Project number: 972.565.01
Project title: Potential environmental introduction of unapproved GM crop species in the Netherlands

Project leader: Ms E.J. Kok

Report 2009.007 July 2009

Potential environmental introduction of unapproved GM crop species in the Netherlands

This report is a co-production of RIKILT and Plant Research International

T.W. Prins, C.C.M. van de Wiel[1], G.A. Kleter, O. Dolstra[1] and E.J. Kok

RIKILT - Institute of Food Safety
Wageningen Universiteit and Research Centre
Bornsesteeg 45, P.O. Box 230, 6700 AE
Wageningen, The Netherlands
Tel +31 317 480 256
Fax +31 317 417 717
Internet www.rikilt.wur.nl

[1]**Plant Research International**
Biodiversity and Breeding
Wageningen University and Research Centre
Droevendaalsesteeg 1, P.O. Box 16, 6700 AA
Wageningen, The Netherlands
Tel +31 317 486 001
Fax +31 317 418 094
Internet www.pri.wur.nl

The research described in this report was funded by: Environment Inspectorate North-West, Ministry of Housing, Spatial planning and the Environment.

Steering committee:

- Mr J.B.F.C. van den Assum (LNV-VD: Ministery of Agriculture, Nature and Food Quality, Department of Food Quality and Animal Health)
- Mr D.A. Bleijs (RIVM: National Institute for Public Health and the Environment)
- Ms H. Bresser (VROM: Ministry of Housing, Spatial Planning and the Environment)
- Mr J.H.G. van Dongen (Belastingdienst/Douane Rotterdam)
- Ms B. Glandorf (RIVM: National Institute for Public Health and the Environment)
- Mr E. Laurensse (VWA: Food and Consumer Product Safety Authority)
- Mr J.P.F. Tijssen (VROM-inspectie: Environment Inspectorate North-West, Ministry of Housing, Spatial Planning and the Environment)
- Mr B.A. Uijtewaal (Nunhems B.V.)
- Mr P.J.M. de Wildt (VROM-inspectie: Environment Inspectorate North-West, Ministry of Housing, Spatial Planning and the Eenvironment)
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Executive summary

With the increasing numbers of new genetically modified (GM) (crop) varieties on the world market, the increasing acreage of GM crops and the increasing complexity of food and feed supply chains, the chances of unintended introduction of GM varieties into the Dutch environment also are likely to increase. Such GM varieties, which have not (yet) been approved for cultivation in the EU, may establish in the Dutch environment and, in a worst case, may (significantly) affect it. This fact, in combination with the limited resources of inspection services to monitor all possible commodities and points of entry of (GM) varieties into the Netherlands, has led to the question as to how to prevent the unintended introduction of GM varieties or material admixed with GM varieties into the Dutch environment.

In this report, the possible introduction of unapproved GM crop varieties is discussed in view of their potential to grow in the Dutch and, in second instance, EU environment. The definition of what must be regarded as an illegal (unapproved) GM introduction is based on the contents of Directive 2001/18/EC. For this study, only viable plant material (seed, rootstocks, stolons, rhizomes, bulbs, tuberous plants etc.) has been taken into account.

At this moment (January 2009) 29 crop varieties are approved for introduction in Europe (EU GM-register, 2008). These crop varieties also need to be registered in the European variety list before they can be cultivated. In practice, only maize cultivars having the insect resistance transgenic Bt event MON810 and some GM carnation cultivars are approved for cultivation in Europe. A series of other transgenic events are allowed for import as food or feed only (See Appendix V). For the scope of the report, the focus is on the Netherlands, but as the Netherlands is a major European port of entry for many different kinds of raw materials, attention is also paid to other countries in the EU-27 that could import unapproved GMOs by importation through the Netherlands (See Appendix IV). This applies particularly to the species that do not have the potential for long-term survival in the Netherlands. These species could survive in more Southern parts of Europe where the climate enables growth of plant species that require more light and higher temperatures.

Ecological (dispersal) aspects have been the primary focus to come to a priority listing for inspection services. In second instance, also other aspects have been taken into account, such as level of import, economical considerations and practical aspects of enforcement strategies, like the availability of adequate detection methods and the associated reference materials.

This report thus comprises a shortlist of species that will have the highest likelihood of establishment and/or outcrossing in the Dutch and EU environment. The shortlist includes information with relation to currently known GMOs, although practically all species can nowadays be genetically modified. Based on this shortlist, a combination of import data, exporting countries (including information on their field trials) a priority list was made. This priority list contains species that may require specific attention in the future with regard to possible escape and/or outcrossing into feral or wild populations. The shortlist has to some extent been developed independent of current developments in the area of GMOs, but will nevertheless need to be updated on a regular basis as circumstances may change: the EU might extend with as a consequence, the inclusion of other types of agricultural regions, import flows will change, the climate may change, thus enlarging or diminishing the area where species may

establish, and the development of novel specific GMOs may require an adjustment of the priority list as proposed here. The current priority list includes canola (oilseed rape: *Brassica napus* and bird rape or turnip mustard: *B. rapa*) and alfalfa (*Medicago sativa).* For Southern Europe, this is extended with castor bean.

To enforce EU GMO regulations for the presence of unapproved viable GMOs (in relation to environmental introduction), the Netherlands might want to focus on the species (and/or GMOs) in the priority list. This includes imports for free-trafficking in the EU. However, depending on this containment, also cargo in transit, entrepôt or *in transito*, may need attention since repackaging or processing cannot always be excluded in these situations, which would create possibilities for escape of plant material.

Samenvatting

Met het toenemend aantal nieuwe genetisch gemodificeerde organismen (GGO's) gewassen op de wereldmarkt, het toenemende landbouwareaal van GG gewassen en de toenemende complexiteit in de voedsel- en voedingsketen is het waarschijnlijk dat de kans op onbedoelde introductie van GG gewassen in het Nederlandse milieu ook toeneemt. Sommige GG variëteiten die (nog) niet zijn toegelaten voor teelt in de EU, kunnen zich mogelijk handhaven in het milieu en, in het ergste geval, het milieu schade berokkenen. Dit gegeven, in combinatie met de beperkte middelen van de inspectiedienst om te controleren op alle goederen bij alle punten van binnenkomst van GG variëteiten in Nederland, hebben geleid tot de vraag hoe ongewenste introductie van deze GG gewassen, of insleep van materiaal met GG variëteiten in het Nederlandse milieu toch zo goed mogelijk kan worden voorkomen.

In dit rapport wordt de mogelijke introductie van niet-toegelaten GGO's besproken vanuit het oogpunt van mogelijke groei/verspreiding van deze GGO's in het Nederlandse milieu. De definitie van wat beschouwd moet worden als niet-toegestane GM introductie is gebaseerd op Directive 2001/18/EC. Voor deze studie is alleen levensvatbaar plantmateriaal (zaad, wortelstokken, stolonen, rhizomen, bollen, knollen etc.) meegenomen.

Op dit moment (januari 2009) zijn er een 29 GGO's toegelaten in de EU (EU GM-register, 2008). Daarnaast dienen de GG variëteiten dienen ook geregistreerd te zijn op de Europese rassenlijst voordat ze geteeld mogen worden. Alleen een aantal maïsrassen met een insectenresistentie in de vorm van het transgene Bt event MON810 en enkele GG-anjers zijn toegestaan voor teelt.

Een aantal transgene variëteiten mogen uitsluitend in de EU worden geïmporteerd en worden verwerkt in voedingsmiddelen en diervoeders (appendix V). De focus in dit rapport is op de Nederlandse situatie. Omdat Nederland ook een belangrijk Europees havenland is waar veel grondstoffen voor doorvoer worden geïmporteerd, is er ook aandacht besteed aan de mogelijkheid dat niet-toegelaten GGO's ingevoerd worden in andere EU-lidstaten nadat de grondstoffen in Nederland Europa zijn binnengekomen (appendix IV). Dit betreft dan vooral die plantensoorten die niet langdurig kunnen gedijen in Nederland, maar wel in zuidelijker delen van Europa met een warmer klimaat.

Ecologische (verspreidings)aspecten zijn primair gewogen om tot een voorgestelde prioriteitslijst te komen voor de inspectiediensten. Maar daarnaast zijn ook andere aspecten meegewogen, zoals mate van import van het betreffende gewas, het economische belang van het gewas, en ook praktische aspecten van handhavingsstrategieën, zoals de beschikbaarheid van adequate detectiemethoden en de bijbehorende referentiematerialen.

Dit rapport komt op die manier tot een 'shortlist' van gewassen die de meeste kans hebben op vestiging en/of uitkruising in het Nederlandse, respectievelijk Europese milieu. Deze shortlist bevat informatie ten aanzien van op dit moment bekende GGO's in het betreffende gewas, al dient wel beseft te worden dat van vrijwel alle gewassoorten op dit moment al GG-varianten zijn ontwikkeld. Op basis van deze shortlist in combinatie met importgegevens, kennis ten aanzien van de productie van GGO's in de exporterende landen en beschikbare informatie ten aanzien van veldexperimenten in die landen, is een voorgestelde prioriteitslijst opgesteld. Deze prioriteitslijst bevat soorten die in

aanmerking komen voor specifieke aandacht vanwege de mogelijke verspreiding of uitkruising naar wilde of verwilderde populaties. De shortlist is tot op zekere hoogte onafhankelijk van de huidige ontwikkelingen ten aanzien van GGO's, maar zou te zijner tijd aangepast moeten worden wanneer de omstandigheden veranderen, bijvoorbeeld bij uitbreiding van de EU waardoor andere landbouwtypes en –gronden deel kunnen gaan uitmaken van het EU-grondgebied, of bij veranderde importstromen, en/of een veranderd klimaat in Nederland en/of de EU, waardoor de mogelijkheden voor de verschillende gewassen om zich te vestigen kunnen veranderen. De prioriteitslijst zou moeten worden aangepast wanneer er nieuwe, specifieke GGO's op de wereldmarkt verschijnen, waarmee de huidige lijst nog geen rekening heeft gehouden. De huidige voorgestelde prioriteitslijst omvat canola (koolzaad: *Brassica napus* en raapzaad: *Brassica napa*) en alfalfa (*Medicago sativa*). Voor Zuid-Europa kan hier wonderboom (castor bean: *Ricinus communis*) nog aan worden toegevoegd.

Voor handhaving van Europese GGO-regelgeving op het terrein van de mogelijke aanwezigheid van niet-toegelaten GGO's in het milieu, wordt voorgesteld om met name te letten op de gewassen die zijn opgenomen in de prioriteitslijst. Dit betreft met name het in het vrije-handelsverkeer brengen van deze gewassen. Daarnaast zou echter ook gelet moeten worden op partijen die, in transit, in entrepot of in *transito*, via Nederland worden vervoerd, daar ook het herverpakken en/of verwerken van deze producten in bepaalde gevallen tot onbedoelde introductie van plantmateriaal in het milieu kan leiden.

Contents

1 Introduction

Worldwide, there is an enormous increase in the number and acreage of genetically modified (GM) crops (James, 2008). Figure 1 gives an overview of the acreage in 2008. Also, the number of countries that grow GM crops is increasing. Due to the asynchronous approval of GM crops in different parts of the world, many crops allowed for cultivation in other parts of the world, such as the Americas, are not (yet) approved for cultivation in the European Union (EU). In addition, there are crops that are not allowed on the market anywhere in the world, the majority of which are crops that are grown as part of a research and development procedure (small-scale field tests) that forms the basis for future market crops. With larger regions of a certain GM crop, the chance on commingling or cross-pollination of this GM crop with other crops increases. As a result of these global GMO (GM organism) developments, the possibilities of (un)intended introductions of unapproved GMOs in the European environment increase.

The high volumes of bulk commodities that are imported into the Netherlands pose a challenge to maintaining the regulations on introduction of unapproved GMOs with respect to both the size and number of shipments to be checked and the increasing number of GMOs approved elsewhere but not in the EU. To conduct a more effective screening at potential entry points of GMOs, this first analysis of what species could be prioritised for paying special attention to was performed. Since the main aim was preventing introduction in the field, the focus was on those species that are able to survive and/or outcross with wild populations in the Netherlands. This list of species is combined with a list of countries growing GM varieties of these species to come to a final set of recommendations for adequate monitoring of the potential unintended introduction of GM varieties into the Dutch, and European, environment.

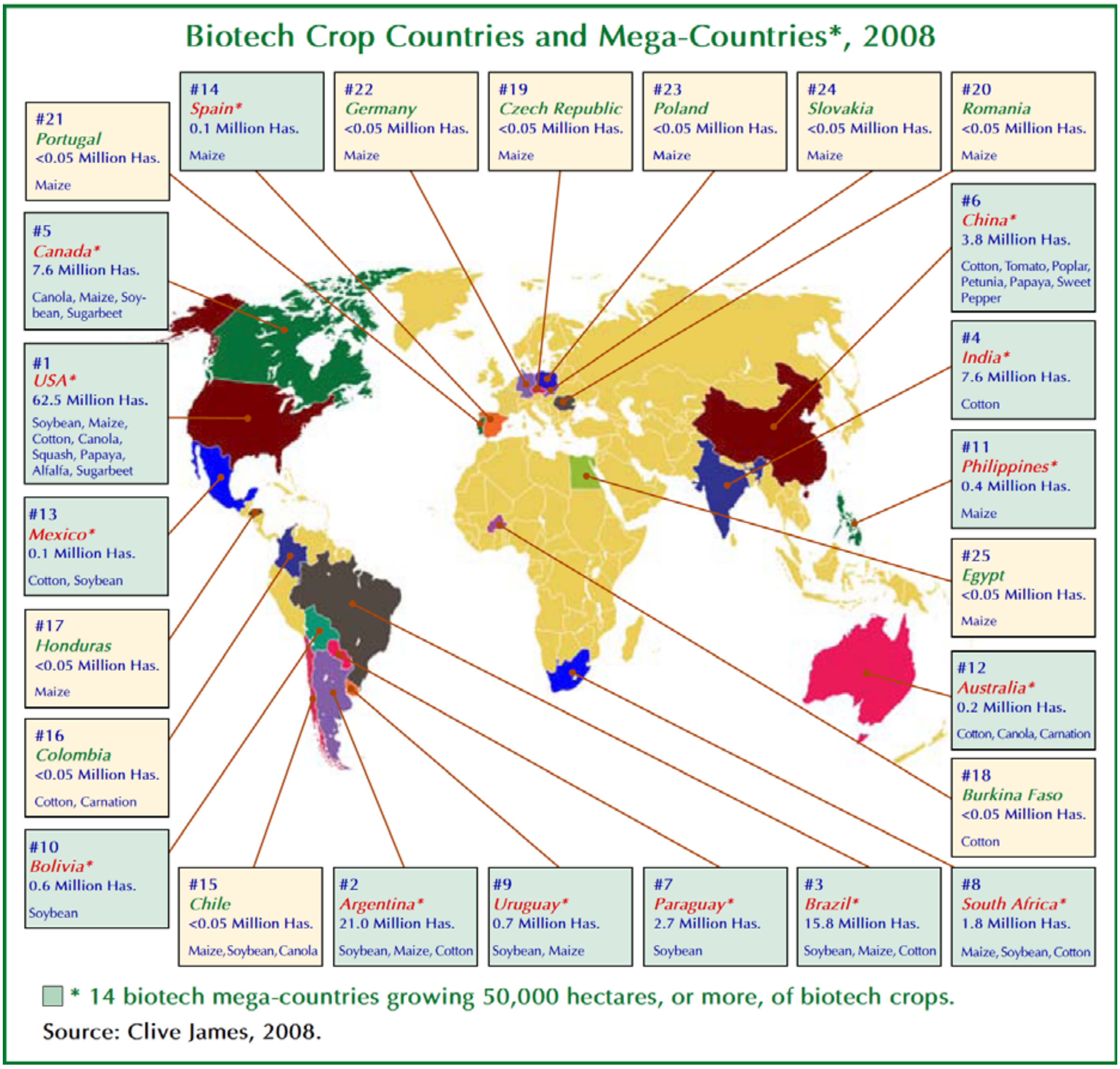

Figure I: Biotech crop countries and mega-countries as of 2008 (Source: James, 2008, vs. 13-02-09).

2 Scope of the investigation

The primary focus of this report is on arable and horticultural crop species. The high abundance and acreage of particularly, arable crop species requires priority attention for the moment. Besides these crop species, also some relevant tree and grass species were included.

The project primarily was focussed on imports that could lead to unapproved introductions of GMOs that could settle in the Dutch environment. In the second stage of the project, this focus was extended to the EU-27 (See Appendix I) as the Netherlands is a major point of entry for raw agricultural materials for the whole of Europe. For pragmatic reasons the EFTA countries Switzerland (CH), Norway (NO) and Iceland (IS) were also taken into account in this study.

Viable plant parts as defined in EU Directive 2001/18/EC (seeds and tubers, roots and other plant parts) can grow and disperse through seeds or vegetatively, or by outcrossing (through pollen) into the environment (cultivation areas and/or natural habitats). The introduction of plant species can occur at different levels:

- Deliberate
  - Legal import through customs
  - Illegal import
- Unintended
  - As accessory of deliberate import (commingling/admixture)
  - Passive import
    - In clothes, shoes, machines, tyres (human traffic)
    - Spreading by water or air

For this study, the primary interest lies with the routes that can be controlled by inspection services. Legal import (including commingled substances) is passed through customs, where control programmes (on behalve of VWA: Food and Consumer Product Safety Authority) are set up for tracking and tracing of GMOs. It should be noted that cultivation is prohibited not only for EU-unapproved GMOs, but also for those that are approved for use as food/feed only. Enforcement of these restrictions of such partially approved varieties is also the responsibility of the environmental (VROM: Ministry of Housing, Spatial Planning and the Environment) and food/feed (VWA) inspection services. It is clear, however, that inspection and control of partially approved GMOs may be more difficult, since they may be imported and can be freely transported throughout the country, and indeed the EU member states, for further processing and/or trade purposes. For this reason, an environmental assessment for accidental spillage has in all cases already formed part of the dossier for market approval, even in those cases where there was no intention, and therefore no permission granted, for growing the crop commercially. At present, in practice the only GM varieties allowed for cultivation in the EU are varieties containing the maize MON810 event and some carnations.

3 Methodology

The investigation was performed in 3 stages:

1. gathering background information.
2. preparing a so called shortlist (See Figure II) on the basis of the likelihood of dispersal and/or outcrossing with wild populations outside of agricultural fields. See chapter(s) 4 and 5.
3. based on this shortlist, preparing a priority list (See Figure II) taking into account actual trade and import data. See chapter 6.

The three subsequent phases of the study will be explained below.

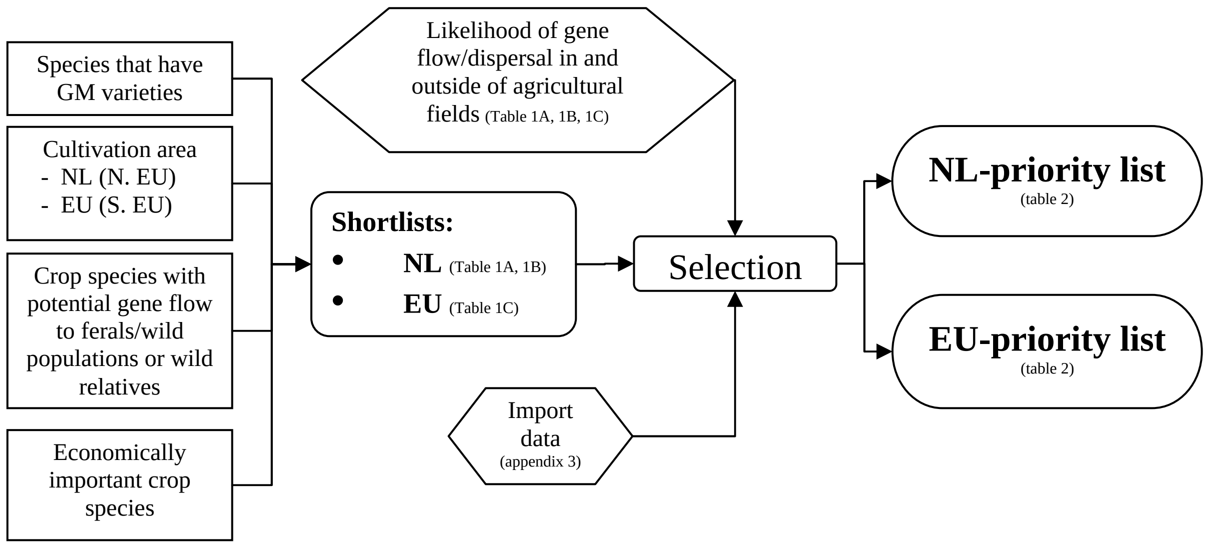

Figure II: Flow chart of parameters used for the compiling of shortlists and priority list. The NL-shortlist is subdivided into Brassica, Grasses and Grains (Table 1A), and other crop species (Table 1B), described both in chapter 4. The EU-shortlist is presented in Table 1C, described in chapter 5. The priority list is summarised in Table 2, chapter 6.

3.1 Aspects considered in the shortlisting process

3.1.1 Gene flow and pollination strategy

Plants have different strategies to enable the spread of pollen in such a way that progeny is guaranteed. These are, among others, cross-pollination (between different plants) and self-pollination (within the same plant) and mixtures of these mechanisms. Outcrossing may be favoured, a.o., by mechanistic ways (flower architecture) or by biochemical systems of self-incompatibility (SI). Another important variation between crop species is in the pollinating agent, wind or by insects. These aspects are listed with the species in Tables 1A, 1B and 1C.

For any possible introduction of unapproved GM plants, the respective pollination strategies each contribute to likelihood of gene flow, although the pollination strategy is not of influence on the initial survival rate of plants established by seed dispersal. With seed dispersal, there is a possibility that a crop species is only capable to germinate and grow in arable fields (so-called volunteers) or that it may also germinate and grow outside of arable fields. In the latter case, plant populations are referred to as ferals. Cross-pollination increases the chances to exchange genetic material with any local compatible wild species. Self-pollination has the advantage of enabling sustained establishment from seeds, without the need of outcrossing with members of the same species that obligatory outcrossing species have. However, one should keep in mind that basically self-pollinating species nearly always show some degree of cross-pollination (cf. Van de wiel, 2007), while obligatory outcrossing species are mostly able to a low degree of selfing, depending on environmental conditions.

3.1.2 Import of vegetable seeds for plant breeding purposes

With regard to imported seed for breeding purposes, there is a discussion in the International Seed Federation (ISF: http://www.worldseed.org) about introducing a self-regulatory system in which companies perform adequate tests on their materials to make sure that no GM-material is imported and used. The breeder also has benefits from this system: a breeding program takes several years and the breeders do not want to take the chance that undesired GM-material is crossed into their material. Furthermore, the reputation of the company is at stake when unapproved GMOs would be found in their seed material. Furthermore, seeds are subject to extra controls: within the EU only approved and certified sowing seed can be made available for EU citizens (farmers). In the Netherlands, the NAK (www.nak.nl) is the official authority monitoring seed quality and releasing certificates for approved seed batches.

3.1.3 Import data for raw materials

The Dutch harbour of Rotterdam (and to a lesser extent, Amsterdam and Delfzijl) is a major port (Fig. III) for the import of agribulk, in particular animal feed and human food, for both the Netherlands and Europe (Fig. IV).

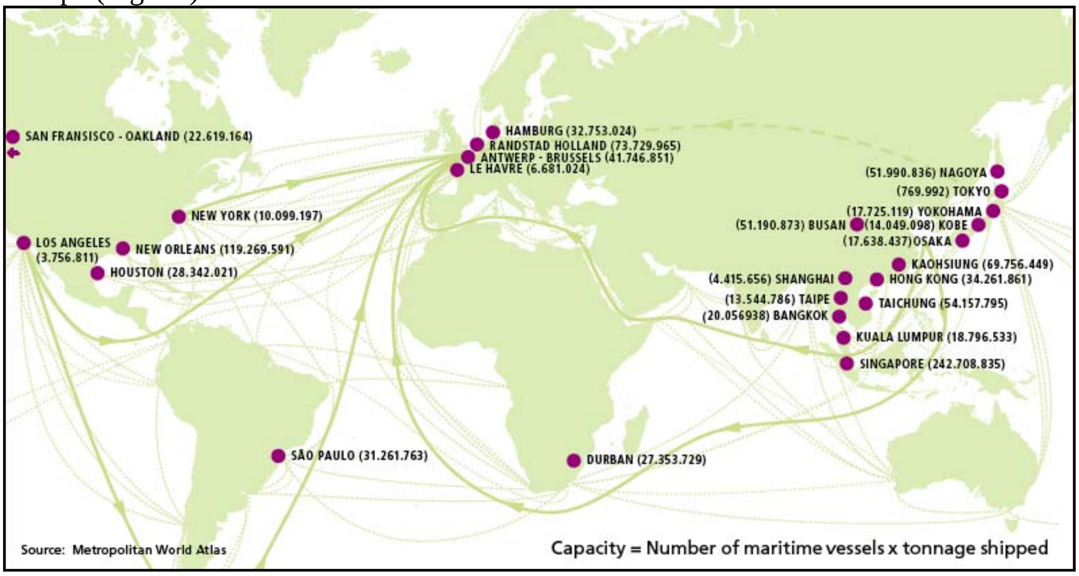

Figure III: Capacity of seaports in terms of annual dry bulk (BvB, 2008-2009).

In 2006, Rotterdam imported among others 8,464,503 tons of oil-containing seeds (including oils and fats that are not considered agribulk), 1,952,137 tons of animal feed, 1,821,348 tons of grains and 210 tons of potatoes (Rotterdam, 2006). The calculated total of agribulk amount to 6,847,000 tons (Rotterdam, 2007). The cargo is either pre-processed (i.e. dried and/or crushed materials) in the harbour and subsequently transported to the company that processes the cargo further or it is trans(ex)ported directly to the hinterland.
In 2006, Rotterdam exported among others 1,726,121 tons of animal feed, 1,264,649 tons of oil-containing seeds (including oils and fats that are not considered agribulk), 932,645 tons of grains and 2,218 tons of potatoes (Rotterdam, 2006). The calculated total of agribulk amount to 2,457,000 tons (Rotterdam, 2007).
Cargo by air plays an important role for the import of (vegetable) seeds and for less voluminous and more expensive cargo. The main airports for freight in the Netherlands are Schiphol and Eindhoven. It is evident that many other ports, airports and roads within the EU are used for importing agricultural products into Europe.

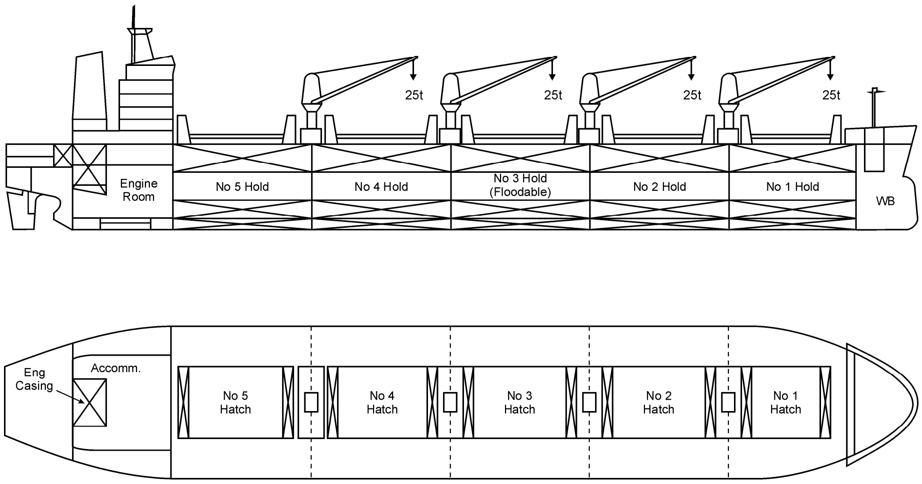

Figure IV: Bulk carrier. Source: Wikimedia.com.

A distinction in the way Customs handles goods depends on the subsequent logistics and the final destination of the goods (J. van Dongen, pers. Comm.). Upon arrival (bringing in; NL=binnenbrengen), goods can:

- be made available for EU citizens (cleared through customs; NL= in vrij verkeer brengen (IVV) or ‘inklaren’)
- follow a transit route in which the goods are followed by Customs.
- be stored elsewhere in NL/EU with possibly minor treatments (NL=entrepôt). After storage, the goods can be cleared through Customs, or be transported to a non-EU destination.
- be transported to a non-EU destination with an official Customs destination (*in transito*; NL= wederuitvoer)

In the Netherlands any handling of GMOs requires a permit. The only exceptions are

- GMOs that have been admitted to the market (like MON810, cultivation, however, needs to be reported to the Ministry of VROM),
- the transport (and storage related to transport) of GMOs if adequately contained by proper packaging.

This implies that attention should also be given to those imports that are not cleared through customs and are destined for transit, entrepôt or *in transito*. Such destinations do not exclude local processing or re-packaging in the Netherlands which could lead to environmental dispersal of GMOs. In those cases only those commodity flows that remain adequately contained in their package are exempted from the requirement of licensing and therefore need not be considered in this study (dr. J.P.F. Tijssen, VROM-Inspection).

For statistical data, EuroStat (EuroStat, 2008) and the Dutch Central Bureau of Statistics (CBS StatLine, 2008) were consulted on statistics of imported volume. The first difficulties arose when the imported products are addressed:

- Some product groups consist of more than one crop species, making it difficult to discriminate between separate import flows.
- Some product groups describe the import flows as combined 'whole', sliced', 'dried' etc. Therefore it is difficult to estimate the amount of viable imported product.
- Imported goods that are crushed or otherwise processed could still contain viable parts. This will have to be assessed on a case-by-case basis for the shortlist plant species and their derived products.
- Some species are not mentioned in the statistics (i.e. trees).
- Import flows may vary between years, both in volume and in the spectrum of countries imported from.

In case of doubt, the worst-case scenario has been taken into consideration in the assessment. For instance, when potatoes are imported as "fresh, chilled, frozen or simply preserved" the product category is considered as fresh and hence viable. Data over 2005-2007 were taken as indicative and the average was used for the assessment. When grains are described as unmilled, they are considered as being able to germinate. For practical reasons, it was assumed that for example maize, wheat or canola seeds imported from Canada, are also viable and can be grown in the Netherlands, or in the EU, although it may concern seeds of varieties bred for cultivation in other parts of the world and therefore less suitable for cultivation in the Netherlands. In the case of bulk categories that are described as processed (broken, milled, husked, pearled, clipped, pellets, sliced, kibbled, flakes etc.) it was assumed for this case-study that there is no viable entity present, although it is known that even these products may contain viable entities.

3.1.4 GMOs on the world market

In addition to the analysis on the basis of import data, an assessment has been made of the GMOs being grown in the exporting countries. For this analysis, several databases and internet sites were consulted to make an inventory of the potential presence of approved and unapproved GMOs.
All relevant categories of agribulk in EuroStat, the European statistics site (http://epp.eurostat.ec.europa.eu) are listed in Appendix II. The Dutch StatLine CBS statistics site was not consulted since this site does not give information on exporting countries.
Using the worst-case scenario, combined categories can identify the amount of agribulk that is imported into the EU. Detailed import information on separate crops is available under the categories mentioned in Appendix III.

3.1.5 GMO traits

Specific traits that have been introduced into varieties through GM may influence the likelihood of establishment and dispersal of such plants in the environment, because specific transgenes may render these plants more competitive/"fit" compared to their non-GM counterparts, in general or under specific circumstances. Thus, not only the dispersal capabilities of a crop species, but also the specific type of GM may be important to the assessment of priorities for monitoring imports.

GMOs having incorporated a gene for herbicide resistance, for example, will only benefit from this trait when specific herbicides are applied in the growing area, which will not be the case in nature areas. Since herbicides could be applied in management systems outside of arable fields, it is noteworthy to mention the specific trait for herbicide resistance. GMOs with other traits, e.g. resulting in male or female sterility, parthenocarpy, and inability to ripen fruit or other features that could reduce the fertility/seed setting, or transgenes in chloroplasts that generally only inherit through the maternal line, would on the other hand show a considerably lower likelihood of gene flow than their non-GM counterparts.

GM traits influencing biotic stress resistance (against pathogenic bacteria, fungi, downy mildews, pest insects etc.) could confer an undesirable selective advantage to a GM crop. However, this depends on whether the disease/pest targeted by the transgene significantly impacts on population fitness outside agricultural fields, and on feedback mechanisms, e.g. resistance development against the transgenic trait in the targeted pest organism. A similar line of reasoning applies to abiotic stress resistance (against drought, salt, low nutrient levels, etc.) in crops. In this case, the transgene may enable a plant to extend the types of habitat in which it can survive, but on the other hand, the expression of resistance against abiotic stresses is often accompanied by fitness costs. For example, investments made in traits conferring e.g. drought resistance may be disadvantageous under normal moisture conditions, particularly when competing with plants not investing in such traits. This can be most strikingly shown by poor growth under normal moisture conditions of plants with a transgenic construct having a promoter directing constitutive expression of a drought resistance gene.
Examples of recent reviews of this subject are Ellstrand (2003), Pilson & Prendeville (2004) and Chandler & Dunwell (2008). Since there is as of yet no conclusive evidence on differences in likelihood of escape between various types of GM varieties, the type of GM as criterion for priority listing was not used.

3.1.6 Other considerations

To some extent other considerations have been taken into account that relate to more socio-economical aspects. These considerations are in part of a more generic nature and can be considered a starting-point of the study as such, e.g. the fact that the Netherlands are a major European point-of-entry and that therefore reduced maintenance of European GMO regulations may result in the detection of unapproved GM varieties elsewhere in Europe. As a result it may be necessary to retrieve (and destruct) shipments that have been transported through the Netherlands to other EU member states, and/or countries outside of Europe. This would indeed affect the high-quality image of the Dutch harbours. Another consideration is the fact that the introduction of unapproved GM varieties in seed materials in the Netherlands may harm the economically important Dutch trade in seeds and seedling materials, and breeding activities by world-wide operating companies.

More practically, the dispersal of e.g. herbicide-resistant species in the (managed) environment could result in higher costs for the (local) authorities for weed control. In general, it can be stated that any shift in biodiversity, although deemed not very likely at this moment on the basis of our findings, may pose additional costs for any restoration found necessary.

Of another nature are the considerations related to the potential for the detection and identification of unapproved GMOs: in practice this will depend on the availability of sequence information and appropriate reference materials. It is important that these data and materials will be shared by countries approving the marketing of GMOs as part of a global consensus approach with relation to GMOs. GMOs that are not approved anywhere in the world and for which no sequence information is available, will remain difficult to detect, and will require large research efforts to identify. New (multi)methods for GMO detection and identification may become available to solve this issue to some extent, but it will take some time before they are validated and commercially available.

3.2 Preparing the shortlists and priority list

For analysis of the possibilities of introduction, a shortlist of crop species has been defined that are able to survive, multiply or outcross in the Dutch environment. Here, a distinction could be made between different types of illegal introduction: potential establishment through seed in the wild (potential establishment by the crop species itself) and outcrossing (pollen-mediated gene flow) with wild species or ferals. Also, combinations of these two phenomena are possible. Outcrossing in itself is not an environmental risk. However, when it comes to unapproved GM varieties, outcrossing is considered to increase the likelihood of gene flow of these into the (ecological) environment.

The shortlists identify all current and possible future GM species that require special attention because of their likelihood of establishment and/or gene flow into the environment. For each of the species, it was analysed whether GM varieties are approved in any part of the world or are known to be currently developed. Also, it was estimated for each species whether it has characteristics that may lead to escape, which in the worst case could lead to invasive growth, potentially affecting ecosystems and reducing biodiversity. A shortlist of candidates able to maintain themselves in the Dutch environment was distilled for which GM varieties are known at this moment.

Next, a distinction was made in cultivation area. For obvious reasons, rice will not be a problem in the Netherlands, while certain areas in the Mediterranean EU countries could be affected by the unintended introduction of GM since there is cultivation accompanied by weedy variants of rice occurring there (cf. Messeguer *et al*., 2004).

On the basis of the above described methodology, limitations and premisses, the results of this study are presented in the subsequent chapters. First the main final outcome will be presented: the NL-shortlist (chapter 4) and a shortlist when extending the scope to survival of GMOs in other (Southern) EU countries (chapter 5). Subsequently, the priority list that was extracted from the shortlists is addressed (chapter 6). The underlying research data and sources are to be found in the appendices to this report.

4 Shortlist of candidate crop species for monitoring in the Netherlands

The shortlists below (Table 1A and 1B) is a compilation of species that are capable to establish and/or outcross in the Dutch (and/or the rest of Europe for that matter) environment. Species that are known to contain transgenes are included although one can presume that in every species, GMOs are potentially present or will be present, either on a laboratory scale, in field tests or in commercial production. For instance, prominent crop species like maize, having GM varieties with a large agribulk import, were included because of the large-scale cultivation in NL/EU, although the likelihood of dispersal outside of agricultural fields is practically non-existent in Northern Europe.

The shortlist in Table 1A more extensively describes dispersal characteristics of individual crop species for three important species groups. The shortlist in Table 1B describes additional crop species in NL that are discussed separately. In both tables, the crop species will be discussed with relation to ecological characteristics (potential establishment in the wild, potential outcrossing to wild species and potential weediness) in the light of the known import data. In the appendix the description is extended to 1) data on GMO varieties, 2) import data and 3) additional comments with relation to economic aspects and aspects of sampling and maintenance of EU GMO regulations, such as e.g. the availability of adequate methods for detection and identification.

4.1 Brassica

Brassica nigra, *B. rapa* and B. *napus* occur on ruderal grounds in NL, while *B. napus* is cultivated for seeds, *B. rapa* as turnips and *B. oleracea* as diverse types of vegetables. The possibility of *B. napus* GM seed escape from importation and transport through harbours has been shown in Japan (Aono *et al*., 2006). *B. oleracea* may occur as occasional escape from cultivation or in a wild form along the coast in NL. *B. juncea* and *B. carinata* are not known to occur in the wild in NL, but *B. carinata* may be used for biofumigation. The genus *Sinapis* is closely related to *Brassica*, with *Sinapis* alba being used as green manure in NL; *S. alba* can occur as volunteer or feral in NL. *Picture: B. napus (Wikipedia)*

Escape may also occur through outcrossing (pollen-mediated gene flow, PMGF): *B. rapa* and *B. oleracea* have self-incompatibility systems, so are highly outcrossing. Their species hybrid, *B. napus*, is self-compatible, but varieties have been shown to outcross for up to 55% in the field. Stacking of HT (herbicide tolerance) genes through outcrossing has been shown to occur in populations of volunteers and ferals of *B. napus* in Canada (Knispel *et al*., 2008). There is also the possibility of hybridisation between species of this group (reviewed e.g. by Eastham & Sweet, 2002; Warwick *et al*., 2003). *B. napus* shows the highest likelihood of hybridisation with *B. rapa*. Because *B. rapa* shows self-incompatibility, hybridisation with *B. napus* can even be favoured in situations where few weedy *B. rapa* grow among *B. napus* cultivations so that the *B. rapa* is confronted by overloads of pollen from *B. napus* and very little compatible pollen from members of its own species. Persistence of *B. napus/rapa* hybrids has been shown in Denmark (Hansen *et al*., 2001) and Canada (Warwick *et al*., *Tabel 1A: Shortlist of candidate-crops for monitoring in NL, discussed by group*

Name	Latin name	Pollination *	GM varieties known	EU-import **	Remarks
Brassica					
Cabbage	*Brassica oleracea*	CP (SI) (insect/wind)			rare, mainly coastal, hybridisation to *B. napus* low. CMS.
Ethiopian mustard	*B. carinata*				North African, EU occasional (not in NL), amphidiploid species hybrid of *B. oleracea* and *B. nigra*, no wild form known
Black mustard	*B. nigra*	CP (SI) (insect/wind)			quite common NL
Indian mustard	*B. juncea*	SP (CP 4-14%) (insect/wind)			Asian, amphidiploid species hybrid of *B. rapa* and *B. nigra*
Yellow mustard	*Sinapis alba*	CP (insect/wind)			green manure, escapes
Oilseed rape (Arg. canola)	*B. napus*	SP (SC), but CP up to 55% (insect/wind)	yes	high	quite common NL, amphidiploid species hybrid of *B. rapa* and *B. oleracea*, can hybridise to *B. rapa*. GMOs with Herbicide resistance.
Rapeseed (Pol. canola)	*B. rapa*	CP (SI) (insect/wind)	yes		quite common NL, can hybridise to *B. napus*. GMOs with herbicide resistance.
Grasses					
Creeping Bentgrass	*Agrostis stolonifera*	CP (wind)	yes		common NL, GF to conspecifics (dispersal also through stolons), hybrids to other native *Agrostis* spp. reported despite proven OC rate low, however, species difficult to distinguish also. GMOs with herbicide resistance.
Meadow fescue	*Festuca pratensis*	CP (wind)			common NL, can hybridise to *Lolium* spp. (x *festulolium*)
Tall fescue	*F. arundinacea* (*L. arundinaceum)*	CP (wind)	yes		common NL, morphologically quite similar to *F. pratensis*
Perennial ryegrass	*Lolium perenne*	CP (wind)	yes		very common NL
Italian ryegrass	*L. multiflorum*	CP (wind)			common NL, hybridisation with perennial ryegrass possible, also hybrids (*L.* x *hybridum*) in cultivation
Kentucky bluegrass	*Poa pratensis*	apomict, CP (0-15%) (wind)			common NL
Westerwolds ryegrass	*L. multiflorum* var. *westerwoldicum*	CP (wind)			annual variant of Italian ryegrass, nowadays little used
Grains/cereals					
Barley	*Hordeum vulgare*	SP	yes		no compatible wild relatives in NL
Buckwheat	*Fagopyrum esculentum*	CP (SI) (insect)			not wild in NL, escapes from birdseed
Crab grass	*Digitaria sanguinalis*	(CP?)			ruderal NL
Witch grass	*Panicum capillare*	CP (wind)			recently introduced into maize fields
Finger millet (vingergierst)	*Eleusine corocana*	SP			not wild in NL except for wild relative *E. indica*
Foxtail millet (trosgierst)	*Setaria italica*	SP (CP <2%)			occasional escapes
Maize	*Zea mays*	CP (wind)	yes	high	no volunteers or occurrence of wild relatives in NL. GMOs with herbicide resistance.
Oat	*Avena sativa*	SP	yes	low	not wild in NL, hybridisation to *Avena fatua* (weed) possible but not established in NL. GMOs with herbicide resistance.
Pearl millet (parelgierst)	*Pennisetum glaucum*	mainly CP (wind)			not wild in NL
Proso millet (pluimgierst)	*Panicum miliaceum*	(SP?)			occasional escapes
Rye	*Secale cereale*	CP (SI) (wind)			no wild relatives in NL
Sorghum (gierst/kafferkoren)	*Sorghum bicolour*	SC (CP up to 50%) (wind)			occasional escapes, outcrossing with weedy *S. halepense* (species hybrid of *S. bicolor* and *S. propinquum*) rare ruderal in NL
Triticale	x*Triticosecale*	SP			Cross of wheat and rye, hybridisation to either parents possible, but less likely for rye than for wheat
Wheat	*Triticum aestivum*	SP	yes		no wild relatives in NL. GMOs with Herbicide resistance.

* *CP=cross-pollination (increased chance on gene flow); SP=self-pollination (low chance on outcrossing); SI=self-incompatible; dioecious= male and female plant; GF = gene flow; cms = cytoplasmic male sterility.*

** *Import is per year on average over 2005-2007.*

2008). Hybridisation to *B. oleracea* or *B. nigra* is less likely, but was recently shown for *B. oleracea* in the UK by Ford *et al.* (2006). *B. napus* may also hybridise with low frequency outside of the genus *Brassica*, with *Raphanus raphanistrum*, and with only an apparently remote chance, with *S. arvensis* or *S. alba*, e.g. the only evidence from several reports on hybridisation with the commonly occurring *S. arvensis* being one plant found in a large scale study during the Farm Scale Evaluations in the UK (Daniels *et al*., 2005).

4.2 Grasses

The grasses mentioned in Table 1 are all common in NL and are strongly outcrossing wind-pollinators. Therefore, likelihoods of gene escape are quite high. For example, outcrossing from a transgenic herbicide-tolerant Agrostis stolonifera field trial in Oregon was found to a distance of up to 21 km (Watrud *et al*., 2004). Transgenic *Agrostis stolonifera* plants were found over the three-year period that occurrence of GM plants was monitored in the study by Zapiola *et al*. (2008). *Agrostis stolonifera* can hybridise with low frequency to NL congeners, *A. capillaris* and *A. gigantea* (Belanger *et al*., 2003; Watrud *et al*., 2004). In addition, Agrostis species can be difficult to distinguish, partly due to occurrence of intermediate forms/putative hybrids. *Lolium perenne* and *L. multiflorum* can also hybridise; the species hybrid *L. x hybridum* is also cultivated. There even occur hybrids between *Lolium* and *Festuca pratensis* (named *x Festulolium*).
Poa pratensis is an exception among these grass species. It mainly is an apomict, that is, produces seeds without fertilisation, which essentially results in vegetative propagation by seeds. However, cross-pollination is still possible and was shown to a level of up to 15% in a field trial by Johnson *et al.* (2006).

4.3 Grains/cereals

Most of the classical cereals grown in NL (*Triticum aestivum, Hordeum vulgare* and *Avena sativa*) are basically self-pollinating. The little cultivated rye (*Secale cereale*) is the sole exception, being strongly outcrossing. An artificial hybrid of rye and wheat, triticale (*x Triticosecale*) is also grown, which can backcross to either parents, but this is less likely for rye than for wheat. None of these cereals is occurring in the wild in NL.

Another grain crop that is extensively grown in NL, but in this case mostly for the production of silage, is maize (*Zea mays*). Maize is strongly outcrossing, but no volunteers occur in Northern Europe and, originating from Middle America, no cross-compatible wild relatives are present either in Europe. In Southern Europe, maize volunteers do occur.
A series of millets can occur occasionally as volunteers from spillage of birdseed (see Table 1A). However, most of them did not establish themselves in NL up till now, except for some rare ruderal species, also occurring in maize fields (several *Panicum species*) and *Sorghum halepense*. In other parts of the world, *Sorghum halepense* did manifest itself as a noxious weed.

Table 1B: Shortlist of candidate-crops for monitoring in NL, discussed separately.

Name	Latin name	Pollination *	GM varieties known	EU-import **	Remarks
Alfalfa (luzerne)	*Medicago sativa*	CP (insect)	yes		grown in NL (6 kHa) and occurring in the wild. GMOs with herbicide resistance.
Apple	*Malus domestica*	CP (SI) (insect)	yes		"ferals" growing locally in NL from spilled cores (e.g. Wadden isles), "wild" relative (*M. sylvestris*) relatively rare
Bean	*Phaseolus vulgaris*	SP (CP 0-5% through insects)			no wild relatives in NL
Caraway	*Carum carvi*	CP (insect)			occurring in the wild in NL
Carrot	*Daucus carota*	CP (insect)			common in NL. Commercial hybrids produced by cms.
Cherry	*Prunus avium*	CP (insect)			wild relative occurring in woods in E. NL
Chicory	*Cichorium intybus*	CP (insect)	yes		wild relative common at roadsides. Commercial hybrids produced by cms. GMOs with herbicide resistance.
Clover, red	*Trifolium pratense*	CP (SI) (insect)	yes		common in NL
Clover, white	*Trifolium repens*	CP (SI) (insect)	yes		common in NL
Flaxseed	*Linum usitatissimum*	SP (CP 1% (0-5%) through insects)	yes		local cultivation (Flevo + S.W. NL), also locally at roadsides in NL. GMOs with herbicide resistance.
Hemp	*Cannabis sativa*	CP (dioecious) (wind)			occasional escapes
Lettuce	*Lactuca sativa*	SP (CP 0-5%) (insect)			compatible wild relative *L. serriola* expanded in recent decades, but as yet no evidence found for gene flow from the crop being involved in that
Lupin	*Lupinus luteus*	SP (CP 0-20%) (insect)			used as green manure in NL, escapes or sown at roadsides
Lupin	*Lupinus angustifolius*	SP (CP 0-2%) (insect)			used as green manure in NL, escapes or sown at roadsides
Pear	*Pyrus communis*	CP (SI) (insect)			escapes not common in NL
Plum	*Prunus domestica*	CP (some SI) (insect)			escapes possible NL, may hybridise to *P. spinosa* and *P. cerasifera*
Poplar	*Populus nigra*	CP (dioecious) (wind)	yes		hybridisation possible to *P.* x *canadensis* (hybrid *P. deltoides* x *P. nigra*)
Oilseed Poppy	*Papaver somniferum* ssp. *Somniferum*	SP (CP 0-3%) (insect)	yes		poppy seed 300 ha S. NL, escapes, naturalised ruderal C. & S. EU
Potato	*Solanum tuberosum*	mainly SP (CP up to 20%) (insect)	yes	high	occurrence of volunteers, but no cross-compatible wild relatives in NL
Radish (Daikon)	*Raphanus sativus* (subgroups *niger, sativus, oleiferus)*	CP (insect)			vegetable or green manure, ruderal occurrence NL
Rose	*Rosa hybrida*	CP (SI) (insect)	yes		several wild species cross-compatible with cultivars EU
Sugar Beet	*Beta vulgaris*	CP (wind)	yes		volunteers, but no ferals occurring in NL, cross-compatible *Beta maritima* growing along coast, mainly S.W. NL, weed beets (crop-wild hybrids inadvertently produced in seed cultivation S. Europe) may act as "bridge" for gene flow to wild beet
Sunflower	*Helianthus annuus*	SP (cvs, wild forms even SI) (insect)	yes		escapes in NL, a.o. along rivers
Tobacco	*Nicotiana tabacum*	SP	yes		no wild occurrence in NL
Tomato	*Solanum lycopersicon*	SP	yes		escapes in NL, a.o. along rivers, but no establishment

* *CP=cross-pollination (increased chance on gene flow); SP=self-pollination (low chance on outcrossing); SI=self-incompatible; dioecious= male and female plant; cms = cytoplasmic male sterility.*

** *Import is per year on average over 2005-2007.*

Picture left: Daikon cress (www.kokswereld.nl); right: Daikon (Wikimedia.org).

4.4 Other crop species

Many of the remaining plant species (Table 1B) are either not occurring in the wild in NL or they are predominantly self-pollinators, so with a lower potential for gene flow, though this is also highly dependent on any advantage conferred by the GM trait in the field. Of particular interest are the crops that have wild counterparts reasonably common in NL and that are strong outbreeders: alfalfa, carrot, chicory and the clovers. Alfalfa is one of the very few examples where a crop was shown to be able to replace natural populations of a wild relative by introgressive hybridisation, in this case *Medicago falcata* populations in Switzerland were replaced by hybrids with the cultivated *M. sativa* (Rufener & Ammann, 1999). Outside of Switzerland e.g. in NL, such replacement was not reported, as far as known. For producing modern hybrid varieties in carrot and chicory, cms (cytoplasmic male sterility) is used. Therefore, pollen-mediated gene flow is less likely in these crop species. In addition, chicory and carrot normally do not reach the flowering stage during cultivation, as is also the case with another strong outbreeder with wide-spreading of pollen by wind, namely sugar beet. A wild relative of sugar beet, sea beet (*Beta maritima*), is occurring only in some coastal areas in NL, but sugar beet has another peculiarity, the existence of so-called weed beets. These are thought to arise from outcrossing of the sugar beet with wild beets in the sowing seed production areas in S. Europe. In this way, they reached the N. European cultivation areas inadvertently with sowing seed lots. In the beet cultivation areas, this has led to a weed problem mostly restricted to arable fields, but the weed beets may act as "bridge" for gene flow (hybridisation) to wild beets. Still, little evidence for introgression of sugar beet into wild sea beets has been found up till now in Europe (cf Andersen *et al*., 2005). There are already regulations in place to check sowing seed for weed beets. Similar phenomena could take place in carrot and chicory, which also have sowing seed production in S. Europe.

There are also tree species with an outcrossing reproductive system on the list. Apple, pollinated by insects, locally shows quite some ferality from thrown away cores, e.g. on Wadden isles. In addition, a "wild" counterpart is occurring in small numbers in woody parts of E and S NL. These might sometimes also show evidence of introgression from modern cultivars, while the proper maintenance of these "wild" populations is regarded as highly important to conservation purposes (Koopman *et al*., 2007). A similar phenomenon is of interest with the wind-pollinated poplar: in NL, wild black poplar growing along river banks has become scarce and also shows hybridisation to the commonly planted *Populus x canadensis*, which is a species hybrid of American *P. deltoides* and *P. nigra* (Smulders *et al*., 2008). Again, this may pose a problem to species conservation. There are also other poplar species of interest because of their use in GM experiments, such as *Populus x canescens*, a species hybrid of *P. alba* and *P. tremula*. *P. tremula* occurs in the wild and is also planted in NL, and *P. alba* is planted with "ferals" being also found, in NL; both of them can backcross to *P. x canescens.*

Several species have GM varieties allowed for cultivation elsewhere in the world, but have a considerably lower likelihood of settlement in NL: flax, tomato and potato. Flax and tomato are self-pollinating species and only locally occur as escapes on ruderal land without surviving during winter. Flax cultivation mainly occurs in the south-western part of the Netherlands. Tomato cultivation is mainly performed in greenhouses. Potato shows outcrossing up till 20%, but has not been found outside of arable fields or shown hybridisation to related wild species in the Netherlands (Van de Wiel and Lotz, 2006).

Finally, there is a species mentioned in the list that already has shown invasive behaviour in N.W. Europe, prickly lettuce (*Lactuca serriola*), a wild relative of crop lettuce. However, there are as yet no indications that hybridisation with lettuce played any role in increased occurrence of wild lettuce, like it was implied for *Sorghum halepense*, a species hybrid of cultivated *S. bicolor* and *S. propinquum* (Ellstrand, 2003; see also above, under cereals). Lettuce is also basically a self-pollinating species.

4.5 GMO approvals in exporting countries

Information on the approval for cultivation of GM crop species worldwide (able to grow in the Netherlands) can be used to predict the chance of GM varieties entering the Netherlands. In Appendix VI, the world-wide approval for cultivation of specific GM-crops is summarised (Agbios, 2008). In the table in Appendix VI, the different countries are listed (AR, AU, BR, CA, IN, JP, MX, PY, PH, ZA, UY and US) with the relevant crop species and GMOs therein. In Annex V the GM-species that are allowed for food/feed in Europe (EU GM-register, 2008) are described. Below, Appendices V and VI are discussed together to assess world-wide releases for GM-cultivation. The main species with known GM varieties relevant for the Netherlands in this regard: maize, canola, alfalfa, flax, potato, sugar beet and tomato are imported from the countries mentioned above. Cross-comparison of the two lists and export data (EuroStat, 2008) reveals the following data:

Maize:
All countries mentioned above allow EU-unapproved (food/feed/cultivation) GM-maize. The conclusion is that all imported maize could contain GMOs that are not allowed for food/feed/cultivation in the EU.

Canola:
B. napus (Argentine canola): In AU, CA, JP and US GM-canola is approved and these countries export canola to the EU. These include GMOs that are not allowed in the EU.
B. rapa (Polish canola): Canada is the only country were HCR-1 and ZSR500/502 are approved for cultivation.
The result is that canola seed from AU, CA, JP and US could contain GMOs that are not allowed for food/feed in the EU.

Flax:
Over the last three years, Canada is the largest exporter of flax seed to the EU. Canada is also the only country allowing production of GM-flax. No GM flax has been cultivated to date (GMO-compass, 2008). The conclusion is that, with respect to the approval, flax seed from CA could contain GMOs that are not allowed for food/feed/cultivation in the EU, but since cultivation is absent, this is not likely.

Alfalfa:
The Netherlands imports rather substantial amounts of alfalfa seed materials, amounting to 117.500 kg in 2008 (J. van Dongen, pers. comm.). CA is the main exporting country. CA, JP and US are allowed to produce GM-alfalfa, although no cultivation is known today (GMO-compass, 2008). In 2006, US produced 80,000 ha. Up to March 2007, GM-alfalfa was sown and this was allowed to be harvested (GMO-compass, 2008). GM-alfalfa is not allowed for food/feed/cultivation in the EU. James (2008) reports a low acreage of alfalfa in the US in 2008.

Potato:
CA and US are the only countries that allow cultivation of GM-potato. Both export to Europe, although the contribution of US is rather low. The result is that potatoes from CA and US could contain GMOs that are not allowed for food/feed/cultivation in the EU, although commercial cultivation of GM potato is not confirmed (James 2008 does not mention any potato cultivation).

Tomato:
JP and MX allow cultivation of GM-tomato FLAVR SAVR that is not allowed in the EU, but they do not export to the EU. US allow cultivation of (many) different GM-tomatoes that are not allowed in the EU, while exporting to the EU. The result is that tomatoes from US could contain GMOs that are not allowed for food/feed/cultivation in the EU, although commercial cultivation of GM tomato is not confirmed. James (2008) reports cultivation of tomato in CN.

Sugar beet:
CA allows cultivation of GM-sugar beet that is not allowed in EU, but they do not export to the EU. JP and US allow cultivation of GM-sugar beet (seed) that is not allowed in the EU while exporting to the EU. The result is that sugar beet seed from JP and US could contain GMOs that are not allowed for food/feed/cultivation in the EU. James (2008) reports cultivation of sugar beet only in the US and CA.

Poplar:
James (2008) reported GM poplars being grown in CN as of 2008, but allegedly, GM poplar had already been introduced in the past in CN. No data is available on tree imports.

Unless mentioned otherwise, the statistical data on import into the EU are derived from EuroStat (http://epp.eurostat.ec.europa.eu: EuroStat, 2008) and are the average over 2005, 2006 and 2007. GMO data were derived from Agbios (http://Agbios.com: Agbios, 2008), RIKILT database (http://www.rikilt.wur.nl/UK/services/GMO+database/: RIKILT, 2008) and GMO-compass (http://GMO-compass.org: GMO-compass, 2008).

5 Shortlist of candidate crop species for monitoring with respect to Southern Europe

Below, the shortlist of crops that could manifest themselves in the environment when introduced in the EU-27 is described (Table 1C). The shortlist that was discussed for the Netherlands (Table 1A and 1B) is also valid for most EU-countries, but the shortlist below is specifically more valid for the more Southern countries within the EU.

Table 1C: Shortlist of candidate-crops in specific parts of the EU.

Name	Latin name	Pollination *	GM varieties known	EU-import **	Remarks
Aubergine	*Solanum melongena*	SP (CP 1-7% , occasionally up to 29% , or even 47% in OPV through insects)	Yes		native to S. Asia, weedy forms up to N. Africa
Banana	*Musa*	Parthenocarpy	Yes	high	no seeds in commercial banana fruit, no wild occurrence EU. GMOs with herbicide resistance.
Castor bean	*Ricinus communis*	CP (monoecious) (wind/insect)	Yes		common ruderal in Mediterranean
Chick peas	*Cicer arietinum*	SP	Yes		from Asia, wild form unknown, escapes EU
Cotton	*Gossypium hirsutum*	SC (CP 10-50%) (insect)	Yes	high	tropical origin, grown and locally naturalised ruderal S. EU. GMOs with herbicide resistance.
Grape vine	*Vitis vinifera*	CP (wind/insect)	Yes		naturalised in C. & S. EU
Melon	*Cucumis melo*	CP (insect)	Yes		native Asia/Africa, grown S. EU
Olive	*Olea europaea*	CP (SI) (wind)	Yes		planted and both "ferals" and wild relative in Mediterranean
Pea	*Pisum sativum*	SP (CP 0-2%) (insect)	Yes		widely cultivated, naturalised ruderal Mediterranean/S.E. EU
Pepper	*Capsicum annuum*	SP (CP 2-9, up to 26 or even 42% in OPV through insects, also, protogyny occurring)	Yes		grown and sometimes escapes S. EU
Rice	*Oryza sativa*	SP (CP 0-5%) (wind)	yes	high	weedy cross-compatible red rice occurring in rice cultivation S. EU. GMOs with herbicide resistance.
Safflower	*Carthamus tinctorius*	SP (CP mostly <10, but 5-45(100) %)	yes		native Asia, small cultivation and sometimes escapes S. EU
Soya bean	*Glycine max*	SP (CP 0-5%)	yes	high	grown, but no wild relative in S. EU. GMOs with herbicide resistance.
Water melon	*Citrullus lanatus*	CP (monoecious) (insect)	yes		native S. Africa, grown and escapes Mediterranean
Zucchini (courgette)	*Cucurbita pepo*	CP (insect)	yes		native America, grown and escapes EU

** CP=cross-pollination (increased chance on outcrossing); SP=self-pollination (low chance on outcrossing); SI=self-incompatible; dioecious= male and female plant; OPV=open pollinated varieties.*

*** Import is per year on average over 2005-2007.*

From left to right: Citrullus lanatus (watermelon); Cucumis melo (sugar melon); Cucurbita pepo (courgette); Solanum melongena (aubergine).

5.1 GMO approvals in exporting countries

Information on the approval for cultivation of GM crop species worldwide can also be used to anticipate the possibility of GMOs entering Europe that are able to grow in the more southern parts of Europe. The main species with known GM varieties that are relevant for Europe are cotton, soya, rice and chicory, papaya, plum, squash and tobacco. Cross-comparison with the two lists (AgBios, 2008; EU GM-register, 2008), compared with export data (EuroStat, 2008) reveals the following:

Cotton:
Of the countries that allow GM-cultivation, BR and BF export to the EU, but their GM varieties are allowed for food/feed and other uses (clothing) in the EU. James (2008) reported that the cotton in BF is for seed multiplication and initial commercialization. AR and CO allow GM-cultivation that is allowed for food/feed in the EU, but do not export to the EU. JP and MX allow GM-cultivation that is not allowed in the EU, but they do not export to the EU. AU, ZA, IN and US allow GM-cultivation that is not allowed in the EU, while exporting to the EU. As a result, cotton seed from AU, ZA, IN and the US could contain GMOs that are not allowed for food/feed in the EU. None of the GM-cotton produced by these countries is allowed for cultivation in the EU.

Soya:
Of the countries that allow GM-cultivation, AR, BR, PY, UY and IN export soya to the EU, but these are allowed for food/feed in the EU. MX and ZA allow GM-cultivation that is allowed for food/feed in the EU, but do not export to the EU. CA, JP and US allow GM-cultivation that is not allowed in the EU, while exporting to the EU. As a result, soya from CA, JP and US could contain GMOs that are not allowed for food/feed in the EU. None of the GM-soya produced by these countries is allowed for cultivation in the EU.

Rice:
The US are the only country allowing cultivation of GM-rice in the world. Over the last three years they are also the largest exporter to the EU. Since GM-rice is not allowed in the EU, rice from US could contain GM-rice that is not allowed for food, feed and cultivation in the EU. With the recent findings of the unapproved Bt63 (EC decision, 2008) from China and LLRice601 (EC decision, 2006) from the USA these countries should be kept in mind for checks on unintended import of unapproved GM-rice.

Papaya, plum, squash, tobacco, eggplant (brinjal), sweet pepper:
The US are the country allowing cultivation of GM papaya, -plum, -squash and -tobacco. Since these GMOs are not allowed in the EU, when importing these species from the US, these could contain GMOs that are not allowed for food, feed and cultivation in the EU. James (2008) reported cultivation of squash (US) and papaya (US and CN). Bt eggplant is at present under consideration for commercial release in India (Choudhary & Gaur, 2009). Sweet pepper GM cultivation was reported for CN by James (2008).

The remaining crops that are known to have GM varieties on the world market or that are currently in development or in field trials are not described in detail because these crops are not likely to establish themselves in Europe. The main reason is the lack of optimal environment and climate to flourish. In Appendix III.3, a table with these crops is included.

6 Candidate crop species for priority in monitoring in the Netherlands and (specific parts of) Europe

To make a first step in the analysis of the current situation, shortlists were compiled containing crops that could survive and disperse in the Netherlands (Northern Europe: Tables 1A and 1B) or Southern Europe (Table 1C). From these shortlists, species were identified that have been genetically modified, including species like cotton, maize, soya, canola, alfalfa, flax, potato, tomato, sugar beet, chicory, papaya, plum, squash and rice.

With regard to possible dispersal and/or gene flow in the Netherlands, the currently marketed GM varieties in canola (*Brassica napus* and *B. rapa*) and GM herbicide-resistant alfalfa (*Medicago sativa*) are potential candidates (Table 2): Canola is imported from Canada, Australia and USA. These countries allow cultivation of GM canola. Alfalfa import (seeds) amounts to 117.500 kg, with Canada as the main exporting country (J. van Dongen, pers. comm.). GM cultivation is allowed in Japan and previously in Canada and USA. In the US, some cultivation was reported for 2008 by James (2008). General points of attention are: within the Brassicaceae family, e.g. radish species (*Raphanus* sp.) (occurrence as ferals and hybridization between certain members of the Brassicaceae is possible); and grasses (widely occurring and strongly outbreeding species such as perennial ryegrass (*Lolium perenne*), fescue species (*Festuca* sp.) and creeping bentgrass (*Agrostis stolonifera*), although GM creeping bentgrass is not allowed for cultivation anymore in any part of the world and import into the EU is therefore less likely). Sugar beet is an upcoming GM herbicide resistant crop in US and CA; it was grown there for the first time in 2008. Sugar beet could outcross to its wild relative sea beet by way of bolters (NL: schieters) and also directly by way of the “intermediate” weed beet, but dispersal changes to wild populations are relatively low: the crop usually does not flower, weed beets are limited to arable fields and sea beets occur only in certain coastal areas of NL. Sorghums and millets are not yet produced as GM varieties on a large scale, but if so, some dispersal/outcrossing could be anticipated, depending on the species. Since apple is occurring as “ferals” as well as “wild” in NL, they could be a point of attention, when GM varieties presently tested would be commercialised. The same would apply to the clovers (*Trifolium* sp.), outbreeders with wild counterparts in NL, and, to a lesser extent, to carrot and chicory, since in normal cultivation, they do not flower, and modern hybrids are based on male sterility. Poplar trees are described as GM with commercial growth and trade in China.

For Southern Europe (Table 2), the list can be extended with castor bean. Minor amounts of castor are imported from India where GM field tests are described.

Table 2: Proposed priority list for the Netherlands and additional crop species for Southern Europe. Specific: high likelihood of dispersal and unapproved GM varieties cultivated in exporting countries. General: a certain likelihood of dispersal, but unapproved varieties not yet prominently in cultivation.

	The Netherlands (and Europe)	additional for Southern Europe
Specific	Canola (*Brassica napus* and *B. rapa*)	Castor bean
	Alfalfa	
General	Apple	
	Brassica family, e.g. *Raphanus*	
	Carrot	
	Chicory	
	Clovers (*Trifolium* sp.)	
	Grasses (*Lolium*, *Festuca* and *Agrostis* sp.)	
	Poplar	
	Sorghums and Millets	
	Sugar beet	

7 Conclusions and recommendations

The widespread growth of GMOs in the world, whether in field-tests or for commercial purposes, could possibly lead to an unauthorised introduction in the Netherlands or other parts of Europe. Here, unauthorised introduction is interpreted as the gene flow of all GMOs except maize MON810-cultivars and some GM carnations (at present the only GMOs allowed for cultivation in the EU) in cultivation areas and outside of arable fields. With regard to possible dispersal and/or gene flow, it can be concluded that for the Netherlands (Table 2), the currently marketed GM varieties in canola (*Brassica napus* and *B. rapa*) and alfalfa are potential candidates for escape and therefore monitoring of these species is advocated. General points of attention are the Brassica's and allies, grasses and sugar beet. The latter is an upcoming GM crop in the US and Canada. Both countries are important trading partners of the Netherlands and other EU-countries. Sorghums and millets, apple, clovers, poplar, carrot and chicory could be monitored to a lesser extent. For Southern Europe the list can be extended with castor bean.

It should be noted in this respect that a number of countries do not supply detailed information on the issue of GMO field trials or cultivation of commercial GMOs. As a result, it is prudent to monitor to some extent all species of the shortlists in chapters 4+5. Moreover, it is clear that due to the worldwide GMO developments, the shortlists as well as the priority list should be updated on a regular basis, especially with respect to GMOs developed elsewhere that may have specific characteristics that could render them (more) competitive and thus capable of establishment in the Dutch, and/or European, environment.

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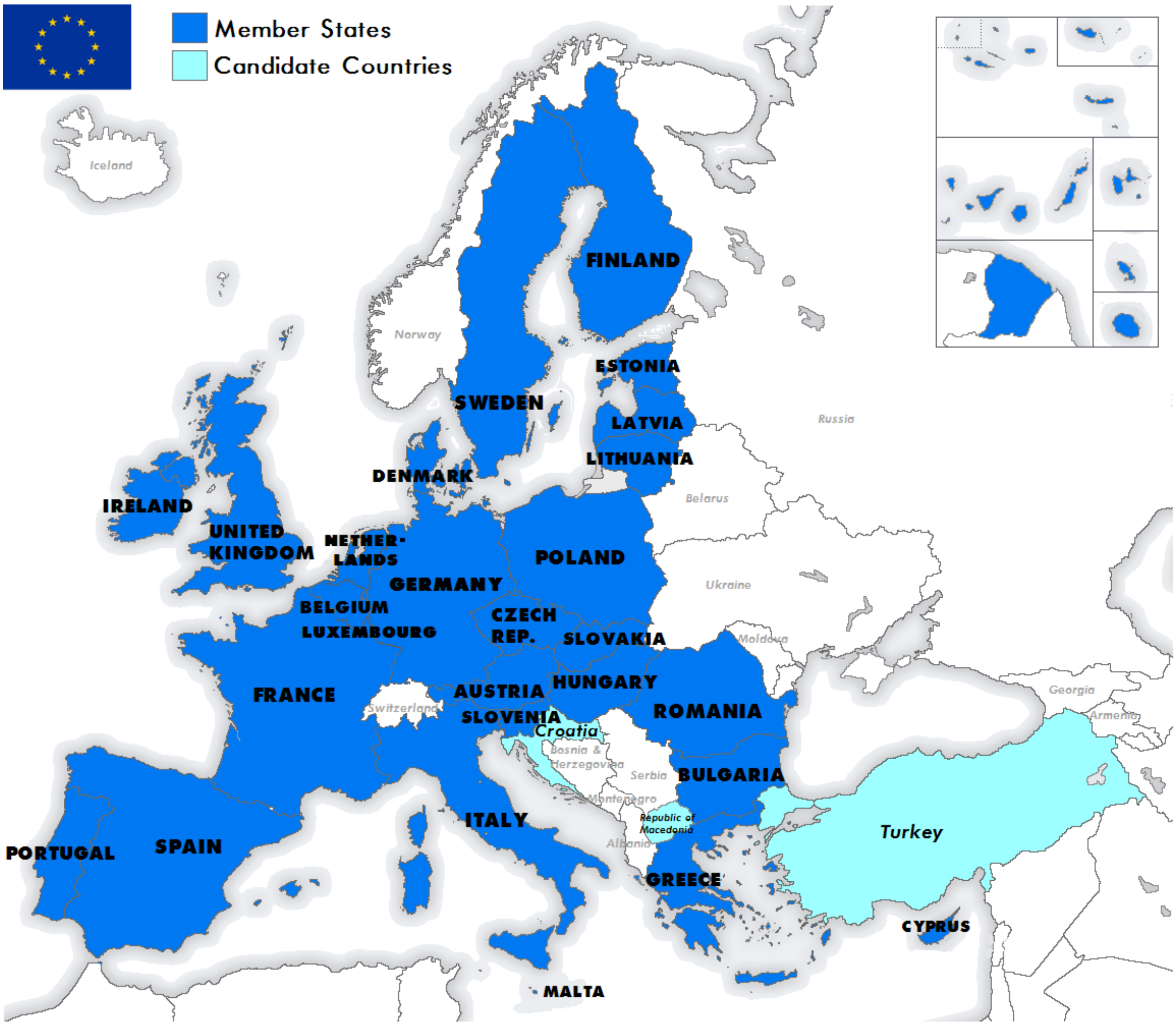
Annex I Countries that are part of EU-27 as of January 2008

Austria	AT	Luxemburg	LU
Belgium	BE	Malta	MT
Bulgaria	BG	The Netherlands	NL
Cyprus	CY	Poland	PO
Czech Republic	CZ	Portugal	PT
Denmark	DK	Romania	RO
Estonia	EE	Slovakia	SK
Finland	FI	Slovenia	SI
France	FR	Spain	ES
Germany	DE	Sweden	SE
Greece	GR	United Kingdom	UK
Hungary	HU		
Ireland	IE	EFTA, but not part of EU-27:	
Italy	IT	Switzerland	CH
Latvia	LV	Iceland	IS
Lithuania	LT	Norway	NO



Source: www.wikimedia.org

Annex II Categories in EuroStat for Agribulk

- Wheat (including spelt) and meslin, unmilled
- Durum wheat unmilled
- Other wheat (including spelt) and Meslin, unmilled
- Rice in the husk (Paddy or rough rice)
- Barley unmilled
- Maize (not including sweet corn) unmilled
- Cereals, unmilled (other than wheat, rice, barley and maize)
- Rye unmilled
- Oats unmilled
- Grain sorghum unmilled
- Millet unmilled
- Buckwheat unmilled
- Canary seed unmilled
- Cereals unmilled (NES)
- Vegetables, fresh, chilled, frozen or simply preserved (incl. dried leguminous vegetables), roots, tubers and other edible vegetable products NES fresh or dried
- Potatoes fresh or chilled (not including sweet potatoes)
- Peas
- Chick-peas
- Beans, other than broad beans and horse beans
- Tomatoes fresh or chilled
- Lettuce and chicory (including endive), fresh or chilled
- Carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, fresh or chilled
- Arrowroot, salep, Artichokes, sweet potatoes and similar roots and tubers (other than manioc) with high starch or inulin content, whether or not sliced or in the form of pellets; sago pits.
- Vegetables, roots and tubers, prepared or preserved NES
- Bananas (including plantains), fresh or dried
- Melons (including water melons) and papaws (papayas), fresh
- Avocados, guavas, mangoes and mangosteens, fresh or dried
- Fruits of the genus capsicum or of the genus pimenta, dried or crushed or ground
- Seeds of anise, badian (star anise), fennel, coriander, cumin or caraway; juniper berries
- Soya beans
- Sunflower seeds
- Rape or colza seeds whether or not broken
- Cotton seeds
- Mustard seeds
- Linseed
- Castor oil seeds
- Sugar beet seeds
- Seeds of forage plants (other than beet seeds)
- Other vegetable seeds
- Bulbs, tubers, tuberous roots, corms, crowns and rhizomes, dormant, in growth or in flower; chicory plants and roots (other than roots of subgroup 054.8)
- Apples, fresh
- Pears and quinces
- Cherry, apricot, peach

Source: EuroStat (2008).

Annex III Possible candidates for illegal environmental introduction

The crops will be discussed with relation to
1) data on GMO varieties, 2) import data and 3) additional comments with relation to economic aspects and aspects of sampling and maintenance of EU GMO regulations, such as e.g. the availability of adequate methods for detection and identification.

III.1. Possible candidates for illegal environmental introduction in the Netherlands

Brassica

***Brassica napus*, Canola, rapeseed (koolzaad)**

GMO: An extensive list with known GM Argentine canola is included. Since 1996 GM rapeseed has been grown in Canada. In 2006, GM rapeseed was grown on 4.8 million hectares. The largest area is in Canada (75% of the total area). GM rapeseed is grown to a lesser degree in the US and in certain states in Australia.
Import: 418,611 tons of rapeseed (including seeds of *Brassica campestris* var. *oleifera = B. rapa*) whether or not broken, was imported on average in the last three years. The major exporting countries are Ukraine, Russia, Australia (87,181/418,611 tons), Kazakhstan, Argentina, Uruguay, Canada (3439/418,611 tons), Japan (15/418,611) and US (1/418,611 tons).
Remarks: Event-specific tests are available for RT73, Rf3 and MS8.

***Brassica* and *Sinapis*, mustard (mosterd)**

GMO: No commercial GMOs known. Field trials were performed in USA (*Brassica juncea*), Canada (*Brassica juncea, Brassica carinata*) and India between 2002-2005. Current field tests in AU with Indian mustard (includes Brown and Oriental mustard: *Brassica juncea* L. Czern and Coss.) (2005-current); Canola and Indian Mustard (*Brassica napus* L. and *Brassica juncea* L.) (2007-current). No commercial application of GM mustard is expected immediately.
Import: 66,088 tons of mustard seeds were imported on average over the past 3 years. Major exporting countries are Canada, Ukraine, India and USA.
Remarks: Black mustard (*Brassica nigra*), Brown mustard (*Brassica juncea*: has virtually replaced black mustard), white mustard (*Sinapis alba*), Ethiopian mustard *(Brassica carinata*).
Picture: B. juncea from www.wikimedia.org.

Grasses

***Agrostis stolonifera*, creeping bentgrass (fioringras)**

GMO: ASR368 is not allowed for cultivation anymore, but since this is a perennial plant, it is expected that there still is residual presence in the field.
Import: Unknown.
Remarks: The sole use of bentgrass is for golf greens.
Picture: www.scheldeschorren.be

Field tests in AU with Perennial ryegrass and tall fescue (*Lolium perenne*) L. and (*Lolium arundinaceum*) (Schreb.) Darbysh (July 2008-current).

Grains/cereals

***Zea mays*, maize (mais)**

GMO: In the appendix an extensive list with known GM maize is included. Major GM-growing countries are AR, BR, CA, JP, PH, ZA, UY and US.
Import: 4,980,929 tons of unmilled seed (not including sweet corn, which has an average import volume of 11,933 tons) was imported on average over the last three years. Major exporting countries are Argentina, Brazil, Paraguay, Ukraine, Turkey, US, Uruguay and Chile. Since maize is not a likely candidate for introduction into the environment, no export data from GM-growing countries was calculated. All countries that grow GM-maize also grow GM-maize that is not allowed in the EU. James (2008) reports planting of GM-maize in Egypt in 2008, but import flows of unmilled maize from Egypt are still minimal.
Remarks: Event-specific tests are available for NK603, TC1507, MON863, MON810, GA21, MON863, DAS-59122, MIR604 and MON810. Not-validated event-specific tests are available for T25, Bt11 and Bt10.

***Triticum aestivum*, wheat (tarwe)**

GMO: MON71800 is not allowed for cultivation, although US have a positive consultation for food/feed (FDA). Field trials are reported in US, CA, AR, JP, CN, AU and CH (1994-2008).
Import: wheat (including spelt and meslin, unmilled) is imported in a volume of 6,174,402 tons on average over the last three years. Major exporting countries are US, Canada, Russia, Ukraine, Brazil, Kazakhstan, Syria, Turley and Mexico.
Imported Agribulk is also categorised in the next categories, although it is not clear if these numbers overlap previous import numbers:
“cereals, unmilled (other than wheat, rice, barley and maize)”. This represents a volume of 1,371,120 tons on average over the last three years. Exporting countries are USA, Argentina, Brazil, Sudan, Russia, Canada, China, Ukraine, Bolivia and Egypt.
“other wheat (including spelt) and meslin, unmilled”, Here, 4,272,175 tons are imported on average over the last 3 years from USA, Russia, Canada, Kazakhstan, Ukraine, Turkey, Argentina, Brazil and Australia.
Remarks: A mixture of wheat and rye that is sown and harvested together is known as meslin.

***Hordeum vulgare*, Barley (gerst)**

GMO: Field tests allowed in Australia (2009-2012), USA (1997-2007) and Canada.
Import: 188,286 tons on average per year over the last three years. Russia, Ukraine and Moldova are the largest exporters.

***Setaria italica*, millet (gierst)**

***Sorghum bicolor*, sorghum, (sorghum)**

GMO: No commercial GMOs known. Field experiments in USA (2002-2008)) and India (sorghum).
Import: 56,575 tons of unmilled millet (not further specified) was imported on average over the last 3 years. Major exporting countries are Russia, China, Ukraine, Argentina, USA, Sudan and Canada.
1,193,776 tons of grain sorghum (unmilled) was imported over the last 3 years on average. Major exporting countries are USA, Argentina, Brazil, Sudan, Ukraine and Egypt.

Remarks: Among the various types of millet, the type known as *Sorghum bicolor or* also simply as “sorghum” is the most significant agriculturally. Foxtail millet (*S. italica*) can outcross to its wild relative S. *viridis* (Shi *et al*., 2008).




Sorghum bicolour (Sorghum); *Setaria italica* (millet); *Setaria viridis* (wild millet); *Fagopyrum esculentum* (buckwheat).

***Fagopyrum esculentum*, buckwheat (boekweit)**
GMO: No commercial GMOs known.
Import: On average 22,223 tons of unmilled buckwheat was imported over the last three years. Major exporting countries are China and Russia.

***Avena sativa,* oats (haver)**
GMO: No commercial GMOs known.
Import: 2,612 tons of unmilled oats on average over the last 3 years. Major exporting countries are Canada, Argentina, China and Australia.

***Secale cereale*, rye (rogge)**
GMO: No commercial GMOs known.
Import: 34,268 tons of unmilled rye was imported on average over the last 3 years. Major exporting countries are Russia, Canada and Ukraine.

Ungrouped species:

***Medicago sativa*, alfalfa/lucerne (Alfalfa/luzerne)**
GMO: J101, J163 (MON-ØØ1Ø1-8, MON-ØØ163-7), J101 x J163, J163 x J101. Field trials in USA, Argentina and Japan. Cultivation allowed in USA, Canada and Japan. In the USA, there was a Court injunction on cultivation in March 2007 wich was upheld by the US Court of Appeals in September 2008. Nevertheless, James (2008) reported cultivation again in 2008.
Import: Import data over 2008 (J. van Dongen, pers. Comm.) show that 117.4 tons of seed was imported. Exporting countries are Canada, and to a lesser extent Pakistan and Australia.

***Phaseolus vulgaris*, bean (boon)**
GMO: No commercial GMOs known.
Import: 469,450 tons of beans (grouped import data: other than broad beans and horse beans) per year on average over the last 3 years. Largest exporting countries Canada, China, Argentina, USA, Ethiopia, Republic of Kyrgyz and Peru.

***Carum carvi*, caraway (karwij)**
GMO: No GM caraway known.
Import: No specified import data are available. Grouped import data (anise, badian [star anise], fennel, coriander, cumin or caraway; juniper berries) 27,538 tons of seeds per year on average over the last 3 years. Largest exporting countries are India, Syria, Turkey, Egypt and China.

***Malus domestica*, apple (appel)**
GMO: No commercial GMOs known. Several field trials in Europe and in the USA.
Import: 901,339 tons of fresh apples on average over the last 3 years. Major exporting countries are Chile, New Zealand, South Africa, Argentina, Brazil, China, Macedonia and USA. In the US, field trials took place between 1991-2008 and commercial exploitation can be expected on the mid-term.
Remarks: Apple is often inoculated on rootstocks. Seeds from apple do not contain the genetic capacity of the rootstock it was inoculated on.

***Daucus carota*, carrot (peen)**
GMO: No commercial GMOs known. Several field trials in the Netherlands (before 2000) and in the USA (before 2002).
Import: No specified import data are available. Grouped import data (carrots, turnips, salad beetroot, salsify (=schorseneren), celeriac, radishes and similar edible roots, fresh or chilled): 49,856 tons per year on average over the last 3 years. Largest exporting countries are Turkey, Israel, Australia, Syria, Morocco, USA and China.

***Prunus avium*, cherry (kers)**
GMO: No commercial GMOs known. Several field trials in Italy and Canada (before 1999)
Import: No import data are available;

***Cichorium intybus*, chicory (cichorei/witlof)**
GMO: RM3-3, RM3-4, RM3-6. Several field trials in Europe and the USA.
Import: 14,861 tons (categorised in a group including bulbs, tubers, tuberous roots, corms, crowns and rhizomes, dormant in growth or in flower; Chicory plants and roots) per year on average over the last 3 years. Largest exporting countries are Brazil, Chile, New Zealand, Taiwan, Israel, China and South Africa.
15,018 tons of “lettuce and chicory (including endive), fresh or chilled” was imported on average over the last three years. Exporting countries are Tunisia, Morocco, Egypt, USA, Chile and Turkey.
Remarks: Radicchio Rosso

***Trifolium pratense*, red clover (rode klaver)**
GMO: No commercial GMOs known.
Import: No specified import data are available.

***Trifolium repens*, white clover (witte klaver)**
GMO: Field evaluation of genetically modified white clover, resistant to infection by Alfalfa Mosaic Virus in Australia (2004-current).
Import: No specified import data are available.

***Linum usitatissimum*, flax, linseed (vlas, lijnzaad)**

GMO: FP967 (CDC-FLØØ1-2). Cultivation allowed in USA and Canada. In Canada, GM flaxseed has been not cultivated to date.
Import: 558,604 tons (seed) per year on average over the last 3 years. Largest exporting countries are Canada (436,444/558,604 tons), USA (63,032/558,604 tons), Russia, Argentina, Ukraine, Kazakhstan, China, Belarus and Norway.
CA and US both produce GM-flax that is not allowed in the EU.

***Cannabis sativa*, hemp (hennep)**
GMO: No commercial GMOs known.
Import: (Illegal) import is currently not monitored.
Remarks: Marihuana used for consumption is widely exported to Europe. For obvious reasons, seeds that are in these shipments are actively used for home-grown production. Fibre hemp is mainly imported without viable seeds.

***Lactuca sativa*, lettuce (sla)**
GMO: No commercial GMOs known. Several field trials in Italy and France (1995-2000) and USA and Japan (1992-2005).
Import: Due to the nature of lettuce, the exporting countries probably lie within Europe. 15,018 tons of “lettuce and chicory (including endive), fresh or chilled” was imported on average over the last three years. Exporting countries are Tunisia, Morocco, Egypt, USA, Chile and Turkey.

***Lupinus angustifolius*, blue lupin (blauwe lupine)**
GMO: No commercial GMOs known.
Import: No import data available.

***Lupinus luteus*, yellow lupin (gele lupine)**
GMO: No commercial GMOs known.
Import: No import data available.

***Pyrus communis*, pear (peer)**
GMO: No commercial GMOs known. Field trials in USA (1999-2001) and Sweden (2004)
Import: 351,635 tons of pear (including quince: *Cydonia oblonga* = kweepeer) on average over the last 3 years. Major exporting countries are Argentina, South Africa, Chile, China, Turkey and US.
Remarks: Pear is often inoculated on rootstocks. Seeds from pear do not contain the genetic capacity of the rootstock it was inoculated on.

***Prunus domestica*, plum (pruim)**
GMO: C5 (US). Field trials in US, CA, AR, NZ, AU and IN (In EU: SP, CZ, RO).
Import: unknown.

***Raphanus sativus* ssp. *sativus, oleiferus* and *niger*, radish, radish, Daikon (radijs, radijs, Daikon)**
GMO: No commercial GMOs known.
Import: No specified import data are available. Grouped import data (carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, fresh or chilled): 49,856 tons per year on average

over the last 3 years. Largest exporting countries are Turkey, Israel, Australia, Syria, Morocco, USA and China.

***Solanum tuberosum*, potato (aardappel)**
GMO: ATBT04-6, ATBT04-27, ATBT04-30, ATBT04-31, ATBT04-36, SPBT02-5, SPBT02-7, BT6, BT10, BT12, BT16, BT17, BT18, BT23, RBMT15-101, SEMT15-02, SEMT15-15, RBMT21-129, RBMT21-350, RBMT22-082 (CA and USA). Field trials in DE, NL, SE, ES, FR, DK, UK, CZ, FI, PT, BE, AU, PL, IR, AR, NZ, CN, IN, ID.
Import: 558,509 tons (fresh or chilled potatoes) per year on average over the last 3 years. Largest exporting countries are Israel, Egypt and Morocco. Minor quantities from Canada (296/558,509 tons) and US (11/558,509 tons).
Remarks: Event-specific test is available for EH92-527-1 (quantitatively, validated).

***Beta vulgaris*, sugar beet (suikerbiet)**
GMO: GTSB77 (US), H7-1 (KM-ØØØ71-4) (CA, JP, US), T120-7 (ACS-BVØØ1-3) (CA, JP, US). Field trials in Canada, US and Japan. The 2008-acreage in US was 257,975 hectares, which is 59% of the total acreage (James, 2008).
Import: 189 tons of seed per year on average over the last 3 years. Largest exporting countries are Russia, Morocco, Chile, New Zealand and Turkey. Minor amounts from US (5/189 tons) and Japan (1/189 tons). No import from Canada. CA and US grow GM-sugar beet that is not allowed in EU. JP only grows EU-allowed GM.
Remarks: Event-specific test is available for H7-1 Event (not validated).

***Helianthus annuus*, sunflower (zonnebloem)**
GMO: No commercial GMOs, but als-mutant X81359 (CA). Field trials in FR, ES, NL (1994-2001) and US, CA, AR (1991-2003)
Import: 492,845 tons of seed per year on average over the last 3 years. Largest exporting countries are Ukraine, China, Russia, Uruguay, USA, Argentina and Israel.

***Nicotiana tabacum*, tobacco (tabak)**
GMO: C/F/93/08-02 (no cultivation), Vector 21-41 (US). Field trials in US, IN and CN.
Import: Import of seeds is not known.

***Solanum lycopersicon*, tomato (tomaat)**
GMO: 1345-4, 35 1 N, 5345, 8338 (CGN-89322-3), B, Da, F (US), FLAVR SAVR (CGN-89564-2) (JP, MX, US). In CN, GM-tomato is known to be permitted.
Import: 391,941 tons (fresh or chilled) per year on average over the last 3 years. Largest exporting countries are Morocco, Turkey, Israel, Macedonia, Syria, Senegal, Jordan, Tunisia, Egypt and US (12/391,941 tons). No export in known from Japan or Mexico where Flavr savr is allowed to grow. US grow many GM-tomatoes that are not allowed in the EU. No import is known from China.

III.2. Possible candidates for illegal environmental introduction in (specific parts of) Europe

***Solanum melongena*, Aubergine [Eggplant, Brinjal] (aubergine)**
GMO: In India, field tests with GM aubergine (BT-brinjal) were reported and commercial release is presently under consideration.
Import: No import data are known. 32,072,972 tons are produced worldwide, of which 469,358 tons in Italy and the UK. Major producing countries are China, India, Egypt and Turkey.

***Musa*, banana (banaan)**
GMO: Field tests in AU on *Musa acuminata* cv. Williams (April 28 2008-current)
Import: 4,398,431 tons per year on average over the last 3 years. Largest exporting countries are Equator, Colombia, Costa Rica, Panama, Cote d'Ivore, Cameroon, Dominican Republic, Belize and Brazil.
Remarks: Cultivated bananas are parthenocarpic, so no seed is present in the fruit.

***Ricinus communis*, Castor (wonderboom)**
GMO: India reports (http://igmoris.nic.in) that GM-castor bean is under development.
Import: 151 tons of castor seeds were imported on average per year over 2005-2006. No data are available over 2007 (or there was no import). The only four exporting countries are India, Pakistan, Chile and Tanzania.

***Cicer arietinum*, Chick peas (kikkererwt)**
GMO: Field tests in US (2006) and IN.
Import: 130,883 tons per year on average over the last 3 years. Largest exporting countries are Mexico, Canada, Turkey, India, USA and Australia.

***Gossypium hirsutum*, cotton (katoen)**
GMO: MON-15985-7 (15985) (AU, BF, IN, SA, US); DD-Ø1951A-7 (19-51A), DAS-24236-5 (281-24-236), DAS-21Ø23-5 (3006-210-23), DAS-21Ø23-5 x DAS-24236-5 (US), 31807/31808, BXN (JP, US); SYN-IR1Ø2-7 (COT102), DAS-21Ø23-5 x DAS-24236-5 x MON-Ø1445-2, DAS-24236-5, DAS-21Ø23-5, MON-88913-8 (DAS-21Ø23-5 x DAS-24236-5 x MON88913) (not approved for cultivation); ACS-GHØØ1-3 (LLCotton25) (AU, US); ACS-GHØØ1-3, MON-15985-7 (LLCotton25 x MON15985) (JP); MON-15985-7 x MON-Ø1445-2 (AU); MON-ØØ531-6 x MON-Ø1445-2, MON-15985-7, MON-88913-8 (MON15985 x MON88913) (AU, SA); MON-Ø1445-2 (MON1445/1698) (AR, AU, JP, SA, US); MON-ØØ531-6, MON-ØØ757-7 (MON531/757/1076) (AR, AU, BR, IN, JP); MON-88913-8 (MON88913) (AU, SA, US). Field tests Argentina, Australia, Japan, China, Burkina Faso, Columbia, Uganda, South Africa (and Spain, Greece and France).
Import: 114,700 tons of seed per year on average over the last 3 years. Largest exporting countries are Cote d'Ivoire, Brazil (14,055/114,700 tons on average over 2005 and 2007), Burkina Faso (13,798/114,700 tons), USA (7488/114,700 tons), Ghana, Mali, Mozambique, Turkey, Australia (643/114,700 tons), India (15/114,700 tons) and South Africa (22/114,700 tons). Of the exporting countries, AR, BR, BF and IN export to EU, but these are allowed for food/feed in the EU. JP and MX produce cotton that is not allowed in the EU, but they do not export to the EU. CO produces cotton that is allowed in the EU but does not export to the EU. AU, ZA and US grow cotton that is not allowed in the EU, while exporting to the EU!
Remarks: Event-specific tests are available for 281-24-236x3006-210-23 Event, MON531 Event, LLCotton25 Event and MON1445 Event (not validated).

***Vitis vinifera*, grape vine (druif)**
GMO: Field tests in US, AU, CA and ZA (1995-current), but no immediate commercial use of GM-grape vines is expected.
Import: unknown.

***Cucumis melo*, melon (meloen)**
***Carica papaya*, papaya (papaya)**
GMO: A, B (melon, US), 55-1 (papaya, US), 63-1 (papaya, US). Papaya field tests in IN.
Import: No detailed import data (grouped in: melons (including water melons) and papaws (papayas), fresh). 535,183 tons per year on average over the last 3 years. Largest exporting countries are Brazil, Costa Rica, Morocco, Panama, Macedonia, Turkey, Russia, Israel and Honduras. Total export from US is 106/535,183 tons.

***Papaver somniferum* ssp. *somniferum*, poppy (papaver)**
GMO: Field trials reported in AU.
Import: unknown

***Olea europaea*, olive (olijf)**
GMO: Field trials have been performed in Italy (1998). In the long run, no commercial utilisation of GM olive trees is expected.
Import: Import of olives is mostly in fermented form, so the olive kernels are not viable anymore.

***Pisum sativum*, Pea (erwt)**
GMO: unknown
Import: 834,197 tons of peas were imported per year on average over the last 3 years. Major exporting countries are Canada, Ukraine, USA, Argentina, Russia and Ethiopia. The physiological state of the peas is not known i.e. viable or not.

***Capsicum annuum*, Hot pepper (hete peper)**
GMO: Field trials in US, IN and CN. In CN, GM-pepper is known to be permitted.
Import: 61,272 tons (fruits of the genus Capsicum or of the genus Pimenta, dried or crushed or ground) per year on average over the last 3 years. Largest exporting countries are Peru, China (11,430/61,272 tons), Brazil, India and Israel.
Remarks: Since 2008, China is also producing GM sweet pepper (James, 2008).

***Oryza sativa*, rice (rijst)**
GMO: ACS-OSØØ1-4, ACS-OSØØ2-5 (LLRICE06, LLRICE62); BCS-OSØØ3-7 (LLRICE601) (US). Iran is also supposedly cultivating unknown GM rice. Unapproved GM rice varieties are Bt63 and LLRice604. Field tests reported in Japan, Argentina, China, India, Brazil, Australia, Mexico, Philippines, Indonesia and other Asian countries.
Import: For rice import, the focus is on paddy rice, which is in the husk and therefore viable. The average import over the last 3 years is 12,204 tons of rice. Major exporting countries are US, Egypt, Bangladesh, Thailand, India, Turkey and China. The rice import of other rice (husked, peeled etc.) is larger in volume.
Remarks: Event-specific tests are available for LLRice62, LLRice601 and Bt63.

***Rosa hybrida*, Rose (roos)**
GMO: Field tests in AU on *Rosa x hybrida* L. (2006-current). In Japan, two GM varieties have been approved (IFD-52901-9 and IFD-52401-4 with modified flavonoid biosynthesis pathway: http://www.bch.biodic.go.jp/english/lmo.html)
Import: Unknown.
Remarks: Rose is often inoculated on rootstocks. Seeds do not contain the genetic capacity of the rootstock it was inoculated on.

***Carthamus tinctorius*, Safflower (saffraan)**
GMO: Between 2002-2008, US, CA and AR conducted field tests, although commercial utilisation of genetically modified safflower cannot be anticipated in the short term.
Import: Unknown.
Remarks: The harvested product (stamina) does not contain any viable parts.

***Glycine max*, Soybean (sojaboon)**
GMO: ACS-GMØØ5-3 (A2704-12, A2704-21, A5547-35), DD-Ø26ØØ5-3 (G94-1, G94-19, G168), MON-89788-1 (MON89788) (CA, JP, US); ACS-GMØØ6-4 (A5547-127) (JP, US); DP-356Ø43-5 (DP356043), ACS-GMØØ3-1 (GU262), ACS-GMØØ1-8, ACS-GMØØ2-9 (W62, W98) (US); MON-Ø4Ø32-6 (GTS 40-3-2) (AR, BR, CA, JP, MX, PY, SA, US, UY).
Import: 14,557,969 tons of seed per year on average over the last 3 years. Largest exporting countries are Brazil (9,320,240/14,557,969 tons), USA (3,208,954/14,557,969 tons), Paraguay (999,684/14,557,969 tons), Canada (620,248/14,557,969 tons), Ukraine, Uruguay (79,655/14,557,969 tons), Argentina (152,513/14,557,969 tons) and China.
Of the exporting countries, AR, BR, MX and PY export to EU, but these are allowed for food/feed in the EU. ZA produce soya that is allowed in the EU, but they do not export to the EU. CA, JP and US grow soya that is not allowed in the EU, while exporting to the EU.
Remarks: A specific test is available for the RRS construct.

***Citrullus lanatus*, Water melon (watermeloen)**
GMO: Between 2004-2006, US conducted filed trials. No immediate commercial use of GM-water melon is expected.
Import: No detailed import data (grouped in: melons (including water melons) and papaws (papayas), fresh). 535,183 tons per year on average over the last 3 years. Largest exporting countries are Brazil, Costa Rica, Morocco, Panama, Macedonia, Turkey, Russia, Israel and Honduras.

***Cucurbita pepo*, Zucchini (Courgette) or squash (pompoen)**
GMO: US, CA and MX conducted field tests between 1989-2001. In the US 2000 Ha of zucchinis are grown but no export is described to the EU.
Import: No detailed import data are known.

III.3. Crops that are known to be transgenic, but are not likely candidates for illegal environmental introduction in Europe

GMO Crops not relevant for NL/EU	
Andrographis (med.)	*Andrographis paniculata*
Avocado	*Persea americana*
Carnation	*Dianthus caryophyllus*
Cocoa	*Theobroma cacao*
Coconut	*Cocos nucifera*
Coffee	*Coffea*
Ginger	*Zingiber officinale*
Groundnut	*Arachis hypogaea*
Kiwifruit	*Actinidia deliciosa*
Lentil	*Lens culinaris*
Mango	*Mangifera*
Manioc (cassava)	*Manihot esculenta*
Okra	*Abelmoschus esculentus*
Papaya	*Carica papaya*
Pigeon pea	*Cajanus cajan*
Pineapple	*Ananas comosus*
Torenia (ornamental)	*Torenia*

Annex IV GMOs allowed elsewhere in the world

Crop (Trait) Identifier
Alfalfa (Herbicide tol.) J101, J163
Argentine Canola (Glufosinate) HCN10
Argentine Canola (Glufosinate) HCN92
Argentine Canola (Glufosinate) T45 (HCN28)
Argentine Canola (Herbicide tol. + fertility) MS1, RF1 =>PGS1
Argentine Canola (Herbicide tol. + fertility) MS1, RF2 =>PGS2
Argentine Canola (Herbicide tol. + fertility) MS8xRF3
Argentine Canola (Herbicide tol.) GT73, RT73
Argentine Canola (Herbicide tol. + fertility) PHY14, PHY35
Argentine Canola (Herbicide tol. + fertility) PHY36
Argentine Canola (Herbicide tol.) GT200
Argentine Canola (Oil content) 23-18-17, 23-198
Argentine Canola (Oil content) 45A37, 46A40
Argentine Canola (Oil content) 46A12, 46A16
Argentine Canola (Oxynil) OXY-235
Carnation (Delayed ripening) 66
Carnation (Flower colour) 4, 11, 15, 16
Carnation (Flower colour) 959A, 988A, 1226A, 1351A, 1363A, 1400A
Chicory (Herbicide tol. + fertility) RM3-3, RM3-4, RM3-6
Cotton (Glufosinate) LLCotton25
Cotton (Herbicide tol. + insect res.) LLCotton25 x MON15985
Cotton (Herbicide tol.) MON88913
Cotton (Insect res. + herbicide tol.) DAS-21Ø23-5 x DAS-24236-5 x MON88913
Cotton (Insect res. + herbicide tol.) DAS-21Ø23-5 x DAS-24236-5 x MON-Ø1445-2
Cotton (Insect res. + herbicide tol.) MON15985 x MON88913
Cotton (Herbicide tol.) MON1445/1698
Cotton (Insect res. + herbicide tol.) MON-15985-7 x MON-Ø1445-2
Cotton (Insect res. + herbicide tol.) MON-ØØ531-6 x MON-Ø1445-2
Cotton (Insect res.) 15985
Cotton (Insect res.) 281-24-236
Cotton (Insect res.) 3006-210-23
Cotton (Insect res.) COT102
Cotton (Insect res.) DAS-21Ø23-5 x DAS-24236-5
Cotton (Insect res.) MON531/757/1076
Cotton (Lepidopteran pests + oxynil) 31807/31808
Cotton (Oxynil) BXN
Creeping Bentgrass (Herbicide tol.) ASR368
Flax, Linseed (Sulfonylurea) FP967
Maize (Cyclohexanone) DK404SR
Maize (ECB + glyphosate) MON802
Maize (ECB + glyphosate) MON809
Maize (ECB) MON80100
Maize (Glufosinate) B16 (DLL25)
Maize (Herbicide tol. + fertility) 676, 678, 680
Maize (Herbicide tol. + fertility) MS3
Maize (Herbicide tol. + fertility) MS6
Maize (Herbicide tol. + insect res.) 176
Maize (Glufosinate) T14, T25
Maize (Herbicide tol. + insect res.) BT11 (X4334CBR, X4734CBR)
Maize (Herbicide tol. + insect res.) CBH-351
Maize (Herbicide tol. + insect res.) DAS-59122-7
Maize (Herbicide tol. + insect res.) DBT418

Crop (Trait) Identifier
Maize (Herbicide tol. + insect res.) MON88017
Maize (Herbicide tol. + insect res.) TC1507
Maize (Herbicide tol.) GA21
Maize (Herbicide tol.) MON832
Maize (Herbicide tol.) NK603
Maize (Insect res. + herbicide tol.) ACS-ZMØØ3-2 x MON-ØØ81Ø-6
Maize (Insect res. + herbicide tol.) BT11 x MIR604 x GA21
Maize (Insect res. + herbicide tol.) DAS-59122-7 x NK603
Maize (Insect res. + herbicide tol.) DAS-Ø15Ø7-1 x MON-ØØ6Ø3-6
Maize (Insect res. + herbicide tol.) MIR604 x GA21
Maize (Insect res. + herbicide tol.) MIR604 x GA21
Maize (Insect res. + herbicide tol.) MON810 x MON88017
Maize (Insect res. + herbicide tol.) MON89034 x MON88017
Maize (Insect res. + herbicide tol.) MON89034 x NK603
Maize (Insect res. + herbicide tol.) MON-ØØ6Ø3-6 x MON-ØØ81Ø-6
Maize (Insect res. + herbicide tol.) MON-ØØ863-5 x MON-ØØ6Ø3-6
Maize (Insect res. + herbicide tol.) MON-ØØ863-5 x MON-ØØ81Ø-6 x MON-ØØ6Ø3-6
Maize (Insect res. + herbicide tol.) MON-ØØØ21-9 x MON-ØØ81Ø-6
Maize (Insect res. + herbicide tol.) SYN-BTØ11-1 x MON-ØØØ21-9
Maize (Insect res. and herbicide tol.) BT11 x MIR604
Maize (Insect res. and herbicide tol.) DAS-59122-7 x TC1507 x NK603
Maize (Insect res. and herbicide tol.) TC1507 x DAS-59122-7
Maize (Insect res.) DAS-06275-8
Maize (Insect res.) MIR604
Maize (Insect res.) MON810
Maize (Insect res.) MON863
Maize (Insect res.) MON89034
Maize (Insect res.) MON-ØØ863-5 x MON-ØØ81Ø-6
Maize (Plant quality + insect res.) MON-ØØ81Ø-6 x LY038
Maize (Plant quality) Event 3272
Maize (Plant quality) LY038
Melon (Delayed ripening) A, B
Papaya (Virus resistant) 55-1/63-1
Plum (Virus resistant) C5
Polish Canola (Glufosinate) HCR-1
Polish Canola (Herbicide tol.) ZSR500/502
Potato ( ) EH92-527-1 (BPS-25271-9)
Potato (CPB + virus resistant) RBMT15-101, SEMT15-02, SEMT15-15
Potato (CPB + virus resistant) RBMT21-129, RBMT21-350, RBMT22-082
Potato (CPB) ATBT04-6, ATBT04-27, ATBT04-30, ATBT04-31, ATBT04-36, SPBT02-5, SPBT02-7
Potato (CPB) BT6, BT10, BT12, BT16, BT17, BT18, BT23
Rice (Glufosinate) LLRICE06, LLRICE62
Rice (Glufosinate) LLRICE601
Soybean (Glufosinate) A2704-12, A2704-21, A5547-35
Soybean (Glufosinate) A5547-127
Soybean (Glufosinate) GU262
Soybean (Glufosinate) W62, W98
Soybean (Herbicide tol.) DP356043
Soybean (Herbicide tol.) GTS 40-3-2
Soybean (Herbicide tol.) MON89788
Soybean (Oil content) G94-1, G94-19, G168
Soybean (Oil content) OT96-15

Crop (Trait) Identifier
Squash (Virus resistant) CZW-3
Squash (Virus resistant) ZW20
Sugar Beet (Glufosinate) T120-7
Sugar Beet (Herbicide tol.) GTSB77
Sugar Beet (Herbicide tol.) H7-1
Tobacco (Oxynil) C/F/93/08-02
Tobacco (Plant quality) Vector 21-41
Tomato (Delayed ripening) 1345-4
Tomato (Delayed ripening) 35 1 N
Tomato (Delayed ripening) 8338
Tomato (Delayed ripening) B, Da, F
Tomato (Delayed ripening) FLAVR SAVR
Tomato (Insect res.) 5345
Wheat (Herbicide tol.) MON71800
Note: Below are non-transgenic listings (i.e. Als-mutagenised)
Argentine Canola (Herbicide tol.) NS738, NS1471, NS1473
Cotton (Sulfonylurea) 19-51A
Lentil (Herbicide tol.) RH44
Maize (Herbicide tol.) 3751IR
Maize (Herbicide tol.) EXP1910IT
Maize (Herbicide tol.) IT
Rice (Herbicide tol.) CL121, CL141, CFX51
Rice (Herbicide tol.) IMINTA-1, IMINTA-4
Rice (Herbicide tol.) PWC16
Sunflower (Herbicide tol.) X81359
Wheat (Herbicide tol.) AP205CL
Wheat (Herbicide tol.) AP602CL
Wheat (Herbicide tol.) BW255-2, BW238-3
Wheat (Herbicide tol.) BW7
Wheat (Herbicide tol.) SWP965001
Wheat (Herbicide tol.) Teal 11A

Source: www.agbios.com (September 2008)

Annex V Allowed GMOs for food/feed/cultivation in the EU-27

Crop	Common GMO name	OECD-ID GMO name
Carnation	1226A (11226)	FLO-11226-8
Carnation	1351A (11351)	FLO-11351-7
Carnation	11363	FLO-11363-1
Carnation	959A (11959)	FLO-11959-3
Carnation	988A (11988)	FLO-11988-7
Carnation	11 (7442)	FLO-7442-4
Carnation	15	FLO- ØØØ15-2
Carnation	16	FLO- ØØØ16-2
Carnation	66	FLO- ØØØ66-8
Carnation	4	FLO- ØØØØ4-9
Cotton	MON1445	MON-Ø1445-2
Cotton	MON15985	MON-15985-7
Cotton	MON15985 x MON1445	MON-15985-7 x MON-Ø1445-2
Cotton	MON531	MON-ØØ531-6
Cotton	MON531 x MON1445	MON-ØØ531-6 x MON-Ø1445-2
Cotton	LLCotton25	ACS-GHØØ1-3
Maize	Bt11	SYN-BTØ11-1
Maize	TC1507	DAS-Ø15Ø7-1
Maize	GA21	MON-ØØØ21-9
Maize	MON810	MON-ØØ81Ø-6
Maize	MON863	MON-ØØ863-5
Maize	MON863 x NK603	MON-ØØ863-5 x MON-ØØ6Ø3-6
Maize	MON863 x MON810	MON-ØØ863-5 x MON-ØØ81Ø-6
Maize	NK603	MON-ØØ863-5
Maize	NK603 x MON810	MON-ØØ6Ø3-6 x MON-ØØ81Ø-6
Maize	T25	ACS-ZMØØ3-2
Maize	DAS59122	DAS-59122-7
Maize	DAS1507xMON603	DAS-Ø15Ø7-1 x MON-ØØ6Ø3-6
Oilseed rape	GT73	MON-ØØØ73-7
Oilseed rape	T45	ACS-BNØØ8-2
Soybean	MON40-3-2	MON-Ø4Ø32-6
Soybean	A2704-12	ACS-GMØØ5-3
Soybean	MON89788	MON-89788-1
Sugar beet	H7-1	KM-ØØØ71-4
Swede-rape	MS8	ACS-BNØØ5-8
Swede-rape	RF3	ACS-BNØØ3-6
Swede-rape	MS8xRF3	ACS-BNØØ5-8 x ACS-BNØØ3-6

Source: http://ec.europa.eu/food/dyna/gm_register/index_en.cfm (January 2009)

Note: Of these GMOs, only maize MON810 and carnations are allowed for cultivation in Europe (valid on January 2009).

Annex VI GM-crops worldwide

The GMOs that are underlined, are allowed in the EU for food/feed, but not cultivation. Only MON810 and some carnations are allowed for cultivation in the EU.

Country	Species	GMOs
AR	Cotton	MON1445, MON531
	Maize	Many
	Soya	GTS 40-3-2
AU	Canola	HCN92, T45, PGS1, PGS2, MS8xRF3, GT73
	Carnation	66,4,11,15,16
	Cotton	LLcotton25, MON1445, MON88913, MON15985xMON88913, MON15985xMON1445, MON531xMON1445, MON15985, MON531
BF	Cotton	MON15985
BR	Cotton	MON531
	Maize	Bt11, MON810, T14/T25
	Soya	GTS 40-3-2
CA	Alfalfa	J101/J163
	Canola	HCN10, HCN92, T45, PGS1, PGS2, MS8xRF3, GT200, GT73, 23-18-17, 23-198, OXY-235
	Flax	FP967
	Maize	Many
	Pol. Canola	HCR-1, ZSR500/502
	Potato	Many
	Soya	A2704, A5547, GTS 40-3-2, MON89788
	Sugar beet	T120-7, H7-1
CO	Cotton	MON1445, MON531
	Carnation	959A, 988A, 1226A, 1351A, 1363A, 1400A
IN	Cotton	MON15985, MON531 and some unidentified GMOs (http://igmoris.nic.in)
JP	Alfalfa	J101/J163
	Cotton	LLcotton25xMON15985, MON1445, MON531, 31807/31808, BXN, GHB614
	Maize	Many
	Canola	many (only OXY-235 acc. to www.bch.biodic.go.jp)
	Soya	A2704, A5547, GTS 40-3-2, MON89788, G94-1, G94-19, G168, MON87754, CV127, MON87769
	Sugar beet	H7-1
	Tomato	FLAVR SAVR, J101, J163
MX	Cotton	MON531
	Soya	GTS 40-3-2
	Tomato	FLAVR SAVR
PY	Soya	GTS 40-3-2
PH	Maize	Bt11, NK603, NK603xMON810, MON810

ZA	Cotton	LLcotton25, MON1445, MON88913, MON15985xMON88913, MON15985xMON1445, MON531xMON1445, MON15985, MON531
	Maize	Bt11, NK603, NK603xMON810, MON810
	Soya	GTS 40-3-2
UY	Maize	Bt11, MON810
	Soya	GTS 40-3-2
US	Canola	Many
	Chicory	RM3
	Cotton	Many
	Flax	FP967
	Maize	Many
	Papaya	55-1, 63-1
	Plum	C5
	Potato	Many
	Rice	LLRice06, LLRice601, LLRice62
	Soya	A2704, A5547, GU262, W62/W98, DP356043, GTS 40-3-2, MON89788, G94-1, G94-19, G168
	Squash	CZW-3, ZW20
	Sugar beet	T120-7, H7-1, GTSB77
	Tobacco	Vector 21-41
	Tomato	Many

Source: Agbios (2008).

Annex VII Abbreviations of countries (ISO 3166 alpha-2)

AR	Argentina	IS	Iceland
AT	Austria	IT	Italy
AU	Australia	JP	Japan
BE	Belgium	LT	Lithuania
BF	Burkina Faso	LU	Luxemburg
BG	Bulgaria	LV	Latvia
BR	Brazil	MT	Malta
CA	Canada	MX	Mexico
CH	Switzerland	NL	The Netherlands
CN	China	NO	Norway
CY	Cyprus	NZ	New Zealand
CZ	Czech Republic	PH	Philippines
DE	Germany	PO	Poland
DK	Denmark	PT	Portugal
EE	Estonia	PY	Paraguay
ES	Spain	RO	Romania
FI	Finland	SE	Sweden
FR	France	SK	Slovakia
GR	Greece	SL	Slovenia
HU	Hungary	UK	United Kingdom
ID	Indonesia	US	United States
IE	Ireland	UY	Uruguay
IN	India	ZA	South Africa
IR	Iran		

Source: http://publications.europa.eu/code/en/en-5000500.htm