)
- Extended measures (approaching the regulations for basic or pre-basic seed).

It has not been possible, within the given timeframe, for the Working Group to thoroughly analyse the significance of the extent of growing of the specific GM crop. Only some of the crops have therefore been divided into 10% and 50% scenarios.

**The economic evaluation**
The Group does not make any recommendations on who should cover the extra expenses incurred if GMOs are adventitiously found, and who should cover expenses in connection with any monitoring and control. Neither does it make any recommendations on who should meet the expenses in

connection with regulations on crop segregation, buffer zones, etc., as this was outside the scope of the report.

The Group has calculated the extra costs that will be incurred in the primary production in order to comply with threshold values in the scenarios as far as the first stage of distribution.

The livestock feed trade and the processing industry has not been included, as this is outside the scope of the Group's work. Consequently, the Group suggests that an economic analysis is carried out of the whole production chain to the consumer end.

The evaluation of the extra costs involved for individual crops has been carried out at field level and is based on the conditions specified in the report on safeguarding measures and levels of GM presence.

Considerable differences have been found between crops in the extra costs incurred. It is also clear that the farming practice currently in use will greatly impact the level of additional costs that can be expected on individual farms.

Organic farms and farms with specialist productions (e.g. multiplication of certified seed) already operate within a set of regulations that largely use the same measures as those specified in the report in order to comply with threshold values.

**Areas where new knowledge is needed**
The Group suggests that their work continues based on existing knowledge with a more thorough analysis of (a) the crops oilseed rape, grass seed, and clover seed, (b) the significance of the extent of GM crop distribution, and (c) the economic relations.

New knowledge in this area is constantly emerging and other European countries have started similar evaluations. For example, a very comprehensive English report on the subject is expected to be published mid 2003. This report will also include environmental assessments and cost-benefit analyses of the consequences of a GM crop production (see http://www.strategy.gov.uk/2002/gm/summ.shtml). The Group therefore proposes that such analyses are progressively included in a Danish evaluation.

It is evident that co-existence in many cases will require good farm management and great care in the production. The group therefore suggests that a course in GM crop cultivation and handling is made compulsory for farmers – possibly as part of the farmer's education.

It is evident from the above that the work of the Group is based mainly on experience gained abroad and on model calculations and that it therefore includes assessments and estimates. There are no specific Danish experiments or model calculations on the co-existence of GM crops with conventional and organic crops.

Consequently, there is a need for improved knowledge in respect of:

- The importance of the extent of GM crop cultivation for the control measures to be adopted
- The effect of buffer zones
- The extent of cross-pollination, including the effect of field size

- Conditions affecting pollination
- The potential for cross-pollination with wild relatives and volunteers
- The development of cropping systems to maintain purity of cultivars in seed production
- Analysis of the economic consequences of GM crop cultivation
- The presence of volunteers as weeds

## Individual crop groups

**Oilseed rape** (tabels 2.1a, 2.1b, 2.1c)

Reproduction: rape is both self-pollinating and cross-pollinating by wind and insects.

Size of area: 82,000 ha, of which 418 are organic (0.5%). Seed are primarily produced in Denmark but in some years the import of seed can account for as much as 50% of requirement. *C.* 0.6% of the rape area is used for seed production.

Most important routes of transmission: seed, cross-pollination and volunteer seed (e.g. through transport).

*The effect of 0%/10%/50% scenarios*

- In the 0% scenario, adventitious presence is possible via imported seed. With an increased cultivation of GM rape, there will be more airborne GM pollen and more GM volunteers in the area. An effective control of volunteers within and outside the field, increased field size, and borders cropped with rape in non-GMO fields should reduce any adventitious presence considerably.

<u>Seed multiplication.</u>

*0% scenario with foreign production of GM seed:*

- For fully fertile as well as hybrid varieties and varietal associations, it should be possible to keep the adventitious presence in conventional seed below 0.3% and it should also be possible to keep the presence in organic seed below the detection limit.

*10% and 50% scenarios:*

- For fully fertile varieties, it should be possible to keep the adventitious presence in conventional seed below 0.3% through strict regulations on separation after the first stage of distribution. It will probably not be possible to keep the presence in organic seed production below the detection limit.
- For hybrid varieties and varietal associations, it is not possible with present knowledge to recommend crop separation distances and lengths of rotation that ensure compliance with levels of adventitious presence below 0.3% for conventional productions and below the detection limit for organic production. With a strict control of hybrid seed before certification, it may be possible to achieve the threshold value by discarding batches that do not meet requirements.

<u>Production</u>

*0% scenario with foreign production of GM seed:*

- For fully fertile inclusive hybrid varieties, it should be possible to keep the adventitious presence in conventional productions below 0.9% and it should also be possible to keep the presence and below the detection limit for organic productions..

*10% and 50% scenarios*

- For fully fertile (incl. hybrid varieties), it should be possible to keep the adventitious presence in conventional seed below 0.9% through strict regulations on separation after the first stage of distribution. A level of ~0.1 % for organic productions is deemed not achievable unless exceptional measures are introduced, such as regions with a very large distance to other rape fields, more rigorous control of seed and of the seed bank.

- For varietal associations, it is not possible with present knowledge to recommend crop separation distances and a cropping interval that ensure compliance with an adventitious presence limit of 0.9%.

Need for further knowledge

- Further analyses are needed of the existing data at field level on the adventitious presence of volunteers and on the dispersal of characteristics such as erucic acid content or other non-GM genetic markers. Several initiatives are under way, *inter alia* under the auspices of the EU. The results of "The farm-scale experiments" in the UK, due to be evaluated in 2003, will be an important source of information. Collaboration with INRA in France is suggested in order to utilise and adapt a simulation model to Danish conditions.

**Maize** (table 2.2)

Reproduction: maize is mainly cross-pollinated by wind. Bees can collect the pollen but do not spread it to female flowers, as these have no nectar.

Size of area: *c.* 100,000 ha of which 5,000 ha is organic (5%).

Most important routes of transmission: Seed and cross-pollination. Maize is unable to shed seed naturally. Nearly all maize grown in Denmark is harvested for maize silage before maturity.

Seed multiplication

There is no maize seed production in Denmark.
A threshold value of 0.5% for the adventitious presence of GMO in conventional maize seed in the EU area is proposed.

Production

*The effect of 0%/10%/50% scenarios*

- An increased cultivation of GM maize will result in more airborne GM pollen. However, as cultivation of maize in Denmark is limited, there will in reality be little difference between the 10% and 50% scenarios regarding the risk of cross-pollination.

- Conventional farming: Threshold value 0.9%. A separation distance of 200 m is proposed, which corresponds to the stipulations for the multiplication of certified seed with a purity of 99.8%.
- Organic farming: A ~0.1 level for organic fields is deemed achievable, as long as organic seed has a very high degree of purity and a separation distance of 200 m to fields with GM maize is introduced.

Need for further knowledge

- Existing knowledge on the levels of adventitious presence is largely based on smaller model experiments and on simulated computer models. An evaluation of the actual adventitious presence levels under field conditions is needed.

**Beet** (table 2.3)

Reproduction: cross-pollination mainly by wind.

Size of area, conventional (2001): *c.* 13,000 ha fodder beet and *c.* 56,000 ha sugar beet.
Size of area, organic (2002): 69 ha fodder beet and 157 ha sugar beet.

Most important sources of transmission: The largest risk is from GM adventitious presence in imported seed. Beet can cross with other wild beets, such as sea beet. The seed of all types of beet can persist for long periods in the soil. The occurrence of bolters and weed beet can be a serious source of adventitious presence.

Seed multiplication
- Seed is mainly imported
- There is no Danish organic seed production

Production
*0% scenario*
- In conventional farming, the import of beet seed is expected to result in a GM adventitious presence of <0.3% with no special measures (table 2.3). In organic farming, a threshold of <0.1% is deemed achievable with no special measures in the 0% scenario (table 2.3).

*10% and 50% scenarios*
- The recommendation for all management practices is that volunteers and bolters both within and outside the field are controlled effectively in order to prevent a secondary dispersal of GM material.
- In conventional beet crops an adventitious presence of <0.3% is deemed achievable, primarily through the use of certified seed and through the cleaning of machinery and transport equipment. Increased crop separation distances (50 m) will, to a smaller extent, reduce the level.
- In organic beet crops it is expected that GM adventitious presence can be kept ~0.1%, primarily through the use of GM-free seed, the control of bolters and the cleaning of field machinery and transport equipment, and to a smaller extent through increased crop separation distances (100 m) and cropping intervals (5 years).

Need for further knowledge
- The incidence of annual weed beets in Denmark
- The decline of cross-pollination with distance into the field in seed production
- The effect of field size on the risk of adventitious presence in seed production

**Potato** (table 2.4)

Reproduction: Normally vegetative reproduction, but may have self-pollinating or cross-pollinating flowers.
Size of area (2001): *c.* 38,000 ha, consisting of *c.* 21,000 ha for starch production, *c.* 12,000 ha for human consumption, and *c.* 5000 ha seed potatoes. 962 ha (2.5%) are organic.

Most important sources of transmission: Through adventitious presence in seed potatoes, over-wintering volunteers (groundkeepers), as well as field machinery, and transport equipment. Pollen dispersal over short distances with subsequent seed development is another possibility. The seed would, however, need to develop into plants and over-winter as tubers in the soil in order to mix with a subsequent potato crop.

Seed multiplication

*0% scenario*

- The only source of transmission would be imported seed, which would have to be controlled if they originate from areas where GM potatoes are grown.

*10% and 50% scenarios*

- The production of potato seed in Denmark already has legal constraints on the maximum level of variety impurity allowed of respectively 0 and 0.05%, depending on class. The control is, however, based on external characteristics and not genetic analysis. There are also regulations on separation distance, cropping interval, deployment of machines, etc.
- It is expected that adventitious presence of seed potatoes can be kept at a very low level through controlled use of seed, regulations on distance to GM potatoes, control of ground keepers, and an increased cropping interval for certified seed potatoes. A conversion from GM potato farming would necessitate a conversion period (table 2.4).
- For organic seed potatoes, it is estimated that any adventitious presence can be kept close to zero with the additional measure of using organic seed potatoes in all classifications. Further, the above-mentioned conversion period following a conversion from GM farming should be increased.

Production

*0% scenario*

- The only source of adventitious presence would be foreign seed potatoes, see above section on seed.

*10% and 50% scenarios*

- There is already a stipulation that seeds in Danish potato production have to be replaced regularly, and that farm-saved seed must be for own use only.
- In conventional production, the present regulations regarding the replacement with certified seed, separation distances to GM potatoes, combined with a varied crop rotation, and control of ground keepers, as well as the cleaning of machinery according to good farming practice should keep any adventitious presence at a very low level (table 2.4). A conversion from GM potato farming to conventional farming methods may necessitate a conversion period.
- In organic farming it is expected that with the use of further slightly more rigorous measures will be possible to keep the level of adventitious presence ~ 0.1%, as long as organic seed potatoes with organic origins are used in all preceding classes.

Need for further knowledge

- Pollen dispersal under Danish conditions with subsequent establishment of potato plants
- The extent of over-wintering groundskeepers.

**Barley, wheat, oat and triticale** (table 2.5)

Reproduction: the varieties are primarily self-pollinating, although triticale has some cross-pollination.

Size of area: Barley, wheat, oat and triticale are area wise the most dominant crops in Denmark, covering a total area of about 1.5 million ha of which *c.* 44,000 ha were organic in 2002. Barley and wheat are the most prevalent.

Most important sources of transmission: Through adventitious presence in seed, transmission by volunteers, and through straw and crop handling.

Seed multiplication

*0% scenario*

- No problems are envisaged with respect to meeting the threshold for adventitious presence in seed of 0.3%, or in maintaining the presence in organic seed below the detection limit.

*10 and 50% scenarios*

- It should still be possible to comply with the threshold of 0.5% for adventitious presence in grain seed and to keep the level below the detection limit in organic seed production, provided an effective production system is established that will keep the lots segregated.

Production

*0% scenario*

- The only source of transmission is imported seed.
- No problems are envisaged with keeping the adventitious presence in conventional production below 0.9%. Neither should there be any problems in keeping the presence in organic production below the detection limit.

*10 and 50% scenarios*

- There should be no problems in keeping adventitious presence in conventional production below 0.9%. It should also be possible to keep the adventitious presence in organic production below the detection limit. The maintenance of these levels will require an effective segregation throughout the production system.

Need for further knowledge

- The importance of sources of admixture originating from volunteers, harvesting, transport and storage operations, respectively, is less well documented.

**Rye** (table 2.6)

Reproduction: rye is wind-pollinated, and in Denmark there are no other species with which it can cross-pollinate.

Size of area: (1999-2001) *c.* 60,000 ha, of which 6,000 ha are organic (10%). About 2,500 ha of the area with organic rye are used for rye whole crop. In 2001, the area used for seed production was 678 ha.

Most important sources of transmission: The primary source is through pollen. Rye does not appear as a weed in the crop rotation, and volunteer seed normally persist less than a year under field conditions. Volunteer plants can be easily identified after a crop rotation.

Seed multiplication

- The threshold value for adventitious presence of GM in rye in conventional seed has not been determined, but will probably be 0.3-0.5%.
- A stipulation of 250 m separation distance for conventional rye, 500 m for rye hybrids, and a cropping interval of 2 years is in force. There should be no problem in complying with the threshold value.

Production

- Conventional farming: Threshold value 0.9%. A separation distance of 250 is proposed, which corresponds to that for seed production with a maximum impurity of 0.05%.
- Organic farming. A ~0.1 % threshold for organic fields is deemed achievable provided GMO-free organic seed is ensured, and a separation distance of 250 and 500 m, respectively, to fields cropped with GM-rye is introduced.

*Effect of 0%/10%/50% scenarios*

- An increased production of GM rye will increase the risk of dispersal of GM pollen to conventional and organic fields. Rye production in Denmark is, however, limited, and, consequently, it is expected there will be hardly any difference between the 10% and 50% scenarios in terms of cross-pollination.

**Forage and lawn grasses** (table 2.7)

Reproduction: Grasses are mainly cross-pollinating (wind) with the exception of smooth stalked meadow grass, which is self-fertile.

Size of area: Grass in rotation *c.* 240,000 ha, continuous grassland *c.* 174,000 ha, set aside with grass 202,000 ha and grass seed crops *c.* 80,000 ha. Grasses are also used in recreational areas (golf courses, sports grounds, parks, private gardens, etc.). Of the fully converted organic areas, grasses in rotation accounts for 37,000 ha, continuous grassland *c.* 20,000 ha and grass seed crops *c.* 1000 ha.

Most important sources of transmission: Pollination and seed dispersal, as well as hybridisation with other cultivated grass species and weed grasses.

Seed multiplication

Denmark is the largest producer of grass seed in the EU with more than 40% of the total EU grass seed production. Denmark is also the world's largest exporter of grass seed. As one of only a few countries in the world, Denmark has established an organic grass seed production.

The threshold value for the adventitious presence of GMOs in conventionally produced grass seed has not been determined. The following estimates have been based on an expected threshold of

0.3%. All grass seed production in Denmark is carried out under contracts in accordance with the on field seed. Maximum content of other cultivar/species in certified seed is 0.1% (0.6% for meadow grass). Results from the Plant Directorate seed controls show, however, that some lots do not fulfil these purity criteria (table 6.3). Control of the purity of cultivar is based on external characteristics and not on genetic analysis.

*0% scenario*

- A certified seed production in accordance with the Ministerial Order on field seed is expected to comply with a threshold of <0.3% (table 2.7).

*10 and 50% scenarios*

- With a limited distribution of GM varieties, compliance with a threshold for the adventitious presence of GMO of 0.3% is deemed achievable, as long as further measures are adopted.
- With an extensive distribution of GM varieties, further measures are expected to be necessary in order to comply with a adventitious presence limit of <0.8%. These further measures could, as an example, be the control of seed, the use of buffer zones in the form of isolation of field margins at harvest, increased separation distances, increased lengths of rotation, guidelines on the control of volunteer seed, guidelines on crop sequence, and the control of grass weeds in the rotation.

On the current basis of knowledge, no concrete guidelines can be advanced for the compliance with threshold values between ~0.1 % (organic seed production) and 0.3% at a moderate to extensive distribution of GM varieties. It should, however, be pointed out, that there is considerable expertise in Danish agriculture in the area of certified seed production, and compliance with threshold values in the interval 0-0.3% is therefore not considered impossible. However, this does assume improved knowledge of the biological proliferation (pollen, seed and hybridisation) as well as the elimination of crop handling errors.

<u>Production (grassland)</u>

*0% scenario*

- As there is hardly any of grass seed for agricultural purposes, a threshold level of <0.3% is deemed achievable.

*10 and 50% scenarios*

- With a limited distribution of GM varieties, a threshold level of <0.8% is deemed achievable, provided certified seed are used at field establishment.
- With an extensive distribution of GM varieties, an adventitious presence of GMO of <0.8% is deemed achievable, provided certified seed are used at field establishment. This is, however, conditional on the GM varieties used not having a competitive and survival ability exceeding those of non-GM varieties.

The maintenance of production with a threshold of ~0.1% (e.g. organic production) assumes access to organic or conventional GMO-free (controlled) seed and that any grass stems are either grazed or cut before seed set.

Need for further knowledge

- Improved knowledge of the pollination conditions for grasses (ability to cross-pollinate as well as the degree of self-sterility) would be necessary before any requirements in terms of minimum separation distance and guidelines in the use of buffer zones can be forwarded.
- The development of cultivation systems that ensure cultivar purity in seed production fields would be of great importance in maintaining Denmark's position as the leading exporter of conventional and organic grass seed.

**Grassland legumes** (table 2.8)

Reproduction: White and red clover and alfalfa are insect-pollinated.

Size of area: grass-clover mixture (white clover) in rotation, *c.* 240,000 ha, white clover seed, *c.* 3700 ha, red clover seed, *c.* 400 ha. Of the area that has been fully converted to organic farming, grass-clover mixture accounts for 37,000 ha, grassland legumes (inc. alfalfa) *c.* 6000 ha, white and red clover seed *c.* 500 ha.

Most important sources of transmission: Pollen and seed dispersal and hybridisation with weeds.

Seed multiplication

Denmark is the EU's largest producer of white clover seed (80%), while the red clover seed production is modest. There is no alfalfa seed production in Denmark.

The threshold value for the adventitious presence of GMOs in conventionally produced clover and alfalfa seed has not been determined. The following estimates have been based on an expected threshold of 0.3%. All clover seed production in Denmark is carried out under contracts in accordance with the Ministerial Order on field seed. Maximum content of other cultivar/species in certified seed is 0.1%. Control of purity of cultivar is based on external characteristics and not on genetic analysis.

*0% scenario*

- A certified red and white clover seed production that accords with the Ministerial Order on field seed is expected to comply with a threshold of <0.3% (table 2.8).

*10 and 50% scenarios*:

- With a limited distribution of GM varieties, compliance with a adventitious presence limit of 0.3% is deemed achievable, as long as further measures are adopted.
- With an extensive distribution of GM varieties, further measures are expected to be necessary in order to be able to comply with a adventitious presence limit of <0.8%. Possible measures are the control of seed, the use of buffer zones in the form of bee-attracting plants and/or isolation of field margins at harvest, increased separation distances, increased cropping interval, guidelines on the control of volunteer seed, and guidelines on crop sequencing.

On the current basis of knowledge, no concrete guidelines can be advanced for compliance with threshold values between ~0.1% (organic seed production) and 0.3% at a moderate to extensive distribution of GM varieties. It should, however, be pointed out, that there is considerable expertise in Danish agriculture in the area of certified seed production, and compliance with threshold values

in the interval 0-0.3% is therefore not considered impossible. However, this does assume improved knowledge of the biological proliferation (pollen, seed and hybridisation) as well as the elimination of crop handling errors.

Production (grass-clover fields)

*0% scenario*

- In grass-clover fields (red and white), it is expected that a threshold of <0.3% can be achieved, as the seed used is mainly produced in Denmark. In alfalfa production, the adventitious presence level will depend on the adventitious presence in the seed batch.

*10 and 50% scenarios*

- With a limited distribution of GM varieties, a threshold of <0.8% is deemed achievable, provided certified seed are used at field establishment.
- With an extensive distribution of GM varieties, a threshold of <0.8% is deemed achievable, provided certified seed are used at field establishment. This is, however, conditional on the GM varieties used not having a competitive and survival ability exceeding those of non-GM varieties.

The maintenance of production with a adventitious presence of ~0.1% (organic production) assumes access to organic or conventional GMO-free (controlled) seed. There is at the moment an insufficient production of organic white clover seed and alfalfa, while the supply of organic red clover is sufficient. A minimum distance to fields with GM clover seed production would also be necessary.

Need for further knowledge

- Improved knowledge on the pollination conditions for white and red clover (the ability to cross-pollinate and the degree of self-sterility) will be necessary before requirements in terms of minimum separation distance and guidelines in the use of buffer zones (such as other bee-attracting plants) can be forwarded.
- The development of farming practices that ensure purity of variety in seed production fields would be of great importance in maintaining Denmark's position as the leading producer of white clover seed in the EU for conventional as well as organic productions.

**Field pea** (table 2.9)

Reproduction: Self-pollinating with a small amount of insect pollination. Peas cannot form hybrids with other wild relatives in Denmark.

Size of area, conventional (2001): *c.* 50,000 ha of which 3,588 ha is for human consumption.
Size of area, organic (2002): 7,554 ha.

Most important sources of transmission: There is no particular risk of propagation in the crop rotation as seed of field pea persist for only a short time in the soil.

Seed multiplication

- The use of conventional pea seed to supplement the need for organic seed will involve a small risk of GM adventitious presence.

Production*0% scenario*

- For conventional pea production, the GM adventitious presence is expected to be <0.3% of the crop without further measures (table 2.9). Increased control may reduce this somewhat.certified seed
- For organic pea production the GM adventitious presence is expected to be ~0.1, with the use of organic certified seed, and without further measures.

*10% and 50% scenarios*

- It is expected that the presence in conventional pea crops can be kept below 0.5% primarily through the use of certified seed, and to a smaller extent through the use of increased crop separation distances (10 m), as well as the cleaning of field machinery and transport equipment. It may also be appropriate to supplement with a buffer zone.
- It is expected that the adventitious presence of GMO in organic pea production can be kept ~0.1%, primarily through the use of GM-free seed, and to a smaller extent increased separation distances, and the cleaning of field machinery, and transport vehicles. It may also be appropriate to supplement with a buffer zone.

Need for further knowledge

- The extent of transmission of pollen by insects
- The dispersion into the field in order to determine critical separation distances.

**Broad beans and lupine** (table 2.10)

Reproduction: The species are to varying degrees cross-pollinated by insects.

Size of area: There is only very limited cultivation with these crops in Denmark – about 1000 ha. The crops may have importance as a source of protein in organic farming and could become more important in the future as a replacement for imported soy bean.

Most important sources of transmission: seed and cross-pollination by insects. For some of the varieties there is furthermore a risk of adventitious presence through volunteer plants and the establishment of volunteer populations.

Seed multiplication

*0% scenario*

- It should be possible to keep the adventitious presence of GMO in conventional production below 0.3%. It should also be possible to keep the presence in organic seed below the detection limit.

*10% and 50% scenarios*

- It should be possible to keep the adventitious presence of GMO in seed for conventional non-GM production below 0.3% with the present regulations on separation distance (400 m) in the production of basic seed and cropping interval.
- In order to keep the adventitious presence in seed in an organic production below the detection limit, it is proposed that the seed are produced in areas with no other cultivation of these species.

Production

*0% scenario with imported GM seed*

- It should be possible to keep the threshold level in conventional production below 0.9% with a separation distance of 400 m and a two-year cropping interval.
- It will also be possible to keep the presence in seed in an organic production below the detection limit with control of imported seed, a separation distance of 200 m, a two-year cropping interval, and the exclusive use of certified seed in the production

*10% and 50% scenarios*

- It should be possible to kept the adventitious presence in a conventional non-GM production can be kept below 0.9% with control of imported seed, a separation distance of 400 m and a two-year cropping interval.
- The adventitious presence in organic productions can also be kept below the detection limit with control of imported seed, a separation distance of 400 m, a two-year cropping interval and the exclusive use of organic certified seed in the production.

*Need for further knowledge*

- The extent of other cross-pollination and of cultivar variation is less well documented.
- Further knowledge on the effect of pollen transmission by insects on the pollination and the decline in dispersal with distance into the field may be necessary in order to determine separation distances.

**Vegetable seed production (spinach, carrot, cabbage, radish, etc.)**

Reproduction: Spinach, carrot, cabbage and radish are cross-pollinated (wind and insects).

Size of area: statistics on the areas under vegetable seed production are inadequate. However, Denmark has a prominent position internationally in the production of vegetable seed. Denmark is thus the world's largest producer of spinach seed.

Most important sources of transmission: Pollen and seed transmission and hybridisation with related weed species.

In this report, the individual vegetable species are not considered in detail. It should, however, be emphasized, that if the adventitious presence of GMO is to be restricted, it will be necessary to initiate further measures in seed production. The measures employed may be the control of seed, the use of buffer zones and/or isolation of field margins at harvest, increased minimum distances, increased lengths of rotation, manual weeding in vegetable production fields (e.g. flower stands of carrots), etc.

The variety owners' quality requirements for these crops are already very high and the production of vegetable seed already takes place in accordance with production guidelines that exceed the official requirements in terms of separation distance, cropping interval, etc. isolation

In order to keep an organic vegetable production GMO-free, it is necessary to procure organic seed or conventional GMO-free seed of varieties that meet the production requirements of organic vegetable producers. Seed production in pollen-proof environments (e.g. plastic tunnels) could be a possible method.

**Table 2.1a: Oilseed rape. Fully fertile varieties**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Raps. Fully fertile varieties(line-vareties)** | 0 | Conventional | Seed multiplicat. | 8yr | ∇∇∇ | 200 m | - | | 0-0.3% |
| | | | Production | ∇ | ∇ | ∇ | - | Effective control of volunteers | 0-0.5% |
| | | Organic | Seed multiplicat. | 8 yr | ∇∇∇ | 200 m | - | Effective control of volunteers in and around fields | ~0.1% |
| | | | Production | 8 yr | ∇∇∇ | 200 m | - | Effective control of volunteers in and around fields | ~0.1% |
| | +GM | Conventional | Seed multiplicat. | 8 yr | ∇∇∇ | 200 m | ? | Effective control of volunteer plants<br>Possible buffer zone around non-GM field<br>Cleaning of jointly used machinery | 0-0.3% |
| | | | Production | 8 yr | ∇ | 100 m | ? | Effective control of volunteer plants<br>Possible buffer zone around non-GM field<br>Cleaning of jointly used machinery | 0-0.8% |
| | | Organic | Seed multiplicat. | ? | ? | ? | ? | ? | >0.1% |
| | | | Production | ? | ? | ? | ? | ? | >0.1% |
| Present regulations on seed multiplication (certified seed) | | | | 6/8 yr | | 100 m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold of adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution.

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.1b: Oilseed rape. Hybrid varieties**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Oilseed rape. Hybrid species (fully fertile in production)** | 0 | Conventional | Seed multiplicat. | 8 yr | ∇∇∇ | 500 m | - | | 0-0.3% |
| | | | Production | ∇ | ∇ | ∇ | - | Effective control of volunteers | 0-0.5% |
| | | Organic | Seed multiplicat. | 8 yr | ∇∇∇ | 500 m | - | Effective control of volunteers in and around fields | ~0.1% |
| | | | Production | 8 yr | ∇∇∇ | 200 m | - | Effective control of volunteers in and around fields | ~0.1% |
| | +GM | Conventional | Seed multiplicat. | ? | ∇∇∇ | ? | ? | | ? |
| | | | Production | 8 yr | ∇ | 100 m | ? | Effective control of volunteer plants<br>Possible buffer zone around non-GM field<br>Cleaning of jointly used machinery | 0-0.8% |
| | | Organic | Seed multiplicat. | ? | ? | ? | ? | ? | >0.1% |
| | | | Production | ? | ? | ? | ? | ? | >0.1% |
| Present regulations on seed multiplication (certified seed) | | | | 6/8 yr | | 300 m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed . For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.1c: Oilseed rape. Varietal associations**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Oilseed rape. Varietal associations** | 0 | Conventional | Seed multiplicat. | 8 yr | ∇∇∇ | 500 m | - | | 0-0.3% |
| | | | Production | ∇ | ∇ | 500 m | - | Effective control of volunteers | 0-0.5% |
| | | Organic | Seed multiplicat. | 8 yr | ∇∇∇ | 500 m | - | Effective control of volunteers in and around fields | ~0.1% |
| | | | Production | 8 yr | ∇∇∇ | 200 m | - | Effective control of volunteers in and around fields | ~0.1% |
| | +GM | Conventional | Seed multiplicat. | ? | ? | ? | ? | ? | ? |
| | | | Production | ? | ? | ? | ? | ? | ? |
| | | Organic | Seed multiplicat. | ? | ? | ? | ? | ? | >0.1% |
| | | | Production | ? | ? | ? | ? | ? | >0.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Present regulations on seed multiplication (certified seed) | 6/8 yr | | 300 m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.2: Maize**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Maize** | 0 | Conventional | Seed multiplicat. | - | - | * | - | | 0-0.5% |
| | | | Production | - | ∇∇ | - | - | | 0-0.5% |
| | | Organic | See multiplicat. | - | - | * | - | | ~0.1% |
| | | | Production | - | ∇∇∇ | - | - | Seed from areas without GM crops | ~0.1% |
| | +GM (10%) | Conventional | Seed multiplicat. | - | - | * | - | | 0-0.5% |
| | | | Production | - | ∇∇ | 200 m | - | Cleaning of jointly used machinery | 0-0.7% |
| | | Organic | Seed multiplicat. | - | - | * | - | | ~0.1% |
| | | | Production | - | ∇∇∇ | 200 m | - | Cleaning of jointly used machinery | ~0.1% |
| | +GM (50%) | Conventional | Seed multiplicat. | - | - | * | - | | 0-0.5% |
| | | | Production | - | ∇∇ | 200 m | - | Cleaning of jointly used machinery | 0-0.7% |
| | | Organic | Seed | - | - | * | - | | ~0.1% |
| | | | Production | - | ∇∇∇ | 200 m | - | Cleaning of jointly used machinery | ~0.1% |

* There is no seed multiplication in Denmark

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.5% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.3: Beet**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Fodder beet** | 0 | Conventional | Seed multiplicat. | 4 yr | ∇∇ | (1000 m) | - | | 0-0.3% |
| **Sugar beet** | | | Production | 3 yr | ∇∇ | - | - | | 0-0.3% |
| | | Organic | Seed multiplicat. | 4 yr | ∇∇∇ | (1000 m) | - | | ~0.1% |
| | | | Production | 3 yr | ∇∇ | - | - | | ~0.1% |
| | +GM (10%) | Conventional | Seed multiplicat. | 8 yr | ∇∇ | 2000 m | - | Cleaning of machinery and transport equipment; monitoring | 0-0.3% |
| | | | Production | 3 yr | ∇∇ | 50 m | - | Cleaning of machinery and transport equipment; monitoring | 0-0.4% |
| | | Organic | Seed multiplicat. | 8 yr | ∇∇∇ | 2000 m | - | Cleaning of machinery and transport equipment; monitoring | ~0.1% |
| | | | Production | 5 yr | ∇∇∇ | 100 m | - | Cleaning of machinery and transport equipment; monitoring | ~0.1% |
| | +GM (50%) | Conventional | Seed multiplicat. | 8 yr | ∇∇ | 2000 m | - | Cleaning of machinery and transport equipment; monitoring | 0-0.3% |
| | | | Production | 3 yr | ∇∇ | 50 m | - | Cleaning of machinery and transport equipment; monitoring | 0-0.4% |
| | | Organic | Seed multiplicat. | 8 yr | ∇∇∇ | 2000 m | - | Cleaning of machinery and transport equipment; monitoring | ~0.1% |
| | | | Production | 5 yr | ∇∇∇ | 100 m | - | Cleaning of machinery and transport equipment; monitoring | ~0.1% |
| Present regulations on certified seed | | | | 4/8 yr | | 800 m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.4: Potato**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Potato** | 0 | Conventional | Seed multiplicat. | 3-4 yr | ∇∇ | 15-50 m | - | | 0-0.5% |
| | | | Production | ∇ | ∇ | - | - | | 0-0.5% |
| | | Organic | Seed multiplicat. | 3-4 yr | ∇∇∇ | 15-50 m | - | Seed from areas with no GM production | ~0.1% |
| | | | Production | ∇ | ∇∇∇ | - | - | Seed from areas with no GM production | ~0.1% |
| | +GM | Conventional | Seed multiplicat. | 4 yr | ∇∇ | 20 m | - | Control of volunteers<br>Cleaning of machinery, etc. | 0-0.5% |
| | | | Production | 3 yr | ∇ | 20 m | - | Control of volunteers<br>Cleaning of machinery, etc. | 0-0.7% |
| | | Organic | Seed multiplicat. | 5 yr | ∇∇∇ | 20 m | - | Only organic seed, control of volunteers, Cleaning of jointly used machinery | ~0.1% |
| | | | Production | 4 yr | ∇∇∇ | 20 m | - | Only organic seed, control of volunteers, Cleaning of jointly used machinery | ~0.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Present regulations on certified seed | 3 yr | | 15 m | | Cleaning of jointly used machinery, etc | |

* If the GM species can be documented to have male sterile flowers or not to form flowers, the distance can be reduced to 2 m for production and to the normal separation distance for seed.

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.5% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.5: Barley, wheat, triticale, oat**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Barley,** | 0 | Conventional | Seed multiplicat. | 2 yr | ∇∇ | - T20m | - | | 0-0.5**%** |
| **Wheat,** | | | Production | ∇ | ∇ | - | - | | 0-0.6% |
| **Oat,** | | | | | | | | | |
| **Triticale** | | | Seed multiplicat. | 2 yr | ∇∇∇ | - T20m | - | | ~0.1% |
| | | Organic | Production | ∇ | ∇∇∇ | - | - | | ~0.1% |
| | +GM (10%) | Conventional | Seed multiplicat. | 2 yr | ∇∇ | - T50m | - | Control of volunteers, cleaning of machinery | 0-0.5% |
| | | | Production | 1 yr | ∇ | - T50m | - | Control of volunteers, cleaning of machinery | 0-0.6% |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | - T50m | - | Control of volunteers, cleaning of machinery | ~0.1% |
| | | | Production | 1 yr | ∇∇∇ | - T50m | - | Control of volunteers, cleaning of machinery Only certified seed | ~0.1% |
| | +GM (50%) | Conventional | Seed multiplicat. | 2 yr | ∇∇ | - T50m | - | Control of volunteers, cleaning of machinery | 0-0.5% |
| | | | Production | 1 yr | ∇ | - T50m | - | Control of volunteers, cleaning of machinery | 0-0.6% |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | - T50m | - | Control of volunteers, cleaning of machinery | ~0.1% |
| | | | Production | 1 yr | ∇∇∇ | - T50m | - | Control of volunteers, cleaning of machinery Only certified seed | ~0.1% |
| Present regulations on certified seed | | | | 2 yr | | 0/T20m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seeds can, however, be imported from other countries with a threshold for adventitious presence of 0.5% for conventional seeds. For organic seeds, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seeds.
∇∇∇ — GM-free seed (admixture <0.1%).
T — Triticale

**Table 2.6: Rye**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Rye** | 0 | Conventional | Seed multiplicat. | 2 yr | ∇∇ | 250-500 m | - | | 0-0.5%* |
| | | | Production | - | ∇ | - | - | | 0-0.5%* |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | 250-500 m | - | | ~0.1% |
| | | | Production | - | ∇∇∇ | - | - | | ~0.1% |
| | +GM (10%) | Conventional | Seed multiplicat. | 2 yr | ∇∇ | 250-500 m | - | | 0-0.5% |
| | | | Production | - | ∇ | 250 m | - | Cleaning of jointly used machinery | 0-0.6% |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | 250-500 m | - | | ~0.1% |
| | | | Production | - | ∇∇∇ | 250 m | - | Cleaning of jointly used machinery | ~0.1% |
| | +GM (50%) | Conventional | Seed multiplicat. | 2 yr | ∇∇ | 250-500 m | - | | 0-0.5% |
| | | | Production | - | ∇ | 250 m | - | Cleaning of jointly used machinery | 0-0.6% |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | 250-500m | - | | ~0.1% |
| | | | Production | - | ∇∇∇ | 250 m | - | Cleaning of jointly used machinery | ~0.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Present regulations on certified seed | 2 yr | | 250/500 m * | | | |

* Applies to rye hybrids.

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.5% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.7: Forage and lawn grasses**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Forage and lawn grasses** * | 0 | Conventional | Seed multiplicat. | 3 yr | ∇∇ | 50-100 m | 50-100m | Cutting of verges and other sources of transmission | 0-0.3% |
| | | | Production | - | ∇∇ | - | - | | 0-0.3% |
| | | Organic | Seed multiplicat. | 3 yr | ∇∇∇ | 50-100 m | 50-100m | Cutting of verges and other sources of transmission | ~0.1% |
| | | | Production | - | ∇∇∇ | - | - | | ~0.1% |
| | +GM (10%) | Conventional | Seed multiplicat. | 5 yr | ∇∇ | 200 m | 200m | Cutting of verges and other sources of transmission<br>Control of volunteers | 0-0.3% |
| | | | Production | - | ∇∇ | - | - | | 0-0.8% |
| | | Organic | Seed multiplicat. | 5 yr | ∇∇∇ | ? | ? | Cutting of verges and other sources of transmission<br>Separation at harvest (buffer zone ? m wide)<br>Control of volunteers<br>Cleaning of machinery, drying plant and store | ? |
| | | | Production | - | ∇∇∇ | - | - | Any grass stems are grazed or removed by cutting | ~0.1% |
| | +GM (50%) | Conventional | Seed multiplicat. | ? | ∇∇∇ | ? | ? | Cutting of verges and other sources of transmission<br>Separation at harvest (buffer zone ? m wide)<br>Control of volunteers<br>Cleaning of machinery, drying plant and store | ? |
| | | | Production | - | ∇∇ | - | - | Any grass stems are grazed or removed by cutting | 0-0.8% |
| | | Organic | Seed multiplicat. | ? | ∇∇∇ | ? | ? | Cutting of verges and other sources of transmission<br>Other farming measures such as row cultivation<br>Separation at harvest (buffer zone ? m wide)<br>Control of volunteers<br>Cleaning of machinery, drying plant and store | ? |
| | | | Production | - | ∇∇∇ | - | - | Any grass stems are grazed or removed by cutting | ~0.1% |
| Present regulations on certified seed* | | | | 3 yr | | 50/ 100 m | | | |

* The table has been composed for cross-pollinating forage and lawn grasses. Other regulations regarding separation distance and purity of cultivars apply for meadow grass.

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed. There is however, hardly any import of grass seed for agricultural purposes.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distances — The distance between a GM and the nearest non-GM crop that can cross-pollinate.

| | |
|---|---|
| Cropping interval | Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop. |
| Buffer zone | Field margins that are cultivated and harvested separately. |

The estimated GM admixture covers the production as far as the first stage of distribution

| | |
|---|---|
| - | Not relevant. |
| ∇ | Good farming practice. |
| ∇∇ | Production: at least certified seed used. Seed multiplication: higher class, i.e. pre-basic or basic seed. |
| ∇∇∇ | GM-free seed (admixture <0.1%). |

**Table 2.8: Grassland legumes**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels.**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **White and red clover** | 0 | Conventional | Seed multiplicat. | 3 yr | ∇∇ | 50-100 m | - | | 0-0.3% |
| **White and red clover, alfalfa** | | | Production | - | ∇∇ | - | - | | 0-0.3% |
| **White and red clover** | | Organic | Seed multiplicat. | 3 yr | ∇∇∇ | 50-100 m | - | | ~0.1% |
| **White and red clover, alfalfa** | | | Production | - | ∇∇∇ | - | - | | ~0.1% |
| **White and red clover** | +GM (10%) | Conventional | Seed multiplicat. | 7 yr | ∇∇ | 200 m | - | Procedures for bee pollination<br>Buffer zone (isolation at harvest ? m wide, bee-attracting plants ? m wide - ? species)<br>Control of volunteers after seed production<br>Cleaning of machinery, drying plant, store | 0-0.3% |
| **White and red clover, alfalfa** | | | Production | - | ∇∇ | - | - | | 0-0.8% |
| **White and red clover** | | Organic | Seed multiplicat. | 7 yr | ∇∇∇ | ? | ? | Procedures for bee pollination<br>Buffer zone (isolation at harvest ? m wide, bee-attracting plants ? m wide - ? species)<br>Control of volunteers after seed production<br>Cleaning of machinery, drying plant and store | ? |
| **White and red clover, alfalfa** | | | Production | - | ∇∇∇ | - | – | Any seed-containing white clover flower heads that appear are removed by cutting | ~0.1% |
| **White and red clover** | +GM (50%) | Conventional | Seed multiplicat. | ? | ∇∇∇ | ? | ? | Buffer zone (isolation at harvest ? m wide, bee-attracting plants ? m wide - ? species)<br>Procedures for bee pollination<br>Control of volunteers after seed production<br>Cleaning of machinery, drying plant, store | ? |
| **White and red clover, alfalfa** | | | Production | - | ∇∇ | - | - | | 0-0.8% |
| **White and red clover** | | Organic | Seed multiplicat. | ? | ∇∇∇ | ? | ? | Other farming measures such as row cultivation<br>Buffer zone (isolation at harvest? m wide, bee-attracting plants? m wide -? species)<br>Procedures for bee pollination<br>Control of volunteers after seed production<br>Cleaning of machinery, drying plant, store | ? |
| **White and red clover, alfalfa** | | | Production | - | ∇∇∇ | - | - | Any seed-containing white clover flower heads that appear are removed by cutting | ~0.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Present regulations for certified seed | 3 yr | | 50-100 m | | | |

| | |
|---|---|
| Scenario 0 | No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed. There is, however, only limited import of red and white clover seed, while all alfalfa seed are imported. |
| Scenario +GM | GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm. |
| Separation distance | the distance between a GM and the nearest non-GM crop that can cross-pollinate. |
| Cropping interval | Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop. |
| Buffer zone | Field margins that are cultivated and harvested separately. |

The estimated GM admixture covers the production as far as the first stage of distribution

| | |
|---|---|
| - | Not relevant. |
| ∇ | Good farming practice. |
| ∇∇ | Production: at least certified seed used. Seed production: higher class, i.e. pre-basic or basic seed. |
| ∇∇∇ | GM-free seed (admixture <0.1%). |

**Table 2.9. Field pea**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Field pea** | 0 | Conventional | Seed multiplicat. | 2 yr | ∇∇ | 1 m | - | - | 0-0.3% |
| | | | Production | 2 yr | ∇ | - | - | - | 0-0.3% |
| | | Organic | Seed | 2 yr | ∇∇∇ | 1 m | - | - | ~0.1% |
| | | | Production | 2 yr | ∇∇∇ | - | - | - | ~0.1 % |
| | +GM (10%) | Conventional | Seed multiplicat. | 2 yr | ∇∇ | 50 m | (2-5 m) | Cleaning of machinery and transport equipment | 0-0.3% |
| | | | Production | 2 yr | ∇∇ | 10 m | (2-5 m) | Cleaning of machinery and transport equipment | 0-0.5% |
| | | Organic | Seed | 2 yr | ∇∇∇ | 50 m | (2-5 m) | Cleaning of machinery and transport equipment | ~0.1% |
| | | | Production | 2 yr | ∇∇∇ | 50 m | (2-5 m) | Cleaning of machinery and transport equipment | ~0.1% |
| | +GM (50%) | Conventional | Seed | 2 yr | ∇∇ | 50 m | (2-5 m) | Cleaning of machinery and transport equipment | 0-0.3% |
| | | | Production | 2 yr | ∇∇ | 10 m | (2-5 m) | Cleaning of machinery and transport equipment | 0-0.5% |
| | | Organic | Seed | 2 yr | ∇∇∇ | 50 m | (2-5 m) | Cleaning of machinery and transport equipment | ~0.1% |
| | | | Production | 2 yr | ∇∇∇ | 50 m | (2-5 m) | Cleaning of machinery and transport equipment | ~0.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Present regulations on certified seed | 2 yr | | 1 m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — the distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed production: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).

**Table 2.10. Broad bean and lupine**
**Co-existence between genetically modified (GM), conventional and organic crops in Denmark.**
**Summary of measures for the control of GM admixture and estimated maximum admixture levels**

| Crop | Scenario | | | Cropping interval | Used seed | Separation distance | Buffer zone | Other measures | Estimated GM admixture |
|---|---|---|---|---|---|---|---|---|---|
| **Broad bean,** | | Conventional | Seed multiplicat. | - | ∇∇ | 200/100m | - | - | 0-0.3% |
| **Lupine** | | | Production | - | ∇ | | - | - | 0-0.3% |
| | 0 | | | | | | | - | |
| | | Organic | Seed multiplicat. | - | ∇∇∇ | 200/100m | - | - | ~0.1% |
| | | | Production | - | ∇∇∇ | | - | - | ~0.1 % |
| | | Conventional | Seed multiplicat. | 2 yr | ∇∇ | 400 m | - | Control of volunteers and stray populations | 0-0.3% |
| | | | Production | 2 yr | ∇ | 400 m | - | Control of volunteers and stray populations, cleaning of machinery | 0-0.5% |
| | +GM (10%) | | | | | | | | |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | 400 m | - | Control of volunteers and stray populations | ~0.1% |
| | | | Production | 2 yr | ∇∇∇ | 400 m | - | Control of volunteers and stray populations, cleaning of machinery | ~0.1% |
| | | Conventional | Seed multiplicat.. | 2 yr | ∇∇ | 400 m | - | Control of volunteers and stray populations | 0-0.3% |
| | | | Production | 2 yr | ∇ | 400 m | - | Control of volunteers and stray populations, cleaning of machinery | 0-0.5% |
| | +GM (50%) | | | | | | | | |
| | | Organic | Seed multiplicat. | 2 yr | ∇∇∇ | 400 m | - | Control of volunteers and stray populations | ~0.1% |
| | | | Production | 2 yr | ∇∇∇ | 400 m | - | Control of volunteers and stray populations, cleaning of machinery | ~0.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Broad bean – present regulations on certified seed | 2 yr | | 200 m | | | |
| Lupine – present regulations on certified seed | 2 yr | | 100 m | | | |

Scenario 0 — No GM plants of this crop are grown in Denmark. Seed can, however, be imported from other countries with a threshold for adventitious presence of 0.3% for conventional seed. For organic seed, a corresponding level of less than 0.1% is assumed.

Scenario +GM — GM plants of this crop are grown in Denmark. Both the 10% and 50% scenarios of GM cropping are included. It is assumed that, within a given season, there is no simultaneous cropping of the same GM and non-GM crop on the same farm.

Separation distance — the distance between a GM and the nearest non-GM crop that can cross-pollinate.

Cropping interval — Years with other crops following a GM crop or a GM contaminated crop and until the same conventional GM-free or organic crop can again be grown in the same field. Control of volunteers in the intervening period is assumed. In a conversion to organic farming, this corresponds to the conversion period for that crop.

Buffer zone — Field margins that are cultivated and harvested separately.

The estimated GM admixture covers the production as far as the first stage of distribution

- — Not relevant.
∇ — Good farming practice.
∇∇ — Production: at least certified seed used. Seed production: higher class, i.e. pre-basic or basic seed.
∇∇∇ — GM-free seed (admixture <0.1%).