Admixture of GM and non-GM crops at import

Overview, insight and supervision

The Hague, April 29, 2009

Admixture of GM and non-GM crops at import

Overview, insight and supervision

Final report

The Hague, April 29, 2009
Ank Jansen, David Thelen

On behalf of the Netherlands Commission on Genetic Modification (COGEM)

Written and published by
Schuttelaar & Partners
Zeestraat 84
2518 AD The Hague
The Netherlands
t +31 (0) 70 318 44 44
f +31 (0) 70 318 44 22
info@schuttelaar-partners.com
www.schuttelaar-partners.com

Advisory committee

Mw. Dr. Ir. M. Bovers	Netherlands Commission on Genetic Modification
Mw. Dr. D.C.M. Glandorf	Genetically Modified Organism Bureau
Dr. T.J. de Jong	Leiden University, Institute of Biology
Ing A.J.W. Rotteveel	Ministry of Agriculture, Nature and Food Quality, Plant Protection Service of the Netherlands

Table of contents

1 **Summary** 6
2 **Introduction** 8
3 **Supply chains** 10
Introduction 10
Potato supply chain 10
Maize supply chain 16
Rice supply chain 21
Chain characteristics that influence admixture 27
4 **Cases of admixture** 34
Introduction 34
Bt10 34
Herculex 35
LLRICE601 rice 35
Lessons learned 36
5 **Visit to Rotterdam harbor** 39
Introduction 39
Report 39
Lessons learned 51
6 **Workshop prevention of admixture** 52
Goal and setup of the workshop 52
Report 52
7 **Control systems** 57
Control systems in the EU 57
Certification 57
Inspection in the Netherlands 58
Existing measure of prevention 59
Traceability systems 59
Sources 59
8 **Conclusions and recommendations** 60
Introduction 60
Conclusions 61
Differences and similarities 63
Recommendations 65
Annex I: Participants of the workshop "Prevention of admixture" 68
Annex II: Program of the workshop "Prevention of admixture" 69
Annex III: Cases of admixture – extensive information 70
Bt10 maize 70
Herculex maize 73
LLRICE601 Rice 75

1 Summary

Introduction

Every year, the area of genetically modified (GM) crops worldwide increases. The use of GM crops in food, feed and industry increases as well. Unfortunately, recently some incidents have been reported in which crops or products unintentionally get mixed with (un)authorized GM crops or products. In the EU, the political decision-making on GMOs stagnated, with the result that many GMOs are not (yet) authorized in the EU while authorized in other parts of the world. This creates a large gap between the GMOs authorized in the EU and those authorized outside the EU, specifically the Americas.

The Dutch authorities want freedom of choice for their citizens and environmental safety. For this reason they want to prevent admixture. In this project, executed by Schuttelaar & Partners, we have mapped the supply chains of three crops of which GM varieties are available or are under development: potato, maize and rice. In addition, we have pinpointed the characteristics of the supply chains that influence admixture, visited the Rotterdam harbor to see a grain warehouse at work, and studied three cases of admixture: Bt10 maize, Herculex maize and LLRICE601 rice.

The COGEM is specifically interested in the environmental consequences of admixture in the Netherlands, but in this project we used a broader interpretation of the theme. Other COGEM projects on this subject focus more on the (possible) environmental effects, while this projects offers the basics of the supply chains.

Main conclusions and recommendations

The main conclusion of this project is that in the Netherlands, the environmental risks for the potato, maize and rice supply chains are minimal. All three crops do not sustain independently in the Dutch environment/climate. However, the characteristics of the plant determine to a great extent the possibility of admixture. For example, out-crossing in the country of origin can result in admixture.

A factor that influences admixture in all supply chains is human activity. People working in the chains often do not realize their behavior has

consequences for admixture. They are not aware of the fact that the products they work with are transported globally and that people in other countries may think differently about the accuracy of methods. ***For that reason we recommend to make all methods that can be used to prevent admixture easy to implement***. Equipment should be designed in such a way that the chance of admixture is as small as possible. Besides that, the design should also facilitate cleaning. Cleaning however should not only be facilitated by design, but also by regulations, and protocols. We have to realize that despite all protocols and administrative requirements, it is man that defines its success or failure of prevention methods.

Specifically in the Netherlands, the largest risk factor is handling of the crops meaning: sowing, harvesting, transporting, etc. ***We therefore recommend to give farmers, contractors and others working with GM crops in arable farming a training on how to deal with GM crops***. This way, they can learn how their behavior effects admixture. This recommendation links up with a recommendation of minister Verburg of agriculture.

Transport and transfer are an important factor with the prevention of admixture. During transport spillage may occur and during transfer complete lots are mixed. GM varieties may, intentionally or unintentionally, be involved in these events. ***In order to prevent admixture during bulk transport, we recommend to pack the GM crops in the country of origin, as close to the production site as possible, in such a way that admixture during transport becomes impossible***. For example in containers or big bags. Another possibility is to pack the non-GM crops, but this can be decided case by case.

Worldwide, there are different technical and regulatory systems concerning GMOs. That means there are different interpretations of definitions, different testing protocols, different regulations at force and different political decision making processes. It is unrealistic to think it would be possible to synchronize all systems. However, ***we recommend to collect all relevant data in one database, under supervision of an internationally recognized organization. For example, these data can be integrated in the database of the Cartagena Protocol.*** **T**his database enables data comparison and we can anticipate on what's in development in other continents and create better understanding and coordination between all countries.

2 Introduction

Worldwide, the area of genetically modified (GM) crops increases every year. The use of GM crops in food, feed and industry is increasing as well. Unfortunately, recently some incidents have been reported in which crops or products unintentionally get mixed with (un)authorized GM crops or products. This unwanted admixture is an important part of the biotechnology discussion, because admixture with unknown or unauthorized genetically modified organisms (GMO) may pose risks for human beings and our environment. Another essential element of the discussion is freedom of choice.

In the past few years, Europe has been confronted with several cases of admixture with unauthorized GMOs. In 2005, a freight consignment of Bt11 maize, authorized for import in the EU, was found to be mixed with the unauthorized variety Bt10. In 2006, admixture of rice with the unauthorized rice variety LLRICE601 caused a temporary import stop of all long grain rice exported from the USA. As a result of this all long grain rice imports are currently monitored for unauthorized GMOs.

In three or possibly four projects the Commission Genetic Modification (COGEM) is investigating the occurrence of admixture with (un)authorized GMOs in bulk freights. COGEM is specifically interested in the (possible) environmental effects of admixture. Schuttelaar & Partners, a Dutch communication consultancy, executed one of these projects. For this purpose we have mapped the supply chains of three crops, of which GM varieties are available or are under development: potato, maize and rice. The other projects focus more on the (possible) environmental effects, while this projects offers the basics of the supply chains.

There are three reasons why S&P chose to map the supply chain of potato; its importance in the; its seemingly well-controlled production and trade chains, and its regional character. Currently a GM potato variety is in the middle of the EU authorization process, and possibly this potato will be available on the Dutch market soon. Maize, successively was chosen because it is a globally traded commodity and there are already a lot of GM varieties available on the global market In the past, some cases of admixture have occurred. Maize is also grown in the Netherlands. Finally we chose rice, because it is a totally different crop with a different type of supply chain, and because a few cases of admixture have occurred already.

Since rapeseed was investigated in another part of the overall project of the COGEM this crop is not addressed in this report.

In order to see where admixture is most likely to occur, we did not only map the supply chain itself, but also pinpointed the characteristics of the chains that influence admixtures in the supply chain to see where admixture is most likely to happen. In addition, we conducted desk research and personal, telephone and/or e-mail conversations. Furthermore, we visited the Rotterdam harbor to see a grain warehouse at work.

In this project, three cases of admixture were analyzed: Bt10 maize, Herculex maize and LLRICE601 rice. We would have preferred to analyze a case of admixture with potato as well, but there have not been any incidents so far. Desk research and telephone conversations serve to find out what the cause(s) for admixture were and what lessons we can learn from that.

At the end of the process, we organized a workshop on “prevention of admixture”. With a diverse group of people from the three supply chains, inspection organizations, government and NGO’s, we discussed this issue.

This project provides an overview of the supply chains and the issues relevant for the prevention of admixture. However, since our resources were limited, this report will not contain all aspects of the supply chains and the admixture events. In this report you will find a simplified schematic overview of the three chains, chain characteristics that influence admixture and recommendations how to prevent admixture.

3 Supply chains

Introduction

In order to map the supply chains of potato, maize and rice, we conducted intensive desk research and contacted people involved in these supply chains. We arranged the information we found in the following categories: the plant, seed production, production of the crop, trading and the use of crop. For every crop studied, we present a simplified schematic overview of the supply chain. These are flow charts that do not provide insight into which flows are the largest. Finally, we specified the chain characteristics that influence admixture in each part of the supply chains.

Potato supply chain

The potato plant
The potato (*Solanum tuberosum* L.) is a herbaceous perennial with underground stolons bearing several tubers. The potato is a self-pollinator, but production plants rarely grow to the flowering stage partly because development of flowers is not a criterion in breeding, but also due to early harvest of seed potatoes. Cross-pollination seldom occurs. Potato plants are almost always propagated vegetatively, using the seed tubers as starting material.
Of the whole potato plant only the tubers are used. The green parts of the potato plant contain solanine, a toxin. Nevertheless, the tuber contains only very little solanine, which is easily degraded during heating. The green parts of the potato plant are destroyed on field.

The potato has no wild relatives within Europe and has no feral populations spontaneously propagating and self maintaining wild populations. Hence, GM genes cannot be stored or stacked in the wild and cause contamination of the crop. Volunteer plants might be a nuisance, for which standard control measures are taken. Contamination of the following crop is rare because of crop rotation, or absent, because of crop rotation and selection.

Seed production
Nowadays a new potato variety commences under controlled circumstances. Two plants (genitor plants) are cross-bred. Then the seed of the offspring, called “true potato seed”, is used to grow new plants and the offspring is cross-bred again. This step is repeated until a plant can be selected with the proper characteristics. The tubers from the selected

plant are used to vegetatively propagate a new plant variety and are called ‘seed potatoes’. All offspring is identical to this single selected plant.

After several propagation cycles the seed potato is destined to become a production potato. Depending on the variety, it may be suited to either starch production or consumption.

Seed potatoes are cultivated by specialized companies. An extensive control system is set up to prevent potato diseases and admixture. During the period of cultivation each field is checked three times and any diversities are removed. This includes infected plants as well as abnormal varieties. This check is visual since specific potato varieties can be distinguished visually. This facilitates the work. If a batch is considered healthy and pure, it receives a certificate stating year, location and producer. A seed potato can be cultivated maximally for seven years, after that it is automatically destined for consumption or used as industrial potato.

The Netherlands has a vast seed potato production capacity. Most of the production is exported to countries within Europe and the Northern part of Africa.

A large part of the potato production area in the Netherlands is cultivated with seed potatoes. The Netherlands produced 1,2 million tons of seed potatoes in 2007. Part of the seed potatoes is used for local cultivation of ware potatoes, i.e. potatoes destined for consumption purposes, food and feed.760 Thousand tons are exported to countries like France, Italy, Germany, Belgium and Spain. Only approximately 40 thousand tons is imported.

Crop production of starch and ware potatoes
The largest potato producing countries in the world are (in million tons produced in 2007): China (72), The Russian Federation (35,7), India (26,3), Ukraine (19,1), The USA (17,6), Germany (11,6), Poland (11,2), Belarus (8,4), the Netherlands (6,9) and France (6,2).

Potato is an important crop in the Netherlands. In 2007 the country produced 3,6 million tons of ware potatoes of which 1,13 million was exported. Germany and Belgium are the largest importing countries. The Netherlands also imported 1,3 million tons of ware potatoes. These potatoes are mainly produced in surrounding countries like Germany and

Belgium. In 2007 the Netherlands produced 2,0 million tons of starch potatoes, which are mostly processed locally.

Trading

In the Netherlands potato production and processing is mainly organized in cooperative business structures. Specialized research companies develop new varieties of potato. These companies generally work in collaboration with larger cooperative companies. Specialized companies grow seed potatoes , mainly under license of a large cooperative company. Each specific lot of seed potatoes has its own certificate stating place of origin, name of cultivator, and year of initial cultivation.
After seed potatoes are cultivated, a part of the production is stored at the cultivation location itself, the other part is used either for production potatoes (starch, consumption) or serve as starting material for subsequent years at other locations. The co-operative company supervises the transport of these different lots. Companies producing consumer products finally retrieve the yield from cultivators and process it in nearby factories. Starch potato companies work in the same manner.
Starch potatoes, as well as ware potatoes, are grown and processed by specific cooperative companies. These companies control logistics, planning and cultivation of the potatoes. Generally they have developed a company based track, trace and control system, supporting its quality management. Furthermore they are bound by regulations of the general control authorities like NAK.

Trade in seed and ware potatoes is organized on a regional level i.e. within the EU. The Netherlands import about 40 thousand tons of seed potato and 326 thousand tons of starch potatoes (CBS, 2007). Starch potatoes are cultivated close to the processing plant and trade only takes place with starch and side products. Opposed to this, trade in potato products is organized on a global level.
Trade of potatoes is hindered by the weight of potatoes. Transport is very costly and this is one of the reasons why the market is regionally, not globally orientated. Potato growth characteristics are nutrient, soil type and climate dependent, which also determines locally oriented cultivation.

Use of potato

There are four main uses of potato.

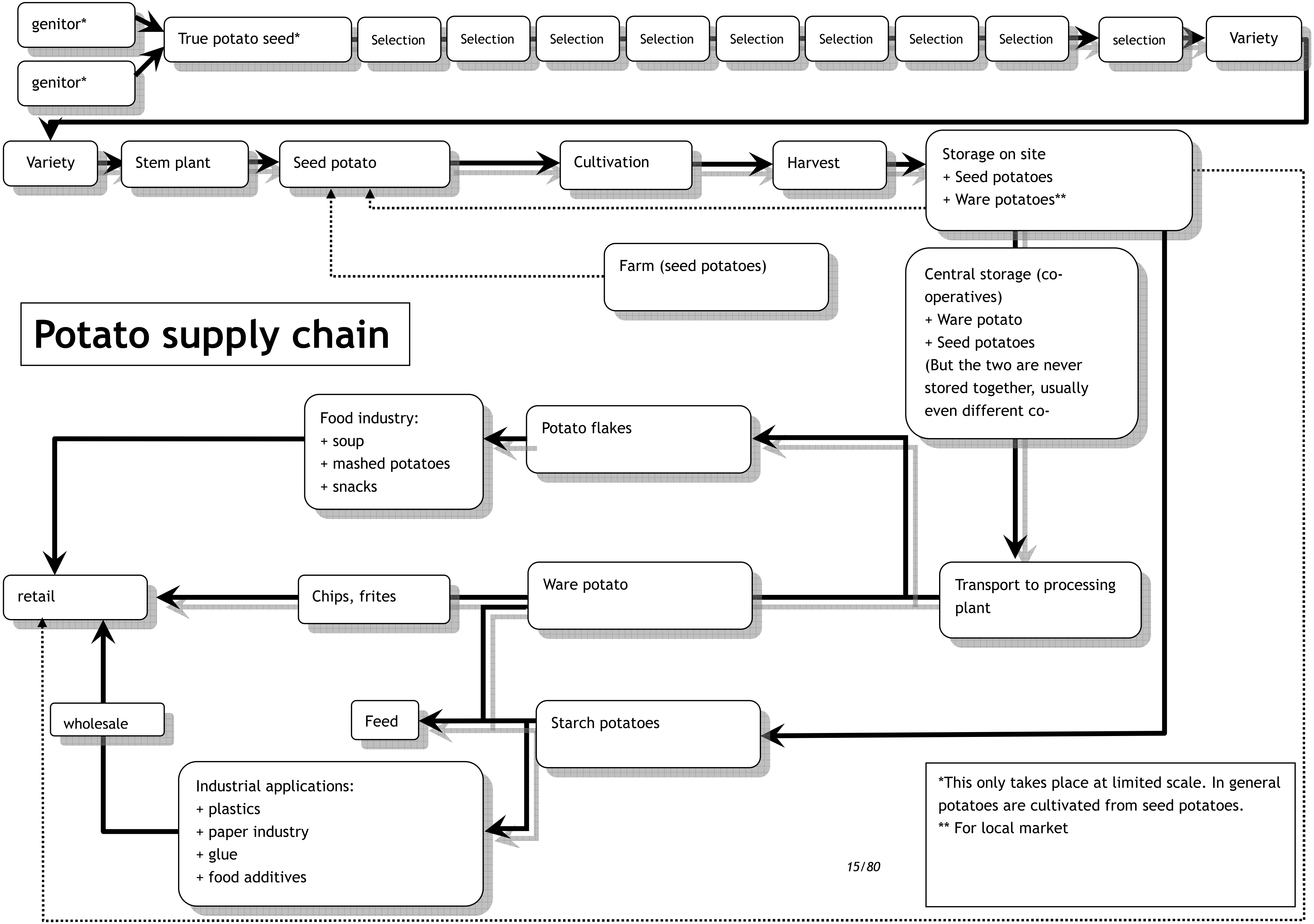
1. Ware potato
   Potato is used for many different consumption purposes. This includes consumption of the complete potato, but also processed products like crisps, flakes and snacks,

2. Starch potato
   This kind of potato is mainly used for the starch. The starch is retracted from the potato and used in the textile, plastic, paper, and adhesive industry. Remainders like potato protein and fibers are used for feed purposes.
3. Seed potato
4. Feed
   Potatoes, or parts of it, are used as feed. Sometimes a complete lot is used as feed if it does not meet certain quality standards for other uses. Potato protein and fibers, waste products after retraction of starch or by-products from processing potatoes for consumer purposes, are used for feed purposes. The parts of the potato that are used for feed, can be mixed with additives like soya.

Sources

- CBS Database: “ international handel; in en uitvoer naar goederengroepen”, 2001 – 2008: http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=71740NED&D1=a&D2=65-69,161,198,233-234&D3=0&D4=35,(l-6)-l&VW=.
- E.J. Kok, A.J. Smelt, L.T. Colon, O. Dolstra, J.J. de Vlieger, J.M.A.J. Verdonk, C. Lokhorst, WUR 2004, GGO-vrije diervoederketens, Kennisscan 2004
- F.T. de Vries, R. Van der Meijden and W.A. Brandenburg, 1992, Botanical files A study of the real chances for spontaneous gene flow from cultivated plants to the wild flora of the Netherlands. Gorteria 1
- Faostat database, Harvested area potatoes in 2007: http://faostat.fao.org/site/567/desktopdefault.aspx?PageID=567
- Faostat database: http://faostat.fao.org/site/535/default.aspx#ancor
- Global year of the potato: http://www.potato2008.org
- Greenpeace: GM contamination report 2007
- NAK: http://www.nak.nl
- Nevedi: http://www.nevedi.nl
- Nivaa: http://www.nivaa.nl/nl
- Personal communication with stakeholders
- Plant Research International - Actualisering uitkruisingsgegevens t.b.v. coëxistentieoverleg 2004 voor aardappel, suikerbiet, maïs en koolzaad (2004)
- RIKILT - Gegarandeerd GGO-vrije diervoederketens - Knelpunten en oplossingsrichtingen (2006)
- UN comtrade database: CBS

- UN trade Database, Commodity Trade Statistics Database, website query; Worldwide export figures for 2007: http://comtrade.un.org/db.
- VAVI, 2007, Telerhandleiding Voedselveiligheid certificaat aardappelen verwerkende industrie [VVA-Certificaat]
- Wikipedia: http://en.wikipedia.org/wiki/Potato
- Wikipedia: http://nl.wikipedia.org/wiki/Aardappel


genitor*
genitor*
True potato seed*
Selection
Selection
Selection
Selection
Selection
Selection
Selection
Selection
selection
Variety
Variety
Stem plant
Seed potato
Cultivation
Harvest
Storage on site
+ Seed potatoes
+ Ware potatoes**
Farm (seed potatoes)
Central storage (co-operatives)
+ Ware potato
+ Seed potatoes
(But the two are never stored together, usually even different co-
Potato supply chain
Food industry:
+ soup
+ mashed potatoes
+ snacks
Potato flakes
retail
Chips, frites
Ware potato
Transport to processing plant
wholesale
Feed
Starch potatoes
Industrial applications:
+ plastics
+ paper industry
+ glue
+ food additives
*This only takes place at limited scale. In general potatoes are cultivated from seed potatoes.
** For local market

Maize supply chain

The maize plant
The maize plant (*Zea mays*) is a grass plant with male and female inflorescences, usually wind pollinated. Maize pollen are released in very large quantities, equating between 14-50 million grains per 'average-sized' plant, over a period of 5-8 days. Under normal field conditions at least 95% of the ovules are fertilized by pollen from other plants.

Maize has in Europe no wild relatives that allow out-crossing, only in Mexico one particular weedy relative is known to occur. No feral maize populations are known in Europe, or elsewhere. There is no potential reservoir for the spontaneous storing, stacking and spreading of GM genes to the crop.

Seed production

Maize plants are predominantly hybrid plants. By crossing two (homozygous) varieties with each other, a hybrid generation is generated which is genetically uniform and has a high level of heterozygosity. Such hybrids in maize typically have higher growth and produce more seeds than each of the two parental lines. If these hybrids are further used in crossing, segregation of genes occurs in their offspring and for each locus a high percentage of the offspring will be homozygous. Such lines then lose their hybrid vigor. The consequence of this system is that it is profitable for farmers to buy hybrid seed from the seed company and hence all farmers do this, including the organic farmers. Any farmer that would continue by setting aside open-pollinated seeds from his own crop for sowing in the subsequent year, would face a yield loss as compared to using hybrid seed. Because farmers always start with hybrid seeds purchased from the seed production company, any pollination with GM pollen in the field will affect the harvested maize crop, but has no consequences for maize production in the same field in the following year; the farmer always starts by sowing non-GM seed.

In the EU maize seed production mainly takes place in France and Hungary. Seed maize production in both countries consists completely of hybrids. The main destination market for French seed maize are countries within the EU. France is the major producer of seed maize in the EU, with almost 50,000 ha in 2005.

In Hungary, breeding is in the hands of 2 to 3 national companies and large multinational companies who hold the patents on the different varieties. The multinational company asks a contractor to produce the seed material. The contractor for his part makes arrangements with seed farmers for the multiplication of the seed material. Once the seeds have been multiplied they are certified and treated (e.g. coating) and then distributed. The majority of seeds (70-75%) is distributed by the contractor company. The remainder of the seed (around 25%) is distributed directly by the multinational breeders, who also get in touch with seed farmers without the intervention of contractor companies.

The largest seed companies in the Netherlands (producing elsewhere) are KWS, Syngenta, Limagrain Genetics and InnoSeeds. Some seed companies in Europe use Chile for cultivation of maize seed during the winter.

Maize production
The largest maize producing countries are (in million tons produced in 2007) China (152), Brazil (51,6), the USA (33,2), Mexico (22,5), Argentina (21,8), India (16,8), France (13,1), Indonesia (12,4) and Canada (10,5).
In the Netherlands the area harvested was 24.000 hectares in 2007, which resulted in a production of 217.000 tons of grain. In 2006, 114.303 tons of maize were exported, while 2.397.424 tons of maize were imported.

Most countries produce grain maize. In mid west European countries (North of France and further North) Maize ripens insufficiently and is usually used as silage maize. With this type of maize the whole plant is harvested and conserved at the own farm. It is usually used for feed. The preservability during transport is low, so only a small part of this type of maize is being traded, mostly to other cattle farms in the neighborhood.

A small percentage of maize grown in the Netherlands is sugar maize, which is sold as corncob in the retail.

In 2007, GM maize was cultivated in USA, Argentina, Canada, South-Africa, Uruguay, Philippines, Spain, Chile, France, Honduras, Czech Republic, Portugal, Germany, Slovakia and Poland.

Trading
The Netherlands produces mainly silage maize. The seeds are produced outside the Netherlands, mostly in France and Hungary. The seed is transported by truck to The Netherlands. Seeds are transported in separate bags, and not in large containers, or ships. This maize is then cultivated,

usually at the same farm where it will be used. It is ensiled for storage. Sometimes, when there is a surplus, it is traded to other farms in the neighborhood.

The major import of maize product is maize gluten feed[1] from the USA. Maize gluten feed is a non-viable by-product, but some viable kernel seeds might remain in the mixtures. In the USA, most of the maize cultivated is genetically modified, so most maize gluten feed is GM as well. Transport in this supply chain occurs mainly by train, road or water in the country of origin, by sea ship to Europe and by water, road or train on the mainland in Europe. The maize processing industry in the EU directly delivers maize gluten feed to the mash industry.

The EU27 are a net importer of maize. The trade volume is relatively small compared to production (between 42-52 million tons over 2000-2005), with imports ranging between 2.9 and 5.5 million tons and exports between 0.16 and 2.1 million tons over 2000-2005. The largest importer in the EU is Spain (between 3-4 million tons over 2000-2005) and the largest exporter is France (between 6-8 million tons over 2000-2005). Extra-EU27 (at that time) trade is small compared to production and intra-EU27 trade. There is some maize imported to the EU from GM maize growing countries, such as Argentina. The largest maize processors in the world are ADM and Cargill.

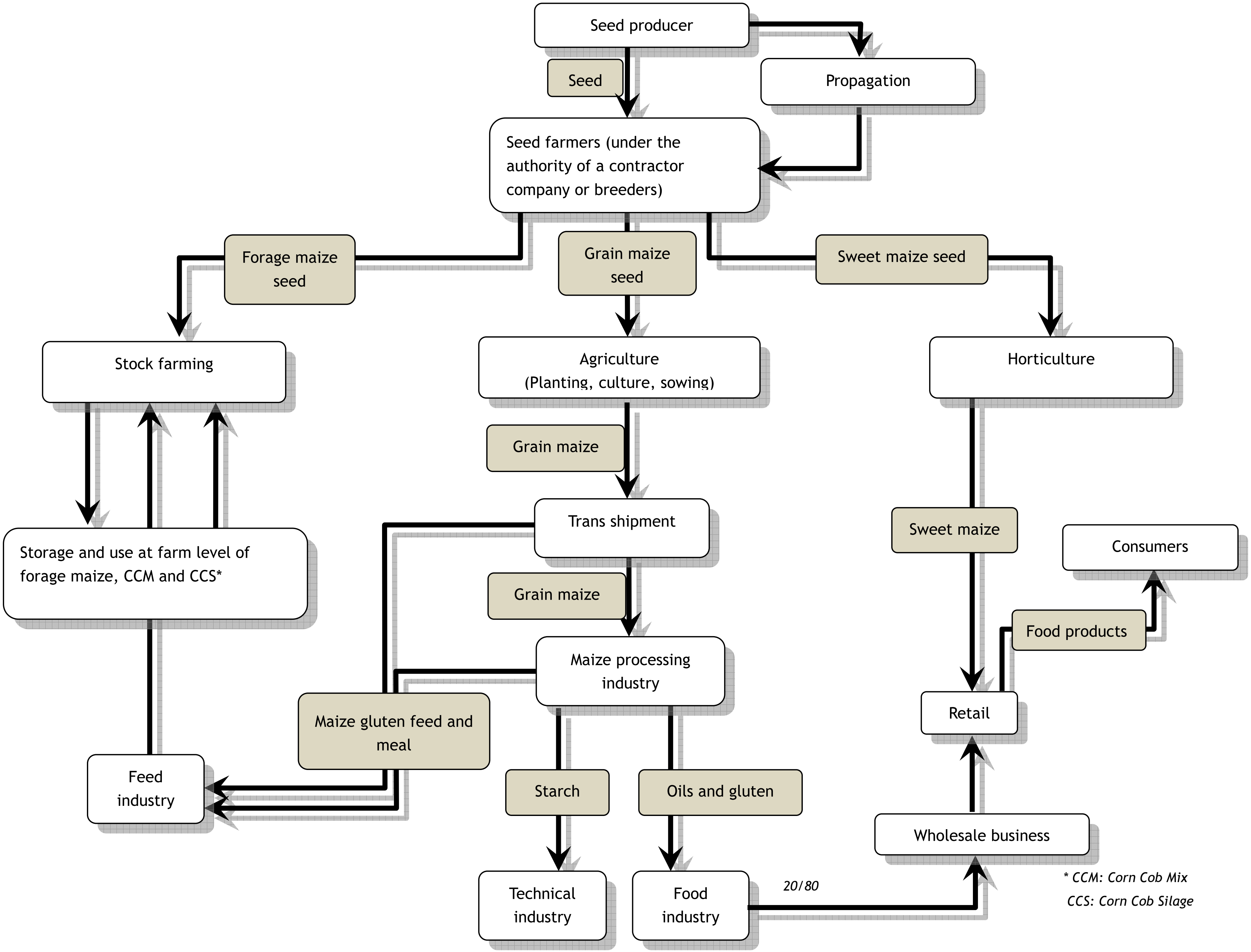
Use of maize
In food, maize is typically used for tortillas, cornflakes, maize bread, starch (as binding agent), maize beer, popcorn and polenta.
In the technical industry, maize is used for adhesives and paper.
Maize gluten meal is used for feed, just as forage maize (the whole maize plant), Corn Cob Mix (just the maize grains) and Corn Cob Silage (the whole cob).

---

[1] *According to Council Directive 96/25/EC of 29 April 1996, maize gluten feed is the "by-product of the wet manufacture of maize starch. It is composed of bran and gluten, to which the broken maize obtained from screening at an amount no greater than 15 % of the product and/or the residues of the steeping liquor used for the production of alcohol or other starch-derived products, may be added. The product may also include residues from the oil extraction of maize germs obtained also by a wet process." Maize gluten is the "dried by-product of the manufacture of maize starch. It consists principally of gluten obtained during the separation of the starch."*

Sources

- Co-existence and traceability of GM and non-GM products in the feed chain, N. Gryson, K. Messens, D. Van Lare and M. Eeckhout, Eur Food Res Technol (2007) 226: 81-85
- Coexistence in maize supply chains in Spain and Switzerland, B. Oehen, M. Costa-Font, M. Morgner, J.M. Gil and M. Stolze, 3rd QLIF Congress, Hohenheim, Germany, March 20-23, 2007
- http://faostat.fao.org/site/535/default.aspx#ancor
- http://faostat.fao.org/site/567/default.aspx#ancor
- http://nl.wikipedia.org/wiki/Mais
- InnoSeeds, personal conversation
- ISAAA - Report on Global Status of Biotech/GM Crops (2007)
- JRC Scientific and Technical Report - A descriptive analysis of conventional, organic and GM crop and certified seed production in the EU (2008)
- LEI - Ggo-vrije veevoedergrondstoffen voor de melkveehouderij (2003)
- Limagrain, personal conversation
- Plant Research International - Actualisering uitkruisingsgegevens t.b.v. coëxistentieoverleg 2004 voor aardappel, suikerbiet, maïs en koolzaad (2004)
- Plant Research International – Toetsing van afspraken over coëxistentie van genetisch gemodificeerde (GG) en niet-GG maïsproductie in Nederland (2008)
- Product Board Agriculture, e-mail conversation
- Product Board Animal Feed - fact sheet “Feed and modern biotechnology” (2008)
- RIKILT - Gegarandeerd GGO-vrije diervoederketens - Knelpunten en oplossingsrichtingen (2006)
- RIKILT - GGO-vrije diervoeders kennisscan (2004)
- Soil Association - Pollen dispersal in the crops Maize, Oil seed rape, Potatoes, Sugar and Wheat (2000)
- www.handboeksnijmais.nl
- www.kennisakker.nl/kenniscentrum/handleidingen/teelthandleiding-korrelmais-en-corn-cob-mix-ccm



* CCM: Corn Cob Mix
CCS: Corn Cob Silage

Rice supply chain

The rice plant
Rice (*Oryza* sp.) is one of the most important grains in the world and has many species in cultivation. It is mostly grown in Asia and in the USA, which are both locations where wild relatives grow as well. Rice species are largely self-pollinating. Some rice is adapted to growing under inundation, some under dry land conditions. Rice is sensitive to day-length, meaning that tropical varieties do not yield at temperate latitudes and vice-versa. There are many wild rice varieties, and they all cross-breed freely with domesticated rice (as is the case with cross breeding among domesticated species) . Because of this, large and varying reservoirs of feral rice exist that can stock and stack GM genes and contaminate the crop.
In Italy, due to typical seeding methods, cross breeding with wild rice varieties is relatively a large problem.

Rice seed production
Rice seed production has been the domain of the subsistence smallholder farmer for ages, and this system is nowadays still dominant in much of Asia. The improvement of the crop and the production of modern, hybrid varieties has long been the privilege of government, because rice is the most important staple food. This is not so much the case anymore, but still there are not much rice seed companies in Asia. In some regions in China, farmers may also produce seed themselves. In this case, rice (seed) production is usually handled by the farmers, traders and co-operations in the country of origin. In China, almost every province has its own rice seed company, because the varieties differ so much between the provinces. It is therefore hard to indicate the largest companies here. The rice seed company Kefeng is already developing transgenic rice seeds in fields trials and is waiting for the permission of commercialization from the government.

There are very few European companies (predominantly international companies based in countries outside Europe) involved in rice seed.
In the USA, rice seed production is in the hands of a few large rice seed companies such as RiceTec, BASF and Bayer. Just like production, it is much more commercialized than in Asia. In general, Asian rice production is intended for the local market.

Rice seed production is typically a 6- to 7-year process that lasts until the availability of certified seed for commercial use. nowhere in the world GM rice has been authorized for commercial purposes.

Rice production

The largest rice producing countries in the world are China, India and Indonesia. In Europe, the largest rice producing country in 2007 was Italy (43%) followed Spain (20%), Greece (6%) and Portugal (4%). All rice producing countries together produced about 645 million tons paddy rice in 2007.

Paddy rice is rice that is derived directly from the field. When the outer hull is removed from the paddy rice, the product can be sold as brown rice. When the bran layer is removed as well, white rice is produced. The bran layer contains a lot of nutrients, so when it is removed from the rice, it is normally used as feed.

The ways in which rice is produced differs greatly between Asia and USA/Europe. In the USA, rice production is completely automated. All rice producers are united in the USA Rice Producers Group from the USA Rice Federation. In Asia it is mainly done by individual farmers. They considerably depend on the production of rice for their income. Asian rice is usually not specifically meant for the global market. Only if there is rice left, this may be sold on the global market.

In Guyana (one of the largest exporters to the Netherlands), there are about 8000 rice farmers, 20 large and 40 small rice companies and 105 privately owned rice mills. These companies buy the rice from the farmers and sell it to trading companies. The vast majority is small-scale farmer with the average size of rice farms being 10 to 20 acres.

Trading

The world market for rice is very small, compared to the tons of rice that are produced yearly. Only 6-7% of world rice production is traded internationally. The imports to the EU are 3% of the total world market. In the Netherlands, 4122 tons of rice were imported in 2006.

Leading suppliers of rice to the Netherlands are Guyana, Italy, Thailand, USA and India. Because of the admixture of GM rice in the American supply chain, most European traders, brokers and millers do not buy rice in the USA anymore despite the efforts of the US rice industry to get the whole supply chain GM free.

70% of Guyana's rice is exported. The EU has traditionally been Guyana's largest export market for rice. The EU rice import market is dominated by a few very large companies and the vast majority of Guyana's rice is imported by just two importers.

The most important players in the rice supply chain are traders, brokers and millers. Traders trade themselves, brokers trade under the authority of others (such as traders, millers and companies), and millers arrange the trade for their own use. In practice the distinction between these 'roles' is not so clear.

In Asia, much of the international market consists of trade in surplus rice, which has suddenly come onto the market. Participants in the market change on a yearly basis. This makes it difficult to find a suitable partner for buying or selling to rice. The search takes time and is expensive, making transaction costs very high. Brokers therefore play a crucial role in the functioning of the market. Rice brokerage houses are located in the EU (Belgium, France and UK), Hong Kong, Singapore and the USA. The most important brokers are Jacksons Son (UK), Creed (USA), London Rice Brokers' Association (UK) and the Grain and Feed Trade Association (GAFTA, UK).

Trans National Corporations (TNCs) control large parts of the rice supply chain. They act as supplier of chemical inputs, buyer, importer, exporter, transporter, speculator and hedger of rice, as well as a borrower and lender of credit. The world's largest TNC's are Cargill (USA), Archer Daniels Midland (USA), Rice Company (USA), Louis Dreyfus (Switzerland) and Rustal (Switzerland). Ebro Puleva (Spain) controls 30% of the European market. The largest importer and exporter of rice in China is COFCO. An important company in Thailand is Charoen Pokphand. The most important importers of rice in the Netherlands are Tradin, Alanheri, Van Sillevoldt, Lassie and International Rice.

The Netherlands is an important importer and miller of rice. When purchased, rice is further processed and milled in the Netherlands, and a large part is traded within the EU (35-63% of total imports).

The EU27 are a net importer of rice. Imports over 2000-2006 range between 120,000-210,000 tons and exports between 40,000-80,000 tons. The largest importer in the EU is Italy (between 14,000-83,000 tons over 2000-2006) and the largest exporter is France (between 17,000-49,000 tons over 2000-2006).

Italy exported 583.903 tons of rice in 2006. About 1% was destined for the Netherlands. In Italy, about 80% of the produced rice goes directly to the processing industry. The remainder is handled by other organizations (such as co-operations and trading companies).

Use of rice

Rice is solely used for consumption rice and processed products like snacks. Only by-products like rice hulls are used for feed. Around 90% of all white rice in the Dutch supermarkets originates from Van Sillevoldt. This rice originates from Guyana, Italy, Thailand, USA, India, Surinam, and Pakistan. Van Sillevoldt also handles Fair Trade rice.

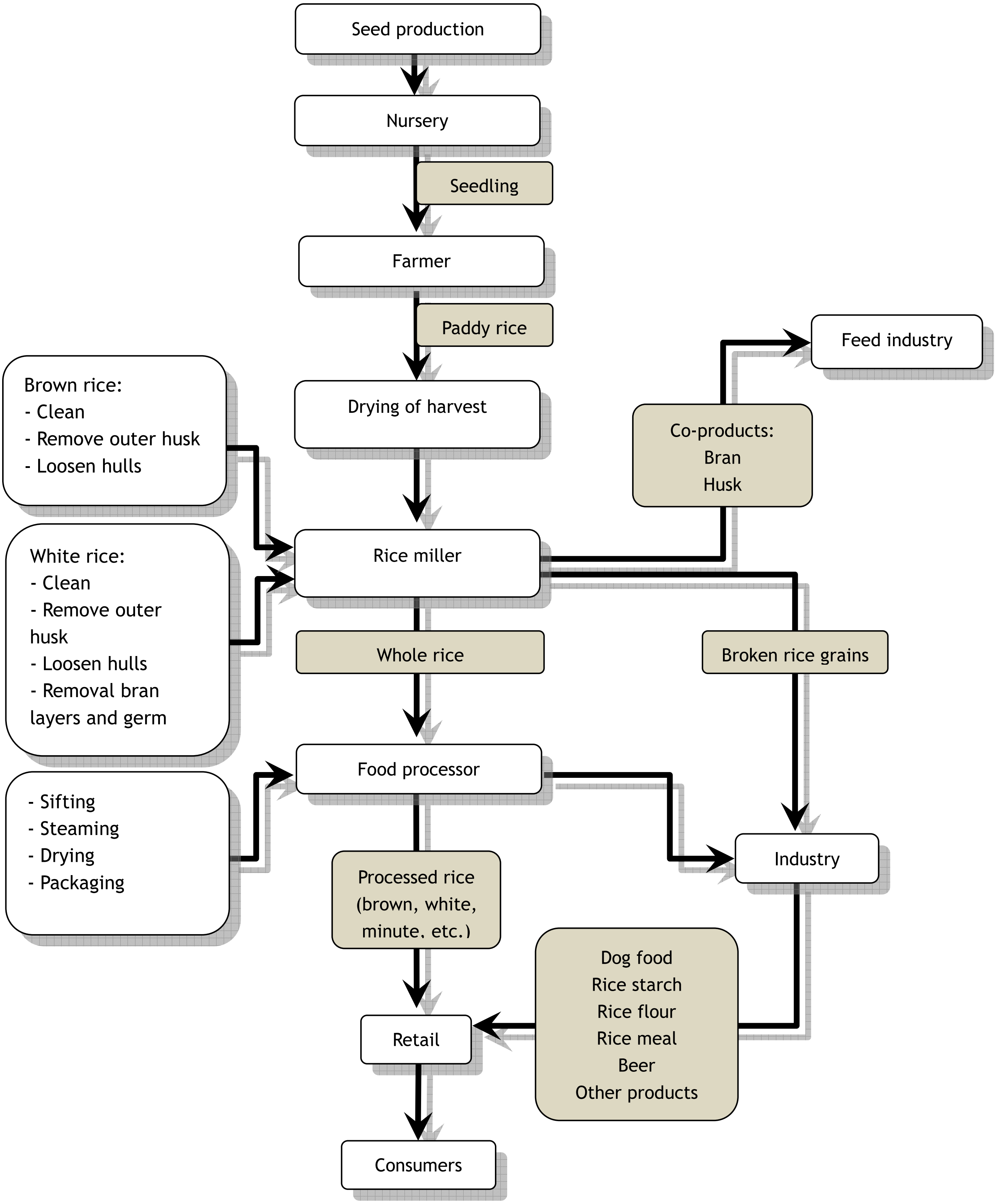
The food processing industry is concentrated. Around 80% is controlled by a few multinationals such as Unilever, Nestle, Sara Lee, the Danone group and Kraft. At the end of the supply chain these companies directly sell the end product to the supermarkets.

Around 60% of the total rice consumption is distributed through the supermarket channel, around 20% is processed further by the industry for feed (waste from the milling process) and rice snacks. The remaining 20% is distributed through specialty shops (Fair Trade, organic shops, took-shops and small shops), the out of home and the catering industry. The main supermarket organizations are Ahold (Albert Heijn), Laurus (Super de Boer, Edah, Konmar), Schuitema (C1000), Aldi and Sperwer (Plus, Spar).

Sources

- COGEM overview field tests worldwide 2006 – half 2007
- CREM: Rice, a first analysis for exporting to the EU (2004)
- E-mail conversation with Chinese biology PhD in Netherlands
- E-mail conversation with Guyana Rice Development Board (www.grdb.gy)
- E-mail conversation with Pesticides Eco-Alternatives Centre, China (www.panchina.org/english)
- E-mail conversation with Rice Research and Extension Center, University of Arkansas (http://aaes.uark.edu/rice.html)
- Greenpeace: Rice at risk – will there be a choice with GE rice? (http://www.greenpeace.org/raw/content/usa/press-center/reports4/rice-at-risk-will-there-be-a.pdf)
- http://faostat.fao.org/site/535/default.aspx#ancor
- http://faostat.fao.org/site/567/default.aspx#ancor
- http://nl.wikipedia.org/wiki/Rijst

- IFAT, FLO and EFTA: Rice Value Chain Analysis, Ir. Corné van Dooren, 2005
- Personal conversation with Alesie
- Personal conversation with Hivos
- Personal conversation with Van Sillevolt Rijst
- USDA, Report of Liberty Link Rice Incidents, October 4th 2007
- www.alesierice.com/aboutrice.html
- www.asiadhrra.org/downloads/april_2005/riceprimer.pdf
- www.fairfood.org
- www.irri.org/about/faq.asp
- www.i-sis.org.uk/GMcontamination.php
- www.ismea.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2671
- www.ricehull.com/common_uses/default.asp
- www.sdnp.org.gy/minagri/subsectors/rice/index.htm#Overview
- www.usarice.com/index.php?option=com_content&view=article&id=671&Itemid=386



Seed production
Nursery
Seedling
Farmer
Paddy rice
Drying of harvest
Brown rice:
- Clean
- Remove outer husk
- Loosen hulls
White rice:
- Clean
- Remove outer husk
- Loosen hulls
- Removal bran layers and germ
Rice miller
Co-products:
Bran
Husk
Feed industry
Whole rice
Broken rice grains
- Sifting
- Steaming
- Drying
- Packaging
Food processor
Industry
Processed rice (brown, white, minute, etc.)
Dog food
Rice starch
Rice flour
Rice meal
Beer
Other products
Retail
Consumers

Chain characteristics that influence admixture

With help of the chain analyses for potato, maize and rice specific characteristics that influence admixture have been identified. Below these characteristics are listed per crop and per part of the chain. We have also identified a few general characteristics, that apply for all three chains.

One important factor that influences almost every part and all crops is the human factor. Awareness of admixture and the influence of human behavior at admixture is very important.

Potato

Risk assessment of admixture on the field and plant characteristics

- Due to limited flower development hardly any (cross) pollination occurs. Many commercial varieties either rarely flower, have distorted flowers or have flowers that soon shed, sometimes in the bud stage. Sometimes the plants do not reach the flowering stage.
- Literature research shows that an isolation distance of 5 and 10 meters is sufficient to prevent cross pollination (<0.1 %).
- There is always a possibility that viable potatoes are left on the field after harvest.
- There are no feral populations in the Netherlands.

Risk assessment of admixture with seed production

- True potato seed is only produced and used by specific breeding companies. These seeds are mainly produced in a contained environment like glass-houses and laboratories.
- During the development of new potato varieties different plants are cultivated separately. This also happens with new breeding lines. The tubers grown at the stem plant are cultivated separately from each other for several years. Only after extensive research and testing the separate lots are brought together again for commercial use.
- In contrast to many other countries, the Netherlands have set up an elaborate and extensive control and labeling system. All grown potatoes are visually checked for diseases and admixture during growth season. Also, laboratory tests are conducted to check for specific diseases. This thorough system prevents admixture and, if a case of admixture occurs, makes it possible to trace back the origin of the potatoes to its producers and cultivation location.
- The (seed) potato production companies are mostly set up as a co-operation. One of the advantages of this in relation to admixture, is

that the complete process, from acquisition to cultivation and processing is controlled by one company.

- Digital track and trace systems follow the consignments and also the transportation movements.
- There is little import of seed potato into the Netherlands. If so, imported seed potatoes are accompanied by a so called plant passport, guaranteeing origin and quality.

<u>Risk assessment of admixture in ware and starch potato production</u>

- During transport of different lots of potato the occurrence of admixture is possible. Due to locally oriented cultivation and transport a possible admixture event is not likely to develop into a widespread case.
- Admixture of different varieties on a global scale does not per se lead to a long lasting effect due to specific requirements for soil type and nutrient composition, and climate. Potatoes hardly survive winter circumstances, and are outcompeted by other plants in a subsequent season. Besides that, potatoes grow in specific areas, with specific growth conditions. Due to inability to grow, or increased vulnerability to diseases outside these specific areas, proliferation of an admixture event is limited.
- Potato plants are visually distinguishable. This facilitates control during field cultivation. Normally adverse plants are removed from the field by hand, but this may not be possible for GM varieties.
- Farmers can cultivate one or more potato varieties at their fields. These varieties may differ in seeding and harvest periods.

<u>Risk assessment of admixture in potato trade</u>

- Transport generally takes place over short distances due to the local oriented market. As far as seed potatoes are concerned, sometimes potato lots are shipped to North-Africa. This is done in bulk carriers. In this case certification and monitoring go as far as the European border.
- In the potato trade, cargos are inspected several times: during cultivation and during transport. All these inspections are conducted to ensure purity of variety, but mostly for prevention of diseases, and because of quality demands. During cultivation of seed potato, abnormalities are removed from the field. If a cargo of ware potatoes enters a processing plant and abnormalities are found, the cargo is discarded (seed and ware potatoes) or destined as feed.
- Limited admixture can occur when potato lots are stored on site, at the farm itself. If two adjacent storage boxes are not separated completely, admixture is difficult to prevent.

- Potato trade is locally orientated. Transport takes place over short distances due to the cargo weight. If admixture occurs this local orientation prevents large-scale events.
- If in one part of the chain the yield has a surplus, this surplus might be distributed to another part of the chain. This exchange of potato lots can provoke admixture. E.g. if the starch potato business is in need of more potatoes, sometimes the surplus of ware potatoes is used for this purpose. Seed potatoes might be used in the same way, or serve as feed. But important: industrial potatoes cannot be used for consumption, and both certainly not for seed potatoes.

<u>Risk assessment of admixture at the end of the potato chain</u>

- Admixture can occur between different lots prior to processing or during processing of consumer potatoes. This kind of admixture does not have any consequences for cultivation, but can have serious implications for market release of the final product.
- There is a possibility that imported potato products contain admixture with GMOs. This is difficult to prevent. Furthermore possibly samples of unexpected compounds may be present e.g. soy. Since these compounds are not expected to be in the product it is not likely that they are detected unless specifically sought for.

Maize

<u>Risk assessment of admixture on the field</u>

- Wind pollination is a risk factor for admixture on the field, but is largely dependent on local and weather circumstances. That is why the European Commission has written a recommendation for guidelines for coexistence[2], laying the responsibility for coexistence guidelines with the Member States. In the Netherlands, several stakeholders have agreed on isolation distances. Between GM and conventional maize the isolation distance is set at 25 meters, between GM and organic maize the isolation distance is set at 250 meters. Other countries, such as Slovenia, consider buffer zones to prevent admixture.

---

[2] *Commission Recommendation on guidelines for the development of national strategies and best practices to ensure the co-existence of genetically modified crops with conventional and organic farming, 23 July 2003: http://ec.europa.eu/agriculture/publi/reports/coexistence2/guide_en.pdf.*

Risk assessment of admixture with maize seed production

- Cross pollination is a problem here as well as with normal maize cultivation, however the effects of admixture are larger because seed is the beginning of the whole supply chain.
- There is a possibility that admixture will occur at the seed bank, so the next generation will be contaminated. This can lead to a wide spread and long lasting case of admixture.
- Seed storage of forage maize in the Netherlands does not pose any threat for admixture, because the seeds will not survive the climate here.
- In Chile, GM as well as non GM maize (seed) is being cultivated. Chile also houses field tests from for example the USA. This is a risk for admixture at the beginning of the supply chain.
- Seed companies claim to be very strict in separating different maize varieties. That holds for GM varieties as well.
- Certification of seeds is obligatory according to the OECD scheme agricultural seeds. In the Netherlands, NAK (Dutch General Inspection Service for agricultural seeds and seed potatoes) is the organization to inspect the OECD scheme.

Risk assessment of admixture on the field

- Wind pollination is a risk factor for admixture on the field, but is largely dependent on local and weather circumstances. That is why the European Commission has written a recommendation for guidelines for coexistence (July 23, 2003), laying the responsibility for coexistence guidelines with the Member States. In the Netherlands, several stakeholders have agreed on isolation distances. Between GM and conventional maize the isolation distance is set at 25 meters, between GM and organic maize the isolation distance is set at 250 meters. Other countries, such as Slovenia, consider buffer zones to prevent admixture.

Risk assessment of admixture with maize production

- Cross pollination with other cultivated maize varieties.

Risk assessment of admixture during trading

- Authorization processes differ between the USA and Europe; application periods and criteria are different. This results in the admission of GM-crops on the US-market whereas these crops are not (yet) allowed in Europe, so called asynchronous authorization. There is a chance that in the USA GM maize, not authorized in Europe, is mixed with maize meant for the European market. The European feed industry therefore made agreements with the US feed industry that introduce measures to prevent this admixture. However, these agreements are not full proof. Besides that, the Dutch and US authorities work together to anticipate on cultivation of new GM varieties in the US. If a new variety, that is not (yet) authorized in Europe, will be cultivated in the USA, the European authorities specifically inspect cargos coming from that area.

- Ad hoc purchases are a higher risk for admixture than the usual trading routes. It is also more difficult to trace the origin of a consignment.
- Maize seed trading companies usually ask for a non GM declaration from their suppliers(generally, no test is done to support these declarations). When they start working with that supplier these declarations are verified. If the declarations prove valid, the frequency of inspections decrease over time.
- A new problem these days is that maize sometimes is contaminated with other GMOs, such as soy. If soy is not a basic ingredient, and the maize contains GM soy after admixture, the product should be labeled GM (as it contains 100% GM soy). The regulatory authorities are discussing how to deal with this issue.
- The prevention of admixture is usually driven by economic reasons. In the specific case of maize this could be a disadvantage because maize gluten feed is a waste product in the USA. This means there is no economic advantage at all to separate the chains.
- A lot of maize is nowadays imported from Paraguay, because there exists no GM maize cultivation there yet.
- There is a possibility that imported maize products contain admixture with GMOs. This is difficult to prevent. Furthermore possibly samples of unexpected compounds may be present e.g. soy. Since these compounds are not expected to be in the product it is not likely that they are detected unless specifically sought for.
- The countries that export to the Netherlands can also import maize themselves. That means the maize we import does not necessarily originates from the country we buy the maize from.

<u>Risk assessment of admixture at the end of the supply chain</u>

- Maize waste from the food chain can be used for feed. Since it is waste, there is less control.

Rice

<u>Risk assessment of admixture with seed production</u>

- In Asia, rice seed production takes place in the country itself and usually on a small scale. This part of the supply chain is therefore not very transparent and Dutch and European rice importers often do not have insight in this part of the supply chain.

- It takes up to 15 years to qualify rice seed for the market. One mistake in the beginning of this supply chain will only be discovered after a long time (predominantly by laboratory testing)especially since rice varieties are not easily visibly distinguishable. This makes it more difficult to identify the source of admixture and to identify other parts of the supply chain that may be contaminated.
- The presence of feral rice populations and the incidence of volunteer rice make zero contamination of rice seed in the long run not realistic.

Risk assessment of admixture on the field

- Out crossing to wild relatives is an important risk for rice. It leads to mixed wild GM – non-GM rice populations that store and stack GM genes and that cross with cultivated rice again and again. Moreover, out crossing between cultivated GM and non-GM rice varieties is a risk factor as well.
- There is always seed shatter of viable rice seeds (crop and feral) on the field (5%-10%).

Risk assessment of admixture with rice production

- The difference between American and Asian production methods has an effect on possible routes for admixture. The industrial production method results in less control by the farmers, because they do not visually check their crops. This in contrast to the Asian method, where farmers harvest by hand, and therefore can identify other varieties. A prerequisite is that the GM rice looks somehow different than non-GM varieties.
- The large scale presence of both feral rice and rice volunteers make GM free production not tenable in the long run if GM rice is grown in the region.

Risk assessment of admixture during trading

- There are many players on the international rice market. More players, more buying and selling more transfers means more possibility of the occasion of admixture.
- Most European rice importers do not import from the USA and China, because of the chance of admixture.
- There is a possibility that imported rice products contain admixture with GMOs. This is difficult to prevent. Furthermore possibly samples of unexpected compounds may be present e.g. soy. Since these

compounds are not expected to be in the product it is not likely that they are detected unless specifically sought for.

Risk assessment of admixture at the end of the supply chain

- Rice cannot grow in the Netherlands, so even if rice is still viable when it is in the supermarket, it has no chance of surviving.

General characteristics that apply for the three chains

- Farmers share tools and transport means for harvesting.
- Continuously, field tests are conducted with GM varieties of rice, maize and sometimes potato. These field tests pose a potential threat to admixture during seed production as well as production of the final product (e.g. rice, maize, potato).
- In some cases the Netherlands imports rice, maize or potato, from a country that is not necessarily the producing country. That means the products we import do not always originate from the country we buy the rice from. This might have consequences for admixture.
- Transport, transfer and storage are the highest risk factors for admixture of the supply chains. Surplus in container ships, trucks or silos are also a high risk.

4 Cases of admixture

Introduction

Based on the expected availability of information and its applicability we chose to analyze three cases of admixture. Through desk research and interviews we analyzed three cases: Bt10 maize, Herculex maize and LLRICE601 rice. We would have preferred to analyze a potato case too, but none were known to us\. We asked ourselves several questions and tried to answer them. The complete answers can be found in annex III. In this chapter we summaries our results and formulate lessons learned.

Bt10

Bt10 maize is developed by Syngenta. The maize was modified with a gene from the soil bacterium *Bacillus thuringiensis* (Bt), which is inserted into the crop to act as a pesticide. The Bt10 maize also contained an inactive antibiotic marker gene. Between 2001 and 2004 Syngenta unintentionally produced and distributed several thousand tons of the Bt10 variety. This resulted in a total of 133 million to 183 million kilograms of maize that was distributed in the USA, Canada, South America and Europe.
Bt10 has no market authorization in the EU and has been replaced worldwide by Bt11 maize that exhibits the same traits (insect resistance), but originates from a different transfer event.

During tests that were performed to verify the purity of the Bt11 maize type (allowed in the USA and EU for cultivation for food and feed purposes) in December 2004, Syngenta discovered traces of Bt10 in Bt11 maize and reported this to the Environmental Protection Agency (EPA). In March 2005 the EPA informed the European Union upon which the EU set up certification regulations. Every cargo that entered Europe had to be certified not to contain any Bt10. In 2007 these extra controls were lifted again.

Probably, the contamination initiated with an unintentional switching in 1995 by mislabeling, but this was never acknowledged. It is highly unlikely that Bt10 as compared to Bt11 carried a real environmental or health risk. The authorization status was the core of the problem.

Herculex

Herculex RW maize was developed by Pioneer Hi-Bred (a DuPont Business) and Mycogen Seeds (a Dow AgroSciences LLC subsidiary). The Herculex maize provides insect protection against the larval stage of the root worm. The maize contains two “CRY-genes”, originating from a common soil bacterium *Bacillus thuringiensis* (Bt).

In 2006 the Herculex variety was not authorized by the EU. However, in April 2006 a Greenpeace Biosafety Patrol published test results indicating the presence of Herculex maize and other GM-maize in a cargo released in the port of Rotterdam. The cargo consisted of several lots. Some were not labeled as GM, but did contain GM maize of a type which was allowed in the EU. The lot with Herculex maize was labeled as GM, and contained the not authorized and because of this illegal maize variety up to 20% admixture. The Dutch Food Safety Authority (VWA) confirmed the test results and set out a recall. However part of the cargo was already processed as feed and was not retrieved, the unprocessed part was sent back to the USA. Based on a report of the EFSA, the VWA then considered the costs of a recall too high compared to the risks for human and animal health.
The VWA increased the frequency of inspections from 10% to 25% after this incident. Eventually, the Herculex maize variety was authorized for food, feed, import and processing purposes in the EU in October 2007.

The origin of the admixture remains unknown as no research was conducted to the cause of this incident. Due to the character (amount and source) of the admixture it is supposedly caused by mixing two lots during transfer.

LLRICE601 rice

The LLRICE601 rice was developed by Bayer CropScience. LLRICE601 is a herbicide resistant rice variety. From 1999-2001 Aventis CropScience (later taken over by Bayer CropScience) conducted field tests with the LLRICE601. Some of these tests were conducted at the Agricultural Center of the Louisiana State University. However, after the tests, the LLRICE601 rice was not further developed and this rice variety was never marketed.

In July 2006, Bayer reported that it found traces of unauthorized LLRICE601 rice in samples of commercial rice seed. Unofficial sources say it concerns 6 GM kernels in 10.000 kernels of rice. This seed may have entered the food and feed supply chain. Bayer reported this to the USDA. A thorough USDA investigation tried to find out how this could have happened. It was concluded that the presence of LLRICE601 rice was still limited to the long grain rice variety of 2003 Cheniere, but it was not possible to give a clear-cut answer to how this could have happened.

Riceland Foods was accused of having knowledge of this mixture in January 2006, but their contribution could not be made clear in this desk research.

In the meantime, traces of LLRICE601 rice were found in about 30 countries worldwide, resulting in import bans of long grain rice from the USA. Bayer CropScience and Riceland Foods faced many lawsuits for lost profits.

In the Netherlands, the VWA inspected 100% of all long grained rice imports from the USA during a half year. After this period, the amount of inspections was reduced to the usual 10%.

From their investigations the USDA formulated lessons learned that give good indications for the prevention of admixture in the supply chain.

Lessons learned

The USDA has performed intensive research on the LLRICE601 case and is to our knowledge the most intensive on an admixture case. In formulating the lessons learned, the conclusions in the report of the USDA were taken into account.

- If, during transport no intermediate tests are conducted, but only upon entering the EU or one of its Member States, it is impossible to point out at which point a certain admixture happened. This complicates a possible solution.
- Intermediary tests are too costly to be supported by either companies or governmental control institutions.
- The present certification system is inconclusive. When a cargo receives a non-GMO status at the start of the transport, this does not guarantee that at the end there is no admixture. During transport cargo's are mixed together to form larger bulk quantities, and during transfer admixture forms a risk. The cargo can still be labeled as non-GM after several transfer and mixing steps, however any admixture may only be found after inspection prior to entrance into the EU.
- Sample analysis can take several days to a few weeks which adds to costs for industry.

- If the test is conducted by a nongovernmental party, that is not able to put the processing of the cargo on hold, a possible recall becomes complicated, except where the test was ordered by the authorities.
- The seed producer or producer of starting material has an important role in the process of detection of admixture. Generally these companies have the information to develop specific detection kits. In the EU the companies are obliged to provide information about their GMO when applying for admittance, so the authorities can develop a detection method. It would be useful to develop a detection method in an earlier stage, for example when a company starts conducting field tests. Detection methods are mandatory in the EU upon application for a new variety, but not during the development and test phase. In the USA this development of a detection method is voluntary.
- Admixture events that occur at the beginning of the chain, e.g. during development of a new variety, or during field tests, can have long lasting effects. Thorough monitoring during this stage is essential.
- Currently seed samples are stored for two years, also those obtained during new variety selection. Current inspections are based on general tests aimed at general presence of a GMO. To be able to develop specific detection methods after an admixture event of unknown origin, seed samples should be stored for a longer period until it is certain that there will not be any risk of admixture with this variety. Storage criteria and period vary per country and per company. Development of standard worldwide criteria might contribute to the detectability of admixture.
- After detection of admixture the process of resolving its possible effects can be complicated. E.g. responsibility issues do not contribute to swift action. Who should take action and who should be consulted for the proper scientific information? Who is accountable for the actions involving the handling of an event? These responsibility issues should be resolved as soon as possible, prior to a possible new event to be able to take immediate action. In the Netherlands responsibilities are well geared between several organizations. However, this might not be the same in other countries.
- Companies should be aware of the latest insights on coexistence measures and cross pollination. Not in every company and country this is the case.
- Thorough quality and control systems are needed to monitor production and trade processes.
- A digital database of all documents related to a specific variety should be made available. This database should contain licenses, research

reports, etc. Such a database should enable swift action during an event.

- These cases may indicate that it is impossible to keep supply chains completely free of GMOs due to human action, transport and transfer, even if there are no GM varieties authorized anywhere in the world.

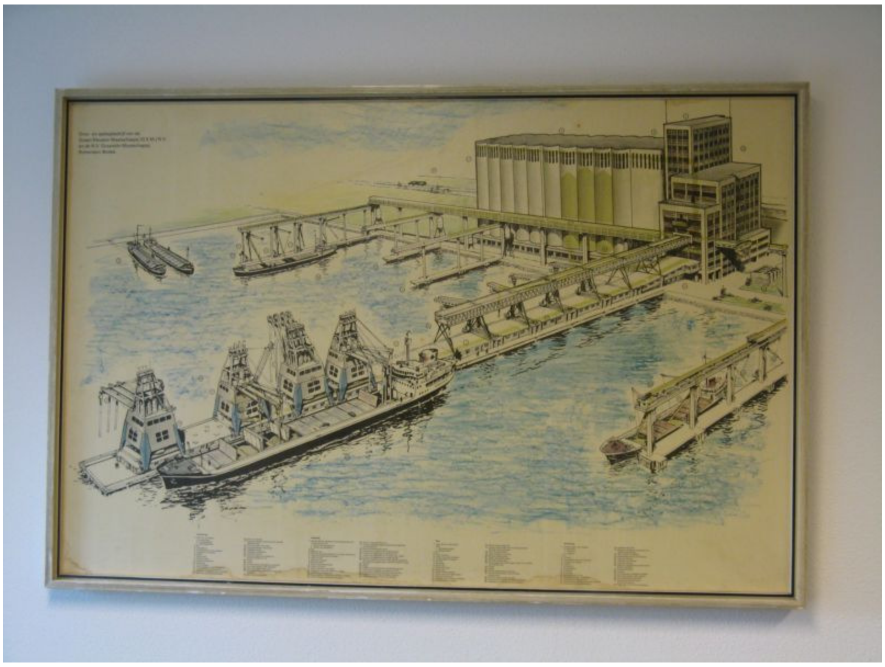
5 Visit to Rotterdam harbor

Introduction

As part of this project we visited Maas Silo in the Rotterdam harbor. Maas Silo is a storage and transfer company for grains and derivates in the Rotterdam harbor. Maas Silo not only has the possibility to store these products but also Maas Silo can store and transfer eatable and industrial oils.

During our visit on October 2^st^ 2008, a coaster from Ukraine arrived at the Rotterdam harbor and released its cargo. We monitored the release transport and storage of a cargo of grains. This report describes our observations, illustrated by pictures. Our goal was to identify possible characteristics of the chains that influence admixtures in this part of the chain. We therefore formulated several points in the process where spilling and admixture may occur.

Report



Overview of the silo

Depicted are the quays and the silo building. The building contains more than 50 large round silos. The spaces between the round silos are separated in compartments (70 to 700 tons), in order to use the space most efficient. In total, there is room for approximately 60.000 tons of grains. Every silo contains a specific product for one client. The silos are often not fully loaded. Through careful planning and the transfer of a freight from one silo to another, all silos are used optimally. If possible, Maas Silo tries to put the same type of grain into the same silo. So if maize was stored in the silo, the next freight is preferred to be maize again.

Quay

The ships that load and offload the grains, anchor at this quay. Over the whole length of the quay, raised conveyer belts are installed to transport products to the silos.

Emptying a ship into a barge

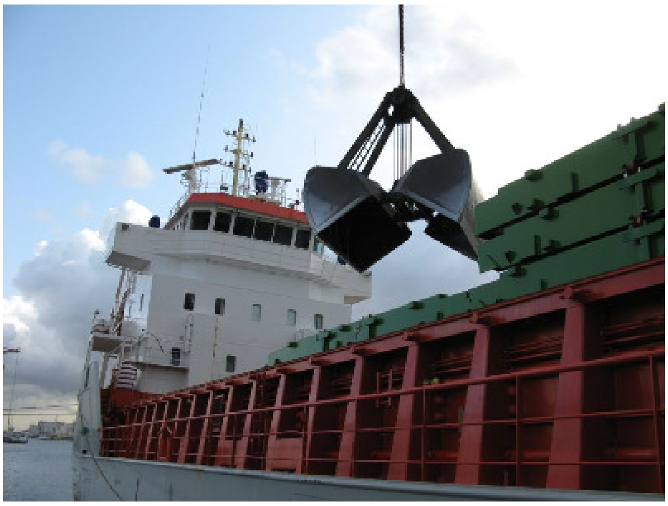
Large ships can be emptied directly into barges. This type of trans-shipment is suitable for freights that do not have to be stored, and that are packed in smaller units, like 'big bags' (see arrow in the photo).

Weighing pontoon

Some freights that are loaded directly into a barge, need to be weighed when they change owner. For this purpose a weighing pontoon can be hired.

The coaster from Ukraine

Large coasters, like this one, can contain up to 3500 tons of grains. Oceangoing vessels can contain much more. Coasters as well as oceangoing vessels cross the oceans. A ship is usually divided into compartments, each compartment containing different types of grains and sometimes other products as well.



Large crane takes grain from coaster

Offloading the grains is usually done by a crane that controls a gripper. This gripper can hold about 50 tons of grain. The cranes float on the water and may be hired per job.

The gripper in the coaster

The gripper offloads above the conveyer-belts

The photo shows the funnel that leads the freight to the belts.

Cleaning the coaster

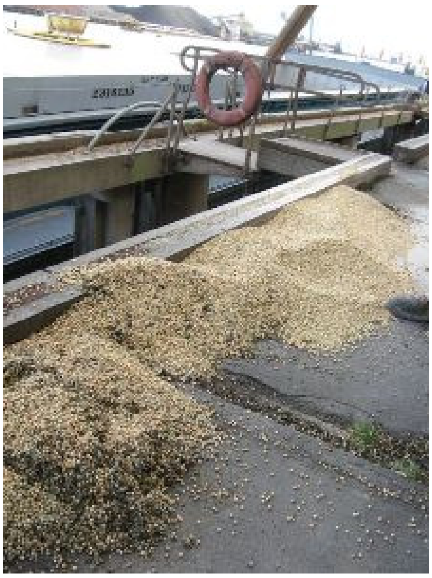
When the coaster is empty, it is cleaned using small bulldozers. There are small gaps in the walls of the coaster, that need to be cleaned as well. However, these walls are so high, that it is almost impossible to clean the coaster completely, including these gaps.

Trucks and trains

Not only ships offload their grains at Maas Silo, but trucks and trains as well. Trains offload above a pit, one wagon at a time. Trucks offload above the same pit. From this pit, grains are transported to the silos using conveyor belts.

Conveyer belts

The conveyer belts transport the grains to the silos. These systems can process about 900 tons per hour. While we were watching the belts, our tour guide took out several contaminations (e.g. a branch of wood, several varieties of grains).



Emptying the conveyor belts

This photo shows leftover grains that are discarded form the conveyor belts. Prior to every new load, belts are emptied on the quay.

Silos

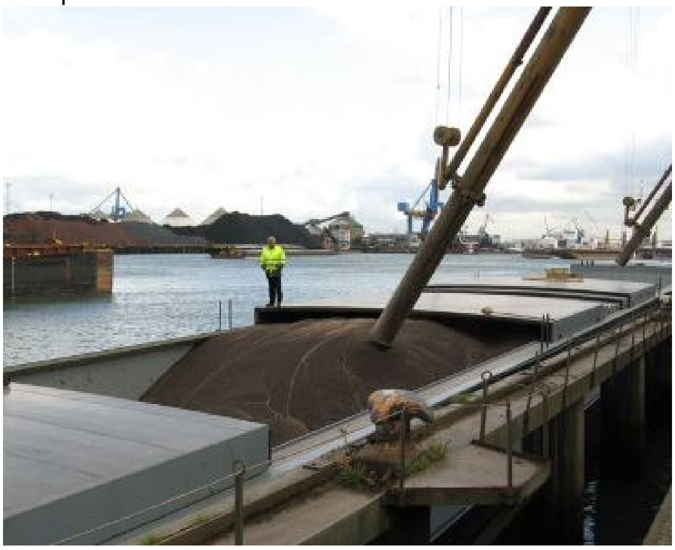
This photo shows the silos from the outside. The mean duration of storage is 6 months, but it can last for several years. Some customers pick up a small part of their freight every week; these silos empty slowly. The most important reasons for storage are: buffering (for import as well as export) and for trading (from a speculative point of view).
More often, goods are sold on their way to the harbor, which is not very convenient for Maas Silos planning scheme. Eventually, a much smaller freight might end up in the harbor than planned and it has to be rerouted to another, smaller silo.
In the silo, humidity level and temperature are monitored well and the silos are always dark inside. That is why products can be preserved for a long time.

Inside the silo building

In the right (square) part of the silo building on the previous picture the grain is transported upward to be deposited into the silo. This photo shows the inside of that building.
The conveyer belts have cups attached to them, so the grains can be transported upwards. The belts are inside the tubes on the photo.
The freights are weighed during this process. Maas Silo wants to keep track on how much grains they store. Buyers and sellers want this as well, because the harbor is often the place where a freight changes owner.

Loading the trucks

Often customers of Maas Silo pick up their freight by truck. Using the same internal system as described above, the grains leave the silos and are transported to the trucks.



Filling the coaster

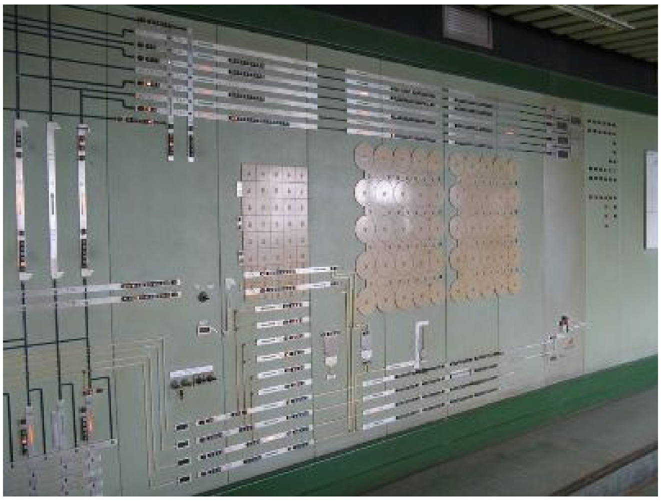
Besides trucks, the grains can leave the harbor by barge as well. On this photo a barge is filled with 1742 tons of rapeseed. This barge is located at the quay and the grains are brought there by the conveyer belts.

Controls

When a freight arrives at the silo, the buyer as well as the seller inspects the freight. Often both parties are represented by one (independent) company, such as SGS. Maas Silo takes samples as well to determine humidity, look for vermin and/or admixture with other grains.
There are different systems to make sure the seller offers his product with a good quality (such as CIF, Cost Insurance, Freight).

Saving the samples

All samples taken by Maas Silo must be saved for 6 months minimally because of the current tracking and tracing regulations.



Nerve centre

In the nerve centre of the silo building, all equipment is operated. Usually, three persons are present here. Besides them, four more work at Maas Silo: someone for offloading containers, someone for loading trucks, someone for inspections and someone for loading the ships.

Lessons learned

Within the transport chain of Maas Silo, there are several places where admixture or spilling can occur.

- The conveyer belts and silos are not emptied completely. It is too much work to do this every time. There are guidelines for prevention of admixture, but in practice most employees do not read them.
- The same holds for the barges and coasters.
- Spilling
    - During trans-shipment from the ship to the conveyer belts, the gripper may spill some grains on the quay and into the water.
    - After the emptying of the conveyer belts the surplus grains end up on the quay.
    - Spilling also occurs during transfer from and to the trucks, trains and containers.
- The whole system is designed for efficient handling of bulk transports of low value commodities. This does not correspond with the demands of handling carefully segregated lots of specified quality.

6 Workshop prevention of admixture

Goal and setup of the workshop

The workshop “prevention of admixture” was organized as part of this project. During the workshop the results of the chain analyses, including the simplified schematic overviews, were presented to an audience of experts from government, industry, science and NGOs. These experts discussed the chain analyses and the characteristics that influence admixture in the chains. Besides that, three cases of admixture were presented as input for a final discussion round in which the experts were asked to discuss possible methods for prevention. The workshop resulted in extra information about the chain analyses and suggestions and ideas for prevention of admixture.

A list of participants and the program of the day can be found in annex I and II respectively.

Report

Differences and similarities
In the first part of the program the participants discussed the similarities and differences between the supply chains and their implications for admixture.

The participants brought up into the discussion that the overviews of the chains were not complete. Throughout the chains, transport and trans-shipment play a vital role, and have a lot of influence on admixture. For example in the rice peeling and drying industry this is the major cause of admixture.

The control system, guaranteeing purity, is very strict and elaborate during the development stage of all three crops. Separation of different breeding lines is essential at this stage. In general new crops are bred in isolation and on a small scale, for example in greenhouses. Hence a possible admixture event in this stage is very manageable.

Potato is exceptional in this matter since it is reproduced vegetatively. All offspring originates from one (stem)plant that is carefully selected. Different breeding lines from one (stem) plant are cultivated separately. Admixture is only possible after all separate breeding lines are combined as

starting material for commercial seed potato cultivation during the several transport and transfer steps.
In maize seed production a quantity of basic seed is produced sufficient for two growth seasons. If a new variety is a success, a new batch of seed will be produced. Possible admixture that occurs during this two-year period is difficult to resolve, but of a temporary nature. In the rice chain, seed production is a relatively non-transparent process.

Potato varieties are visually distinguishable and during cultivation this distinguishing feature is used in the field to check for admixture. However, in the future it might be possible that GM potato plants lack visible phenotypical differences to other related varieties. In that case genetic testing would be necessary to differentiate between two different GM and/or non GM species. Purity tests for maize and rice are more complex in general, because these crops are not easily distinguishable by phenotype, thus requiring DNA analyses.

In the Netherlands an event took place that resulted in some experience with prevention of admixture in the potato chain. In this event the current standard control regulations in place proved sufficient to keep GM and non GM separated.

Extensive research to co-existence in the maize chain demonstrated that it is difficult to rule out admixture totally, even if GM and non GM production are kept separate. In the rice chain this is not an issue yet since there is no commercially cultivated GM rice. However, the LLrice601 case provided some information about possible causes of admixture.

Risks in the supply chains and the prevention of admixture
In the second part of the workshop the participants discussed the characteristics that influence admixture in the supply chains and the possibilities to prevent admixture.

General risks
The participants considered human action or interference as the most influential factor in admixture. Oftentimes employees are not aware that their behavior is essential for the prevention of admixture. For example limited cleaning in the shared use of agricultural equipment, caused by a lack of awareness among employees, can increase the possibility of admixture. In the global (bulk) market generally there are more transfer steps than in locally based trade. A higher amount of transfer steps relates to the risk on admixture.

Regulatory and control systems in the EU and the USA do not seem to fit in with each other. This increases the risk for admixture. For example the difference between regulation in the EU and the USA, but also between different companies in the same supply chain. These differences can be technically as well as socially or culturally based. Another risk factor are different attitudes towards GMOs . Outside the EU biotechnology is not such a dominant issue and therefore it is not as important as in the EU to keep GM and non GM chains separated.

The lack of connectivity also hampers traceability. Administrative systems should be able to connect to each other in order to track and trace cargos. This administrative system supports detection of admixture and swift action after an event.

In addition, the participants mention that the discussion about introduction of GM-crops into the environment is only valid for those parts of the chains involved in viable products. When discussing the possible introduction into the environment not only the viability should be considered, but also several other factors such as crossbreeding, climate, location, etc.

Finally the participants mention that inspections have their limitations. It is impossible to check all cargos. This is time consuming and costly. However introduction of a penalty system for companies can stimulate corporate involvement in prevention of admixture.

Risks per crop
In general the potato chain is well organized and besides seed potato production and transport, there exist little risks. During times of scarcity in the chain sometimes products from one part of the chain are used for other purposes than initially intended.

In the maize chain we can indicate several risk factors. Cross pollination can occur, despite of isolation distances, during seed production at locations where different maize varieties are cultivated close to each other. But also on locations where maize varieties are stored like silos or during transfer steps.

Due to the small scale and the local character of most import countries, rice production is very non-transparent and therefore difficult to control. Besides that, rice cultivation is very sensitive to admixture because (wild) varieties grow in the same areas where rice is cultivated. Crosspollination with wild varieties can lead to a long lasting admixture, since the wild varieties can cross pollinate back to cultivated rice species for several years.

Certain rice varieties bring in more money than others. Sometimes farmers mix rice varieties to increase the amount of the more valuable rice, for example admixture of plain rice with basmati rice.

General prevention methods
The participants suggested several actions and methods for prevention of admixture. Most important is the awareness of people that their behavior has influence on the prevention of admixture and that GM products might be an issue in other countries. Production and processing has to be designed and controlled in such a way that there is little room for human errors. Validated control mechanisms or stewardship from the industry leads to a better process control. Also a reward or penalty system set up for the employees (of the selling points) supports the awareness of admixture.

Labeling of non-GM products might serve as an incentive to separate supply chains and setup a GM free process. It might be possible to label meat(products) of which the cattle was fed with GM free feed. However legislatively it is possible in the Netherlands, but all supplements should be non GM, including e.g. vitamins.

Prevention of admixture should be one of the criteria in the design of new transport, sow, harvest and process machinery. Compartmentalization for example in bulk carriers instead of horizontal separation by sheets would benefit prevention of admixture.

Prevention methods can well be embedded in current quality and certification systems. However, these methods should be easily applicable and accessible.

The organic and Fair Trade (agri) businesses are set up as autonomous systems separated from conventional agriculture. These systems can be a model for the separation of GM and non GM. Import exclusively from countries that do not grow GM crops, would also benefit prevention of admixture. With more and more GM products on the market, this seems to be increasingly difficult. However, in some countries already a specific GM free supply chain is being set up, e.g. Brasil, where several companies are investigating possibilities to set up a GM-free soy chain.

Before prevention measurements are established one should consider whether these measures outweigh the consequences of an admixture event for people and environment. Is it cost effective, is the extent of the measurement in proportion to the risk for people and environment?

Specific prevention methods
Maize and rice seed can be color coated. This can be used to distinguish between GM and non GM, or any other characteristic. However, according to the industry this proposal is too costly and since there are many varieties this would not lead to a useful distinguishable system.

Packaging of rice in the production country prior to transport prevents admixture during transport and transfer. After harvest the rice can be sampled and packed in bulk packing. Upon arrival in the EU the test results are known, and if no admixture was present, due to the packaging this can still be guaranteed.

In the rice industry differently colored rice is separately processed in the factory. These are closed systems, that can be an example for other factories that want to process different rice varieties (for example, GM and non-GM). However, it is possible that little admixture occurs, but the risk is small since systems are thoroughly cleaned after use. Admixture also can happen when different varieties of the same color are processed. These are difficult to distinguish visually.

7 Control systems

Although an analysis of quality and control systems was not the scope of this project, it is an important factor in the prevention of admixture. We present a short non exhaustive overview of (quality) control systems that we identified during the course of this project.

Control systems in the EU

Within the European Union there are several systems involved in quality and safety control of development, cultivation and processing of crops. Predominantly they aim at non-GM crops and products, but they all include passages about GM-crop cultivation and processing.
Examples are:

- Good Agricultural Practices are a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economical, social and environmental sustainability e.g. EUREPGAP (rice) and Global GAP (maize). This includes coexistence.
- The Codex Alimentarius is a collection of internationally recognized standards, codes of practice, guidelines and other recommendations relating to foods, food production and food safety. Within the Codex there are specific regulations for potato, maize and rice. This includes admixture on the shop-floor.
- Hazard Analysis and Critical Control Points (HACCP) is a systematic preventive approach to food safety and pharmaceutical safety that addresses physical, chemical, and biological hazards as a means of prevention rather than finished product inspection. This includes admixture on the shop-floor.

Certification

Several systems aim at certification of products. This involves labeling of GMO containing products, but also certification of the GM crop itself.
Examples are:

- Identity preservation is an important measure for traceability: every product which is a genetically modified organism, or which contains genetically modified ingredients, must be accompanied by documents detailing the identity of this GMO during the whole production chain. For this purpose, the OECD introduced a naming system called Unique Identifiers. In case a GMO must be withdrawn from the market, identity preservation allows authorities to trace all shipments up to the food stores.

- Labeling according to the European Regulation EC/1830/2003: all products containing more than 0,9% GMO content must be labeled as such.

Inspection in the Netherlands

In relation to admixture in the Netherlands the Dutch Food Safety Authority (VWA) and inspections from Ministry of Housing, Spatial Planning and the Environment (VROM-inspectie) are responsible for the control of cargo that enters the country. The VWA inspects non-living GMOs that are imported as food or feed, VROM-inspectie inspects the import of living crops.
Both organizations sample at random, but aim at products that pose the largest threat to human health and environment. The VWA inspects according to guidelines 1829/2003 and 1830/2003. For authorized GMOs they inspect whether the admixture stays under 0,9% and whether companies take sufficient measures to prevent admixture. Besides that, the VWA inspects for unauthorized GMOs. In recent years this last type of inspection becomes more and more important. The VWA also works together with the customs office to determine when specific cargo's enter the country.

From 2004 to 2007, the VWA took 851 food samples, of which 213 tested positive for the 35S promotor, that means some sort of modification has taken place. Of these, 11 tested positive for Roundup Ready Soy, and 1 for GM maize. These samples were taken to test if the labeling is correct[3], so all GMOs are authorized in the EU. However, the test is not representative for the whole market, because the VWA tests specifically for on risk cargo's (for example cargo's with long grained rice from the USA during the time of the LLRICE601 case). According to the VWA, it seems the food industry takes enough measures to prevent admixture.

As for feed, there were more samples tested positive. 956 samples were taken, of which 393 tested positive for the 35S promoter. Of these, 295 tested positive for the NOS terminator, 75 for Roundup Ready Soy, 4 for GM maize and 1 for GM rapeseed. All these GMOs are authorized in the EU as well. Admixture is much more common with feed.

---

[3] *If a product contains more than 0,9% GMO content, it should be labeled according to EU regulation EC/1830/2003.*

Existing measure of prevention

There already is experience with the prevention of admixture. In our desk research we found the following possible prevention measures:

- Non-GMO declaration (but this has become unreliable).
- Cleaning and inspection by an accredited control agency of the silo to be used before discharge.
- Production order and rinsing procedures when GM as well as non-GM products are in the same production line or in the same transport means.
- The use of specific, unique internal codes and a good planning of the production order also help in reducing the contamination risk.

Traceability systems

There are several traceability systems that can guarantee GM free production of feed, in increasing order of reliability:

- GM free statement: the producer of the raw materials states that his product is GM free, based on the information available.
- Declaration of origin: information on the country of origin, that should be able to give sufficient guarantee for a GM free status.
- Experience oriented GM free declaration and analysis: GM free statement and an analysis of the product for GM presence.
- GM free supply chain certificate: raw materials should be able to be traced back to their origin, where administrative issues are supported by analyses.
- Identity Preservation: raw materials are under control during the whole supply chain and an extensive risk analysis makes the chance for admixture as low as possible.

Sources

- RIKILT - GGO-vrije diervoeders kennisscan (2004)
- VWA – Genetisch gemodificeerde organismen, resultaten monitoring en laboratorium onderzoek 2001-2007 (2008)
- Wikipedia
- Co-extra website
- VWA factsheet - Genetische gemodificeerde organismen, Resultaten monitoring en laboratoriumonderzoek 2001 - 2007 (2008)

8 Conclusions and recommendations

Introduction

Every year, the area of genetically modified (GM) crops worldwide increases. The use of GM crops in food, feed and industry increases as well. Unfortunately, recently some incidents have been reported in which crops or products unintentionally get mixed with (un)authorized GM crops or products. In the EU, the political decision-making on GMOs stagnated, with the result that GMOs are not (yet) authorized in the EU while authorized in other parts of the world. This creates a large gap between the GMOs authorized in the EU and those authorized outside the EU, specifically the Americas.

The Dutch authorities want freedom of choice for their citizens and environmental safety. For this reason they want to prevent admixture. In this project, executed by Schuttelaar & Partners, we have mapped the supply chains of three crops of which GM varieties are available or are under development: potato, maize and rice. In addition, we have pinpointed the characteristics of the supply chains that influence admixture, visited the Rotterdam harbor to see a grain warehouse at work, and studied three cases of admixture: Bt10 maize, Herculex maize and LLRICE601 rice.

The COGEM is specifically interested in the environmental consequences of admixture in the Netherlands, but in this project we used a broader interpretation of the theme. Other COGEM projects on this subject focus more on the (possible) environmental effects, while this projects offers the basics of the supply chains.

In this final chapter, we have first identified several differences and similarities between the supply chains of potato, maize and rice. Based on these differences and similarities, on the workshop results and the desk research, we have formulated our final conclusions and recommendations for all stakeholders involved in the three supply chains.

Conclusions

Main conclusion
In the Netherlands the environmental risks for the potato, maize and rice supply chains are minimal. All three crops do not sustain independently in the Dutch environment/climate.

Conclusions on plant characteristics

1. The characteristics of the plant determine to a great extent the possibility of admixture.
2. The possibility of introducing a certain (GM) crop into an ecosystem and it running wild depends on a number of factors. The discussion about the ability of survival of a certain (GM) crop, is therefore complicated. The risk of introducing a certain crop into an ecosystem is only a consideration for that part of the chain that is involved with viable plant material.

Conclusions on human factors

3. Human action is one of the most influential factors in prevention of admixture. Awareness of the risk for admixture of persons working among all parts of the chain is essential for the success of prevention methods.
4. Since mistakes happen due to human influence, it is inevitable that admixture occurs to some extent. Validation, control and certification regulations can decrease the chance that an incident develops into a scale that cannot be reversed, or managed.

Conclusions on factors inherent to the supply chains

5. Transport and transfer are an important factor with the prevention of admixture. During transport spillage may occur and during transfer complete lots are mixed. GM varieties may, intentionally or unintentionally, be involved in these events.
6. During times of scarcity in the chain sometimes products from one part of the chain are used for other purposes than initially intended for. For example crops that were intended for food purposes can be used for feed purposes. Lack of control during transfer increases the chance of unnoticed admixture. Strict control during transfer can minimize this risk.
7. If admixture occurs at the start of the chain, this results in an widespread and long lasting event. Admixture during transfer often is an incident and can be solved relatively easily.

8. A traceability system (to register origin and source of the GMO) is essential in order to find the source of admixture. The system for seed potatoes could be used as an example for other supply chains.
9. In all chains development of new varieties is the element which is most controllable concerning admixture because of the small size and limited cultivation area (sometimes only a enclosed laboratorial environment).
10. Admixture can happen in any part of the chain: breeding, cultivation, transport, processing. One of the general precautionary measures that can be taken is the complete separation of the chains of GM and non GM.
11. To determine if it feasible to set up a GM free supply chain, it is necessary to make a risk analysis per crop, or even per crop application.

Conclusions on international factors

12. Establishment of connectivity between different parts of the chain is not always without problems. Difference in regulations, scale, county, mentality, registration and control systems sometimes hinders problem free cargo transfer.
13. The chances for admixture are much higher with import from countries that grow or develop GM crops. A relatively easy way to prevent admixture is to import from countries that do not grow GM crops. The occurrence of several admixture events with GM rice induced a shift from import from the USA and China to import from countries such as India, Thailand and Guyana, where no GM rice is under development. This will be harder in the future, when the amount of GM products will increase.

Conclusions on national factors

14. At this moment in the Netherlands, the economic effects of admixture in the production chain of maize, rice and potato are larger than the effects on human health and the environment. This consideration should be taken into account when activities are planned after an incident.
15. The approach in the debate on admixture should be refined. The balance between costs and effect (risk for human and environment) should be well considered before severe measurements are taken.

Conclusions on regulations

16. Final products for food purposes are bound by strict food safety regulations. These regulations also take into account the presence of

GM material. This system should not be left out of the discussion on admixture since it is a well developed and solid control mechanism.

17. Current regulations are very general, but apply to different types of crops. Regulations have to be made more specific.

Other conclusions

18. Illegal cultivation and breeding contribute to the risk of admixture due to crosspollination, but also unexpectedly in transport and transfer. Such cases of admixture can only be noticed after control of lots during or after trade, transport and transfer.

Differences and similarities

The above mentioned conclusions lead to recommendations, but to be able to determine the feasibility of the recommendations several differences and similarities within the chains should be taken into account. These factors determine the strength of the recommendations.

Food, feed or industry?

For products intended for food purposes there is a quantitative difference between the three supply chains. Rice is a global source of food, potato provides less people in their daily food supply and only a small part of the maize production is used for human consumption.

Implications:

- Different regulation and different control systems.

Global or local market?

The three chains in this project are set up on different levels. The rice chain is globally organized, whereas the maize and potato chain are much more locally oriented in relation to cultivation and transport.

Implications:

- Large multinationals versus locally organized companies. There is a large difference in mentality and market approach.
- A globally organized chain can be divided into much more steps than a local oriented market, including more transfer steps. This results in a larger possible risk for admixture. The globally oriented chain can be more vulnerable for admixture.

Organization

Companies in the potato chain are predominantly set up as a cooperative business. The maize and rice chain are produced more individually, even by single farmers cultivating their own food and selling their surplus on a local market.

Implications:

- Control mechanism are well developed in cooperative companies, whereas there is no control mechanism in the case of individual farmers that are focused on their own food production.

GM content of the chains

GM maize is already cultivated in large quantities all over the world. At this moment there is no GM-rice or GM-potato commercially available for cultivation. However, currently there are many field tests with GM rice. Therefore the risk for admixture differs per chain.

Implications:

- The possible scale of an admixture event in different chains is different.
- Containment methods to prevent admixture are very different in these chains.

Intended use of production

If cultivation is for personal use only, there is less relevant regulation and control is less intensive. Cultivation intended for market purposes involves quality criteria.

Implications:

- Uncontrollable cultivation intended for personal consumption.

Risks for admixture in the field

Due to characteristics of the plant chances of admixture in the field differs per crop and also between different varieties within specific crops.
For example the distances between non-GM and GM cultivation are 25 meters and 250 meter for potato and maize respectively. This indicates a different pollination distance for these crops.

Implications:

- Per crop there is a different approach towards cultivation surface and distances.
- The risk of admixture and the threat to distribution into the environment vary per crop.

Mentality towards GM crops
The attitude towards genetic modification differs per country. In certain countries several GM crops are accepted. In these countries people might be less concerned with admixture since a national authority considered the crop safe prior to admission and hence they believe there is no imminent threat to people's health and environment. This effect is also present in industries involved with co-products of maize.
This is in contrast with the rice chain where there exists extensive control as a result of the strict regulations in the European Union.

Implications:

- If people on the shop floor are not aware of the risk of admixture, or do not acknowledge these risks, this increases the chance for possible admixture.

Transport
Whether it concerns small lots or bulk cargo, transport plays an essential role in all chains. Especially transfer is a weak point in relation to admixture.

Implications:

- Prevention measurements aiming at transport and transfer have a positive influence on the occurrence of admixture.

Human action
Human action is the most influential factor for admixture in the chains.

Implications:

- Precautionary measures start with the consumer; methods like education and information are therefore very important. Also methods to make human action as simple as possible contribute to a decreasing chance for admixture.

Recommendations

In this paragraph, we give recommendations that, in our view, will prevent admixture. We realize that some of the activities recommended will lead to additional costs. Each recommendation should therefore be checked on feasibility.

The human factor
A factor that influences admixture in all supply chains is human activity. People working in the chains often do not realize their behavior has

consequences for admixture. They are not aware of the fact that the products they work with are transported globally and that people in other countries may think differently about the accuracy of methods. ***For that reason we recommend to make all methods that can be used to prevent admixture easy to implement***. Equipment should be designed in such a way that the chance of admixture is as small as possible. Besides that, the design should also facilitate cleaning. Cleaning however should not only be facilitated by design, but also by regulations, and protocols. We have to realize that despite all protocols and administrative requirements, it is man that defines its success or failure of prevention methods.

The Netherlands

Specifically in the Netherlands, the largest risk factor is handling of the crops meaning: sowing, harvesting, transporting, etc. ***We therefore recommend to give farmers, contractors and others working with GM crops in arable farming a training on how to deal with GM crops***. This way, they can learn how their behavior effects admixture. This recommendation links up with a recommendation of minister Verburg of agriculture.

Specificity

In addition to this, ***we recommend to develop prevention methods that are specific for crop and production method provided they are easily accessible and workable***. The supply chains are often very complex and admixture is possible in every part of the chain. It is unrealistic to develop general prevention methods.

Bulk transports

For bulk transports, for example maize gluten feed from the USA to the EU, the transport and transshipment is the largest risk factor. During transport, cargo of GM maize gluten feed may mix with other transports several times, with the possibility of leaving a trace of cases of GM admixture. ***In order to prevent admixture during transport, we recommend to pack the GM crops in the country of origin, as close to the production site as possible, in such a way that admixture during transport becomes impossible***. For example in containers or big bags. Another possibility is to pack the non-GM crops, but this can be decided case by case.

New varieties

During the development of new GM varieties, it is very important to keep them separated from non-GM varieties. One case of admixture in this stage may have large consequences. An example is the LLRICE601 rice case, where during field tests with a new variety two varieties, without knowing, accidentally got mixed. Only after three years, this mistake was discovered. The consequences were widespread and long lasting, because during several years LLRICE601 rice was illegally imported in at least 24 countries. ***We recommend to intensify the inspections during new variety development at strategic points, in consultation with the companies. Furthermore we recommend to save samples taken during the development of GM crops for at least five years.*** This way, when something happens, it is easier to trace the origin of the admixture. For the execution of this recommendation, however, we depend on the cooperation of companies and governments abroad.

Technical and regulatory systems
Worldwide, there are different technical and regulatory systems concerning GMOs. That means there are different interpretations of definitions, different testing protocols, different regulations at force and different political decision making processes. It is unrealistic to think it would be possible to synchronize all systems. However, ***we recommend to collect all relevant data in one database, under supervision of an internationally recognized organization. For example, these data can be integrated in the database of the Cartagena Protocol.*** This database enables data comparison and we can anticipate on what's in development in other continents and create better understanding and coordination between all countries.

Cooperation
Several Dutch parties that have common goals in the prevention of admixture operate still on very individually basis. ***We recommend for all parties involved to discuss possible ways to cooperate, and to look beyond their usual partners for cooperation, for example Greenpeace and the VWA.***

Annex I: Participants of the workshop "Prevention of admixture"

Organization	***Name***
AVEBE	Peter Bruinenberg
Aviko	Matthijs Meijer
Biologica	Maaike Raaijmakers
Bureau GGO	Boet Glandorf
COGEM	Marjan Bovers
Greenpeace Nederland	Herman van Bekkem
Limagrain	Kees Noome
Ministerie van LNV	Jessica Thio
Ministerie van LNV	Ton Rotteveel
Ministerie van VROM	Hanneke Bresser
Monsanto	Ivo Brandts
Monsanto	Sarah Driessens
Productschap Diervoeder	Paulien van de Graaff
RIKILT	Theo Prins
Schaap Holland	Theo Meulendijks
Schuttelaar & Partners	Edwin Hecker
Schuttelaar & Partners	David Thelen
Schuttelaar & Partners	Ank Jansen
Syngenta	Hilde Willekens
Van Gorp Biologische Voeders B.V.	Arno van Gorp
Van Sillevoldt Rijst	Gabe Kielman
VROM Inspectie	Jan-Piet Tijssen
VROM Inspectie	Piet de Wildt
VWA	Emile Laurensse
Wageningen UR Plant Breeding	Clemens van de Wiel

Annex II: Program of the workshop “Prevention of admixture”

12.00 hr	Reception with a sandwich
13.00 hr	Welcome, explanation of the purposes of the workshop

Chains depicted

13.15 hr	Supply chain analyses of rice, maize and potato
13.45 hr	Discussion

Prevention of admixture

14.45 hr	*Lessons learned* from admixture incidents
15.15 hr	Break
15.30 hr	Discussion and formulation of advice
17.30 hr	Closing of the meeting and drinks

Annex III: Cases of admixture – extensive information

Bt10 maize

Who found the mixture and how?
In December 2004 Syngenta discovered the admixture of Bt11 maize variety with the Bt10 variety while reviewing breeding lines. The company reported this to the Environmental Protection Agency (EPA). Between 2001 and 2004 Syngenta unintentionally produced and distributed several thousand tons of the Bt10 variety.

Which company developed the GMO and where in the chain is this company located?
Syngenta developed Bt10 maize and Bt11 maize of which the latter is authorized for feed and consumption purposes. The Bt10 was a experimental variety which never was introduced on the market. Both varieties are very similar, but Bt10 contains an inactive ampicillin resistance gene. The admixture started at the beginning of the chain, at the development of a new variety.

What happened at the company?
Two types of genetically modified corn seeds (Bt10 and Bt11) were mixed up during the seed research. Syngenta identified the Bt10 event using advanced DNA-based testing. The Bt10 event was found in five Bt corn breeding lines in the USA, three of which were used between 2001 and 2004 primarily for pre-commercial development.
Bt10 has no market authorization in the EU and has been replaced worldwide by Bt11 maize that exhibits the same traits (insect resistance), but originates from a different transfer event.

What was the cause of the incident?
Syngenta spokesman in Lausanne told the New York Times ”The contamination started in an unintentional switching probably in 1995 possibly by mislabeling”.

What actions did the institutions involved take to trace the GMO and/ or recall the cargo?
When Syngenta notified the EPA, USDA and USFDA late December about the possible admixture, these governmental authorities investigated this claim. It seemed that these authorities did not take action until Syngenta made

the announcement in Nature at the 22nd of March that “from 2001 till 2004 the Bt10 maize variety was grown on fields in the USA”. After that, the European Commission requested for information about the Bt10 maize, and an explanation of the scale and background of the contamination. The European Union demanded that every quantity imported from the USA had to be tested Bt10-free before entering the EU. Also other countries like Japan and South Korea took similar measures. In January 2007 the EU lifted the extra controls of USA imports.
Besides governmental actions and regulations, in April Syngenta had to pay the USDA (US Department of Agriculture) a fine of $ 375.000 and in December a penalty of $1.5 million to the EPA.

Was there already a test available for this GMO, or was reference material released to develop a test?
No, in March there was no test nor reference material available. The EU asked Syngenta for this information on the 23rd of March. After several weeks Syngenta provided a detection method for Bt10 maize. This method was evaluated by the EU Joint Research Centre (JRC) and then applied in the European Union. This method was based on the presence of the antibiotic (ampicillin) resistance gene that was present in Bt10 but not in Bt11.

At what scale did the incident take place?
Syngenta stated that farmers in four US States planted about 15.000 hectares of Bt10 maize in the period from 2001 to 2004. This is estimated to yield a total of 133 thousand to 183 thousand tons of Bt10 maize which was distributed in the USA, and to Canada, South America and Europe. The European Commission estimated that 1,102 tons of the mixed maize varieties entered the European Union.

How far did the admixture penetrate the chain?
The Bt10 maize was cultivated and processed for three years prior to discovery. Bt11 was on the market for feed and food purposes, processed and unprocessed. The Bt10 variety therefore was able to penetrate the whole chain including end-products. After discovery Syngenta destroyed all seeds and plant material that might contain BT10 or contained them until destruction. Due to the widespread distribution complete removal of all Bt10 from the chain could take years.

What happened after the incident (extra controls, trade stop, recalls)?
The USDA considered the Bt10 variety safe for human and environment based on the resemblance with Bt11 that was already safe and admitted in

the USA. The European Commission however requested a test to identify Bt10 and forbid import of maize containing Bt10. Cargo had to be certified not to contain Bt10 prior to import into the EU. In 2007 this certification restrictions were released.

Did the company change its conduct of business to prevent this from happening again?
The company has extensively investigated the misidentification that led to the propagation of Bt10. Since the misidentification, enhanced quality assurance and control procedures designed to prevent recurrence have been implemented.

What were the chances of introduction into the environment in The Netherlands?
None, since the maize products containing Bt10 were not viable anymore.

Sources

- Nature, 14 April 2005, 434: p804 “Don’t rely on Uncle Sam”
- Nature, 31 March 2005, 434: 548 “Stray Seeds had antibiotic-resistance genes”
- Nature, 24 March 2005, 434: 423 “US launches probe into sales of unapproved transgenic corn”
- RIVM, 2007, Briefrapport “Detectie van niet-toegelaten genetisch gemodificeerde organismen.”
- Syngenta, March 2005, Fact Sheet “Biotech Corn Release”
- USEPA, Statement on BT10
- European Committee, statement 18 April 2005, “Inzake noodmaatregelen met betrekking tot het niet-toegelaten genetisch gemodificeerde organismen “Bt10 in maïsproducten”
- Several press releases by Greenpeace, 2005
- Saveourseeds.org, dossier: “Syngenta’s unapproved GM maize variety “bt10”distributed worldwide since 2001”
- Personal communication with stakeholders
- ISIS Press Release 30 March 2005 “Syngenta's GM Maize Scandals”.
- New York Times, Tom Wright, 9 April 2005: “US fines Swiss company over scale of altered seed”
- New York Times, Paul Meller, 6 April 2005: “Europe leaves modified corn inquiry to US.”
- Corporate Social Responsibility Report 2005, Syngenta

Herculex maize

Who found the mixture and how?
On the 10th of April 2006 Greenpeace took samples from the cargo of the bulk carrier Pakrac releasing its cargo, consisting of maize gluten and maize feed flour in the port of Rotterdam. These samples were examined by Genetic ID in Ausburg, Germany. The cargo consisted of two different lots, one labeled GM, one labeled non-GM. The GM cargo contained illegal Herculex RW maize (full name Corn Dow AgroSc Herculex RW ,DAS59122) and the non GM cargo contained also GM varieties like MON 863, which is allowed in the EU. Two weeks after Greenpeace discovered the GM maize, the Dutch Food Safety Authority (VWA) confirmed these results.

Which company developed the GMO and where in the chain is this company located?
Pioneer Hi-Bred (a DuPont Business) and Mycogen Seeds (a Dow Agro Sciences LLC subsidiary) developed the maize variety. These companies are the beginning of the production chain. Herculex RW has been genetically modified with the Bt trait to provide resistance against insects.

What happened at the company?
This question is not relevant in this case.

What was the cause of the incident?
From the data that was available it we assume that the admixture occurred during transport and transfer. This indicates that there might have been more cargos that contained admixture with Herculex RW. Admixture of Herculex RW was found up to 25%. These percentages do indicate mixture of two cargos. Contamination at an early stage in the chain, like the producing companies, results in wide spread admixture with a low percentage of admixture, and not only one cargo. The exact source or location of contamination remains unknown.

What actions did the institutions involved take to trace the GMO and/ or recall the cargo?
After Greenpeace presented its results, the European Committee ordered the Dutch Government to take action. The Dutch Food and Authority tested the samples also and confirmed the presence of Herculex RW on 7 May. Based on these results the remainder of the cargo was send back to the USA. The part of the cargo that was already processed in feed was not retrieved. The Dutch Food Safety Authority considered the GM maize not to pose any threat to animal or human welfare. This opinion was based on the

opinion of the EFSA. For the longer term the VWA announced that it would increase the frequency of inspections of US ships, from 10% to 25%.

Was there already a test available for this GMO, or was reference material released to develop a test?
Yes, since Herculex RW was already admitted in the USA, there was a test available.

At what scale did the incident take place?
The Coaster contained 15.000 tons of Maize. It is unknown whether this was part of a larger bulk stock.

How far did the admixture penetrate the chain?
The contaminated maize was partly processed for feed an fed to cattle. Therefore we can assume that part of admixture ended up in the feed.

What happened after the incident (stop the trade, recalls)?
The Dutch Food Safety Authority (VWA) confirmed the test results and set out a re-call. Part of the cargo was already processed as feed and was not retrieved, the unprocessed part was sent back to the USA. Based on a report of the EFSA the VWA considered the costs of a re-call were too high to equal the risks for human and animal health.
The VWA increased the frequency of controls from 10% to 25% after this incident. Eventually the Herculex maize variety was allowed for food, feed import and processing purposes in the EU in October 2007.

Did the company change its conduct of business to prevent this from happening again?
Since the origin of the admixture could not be retrieved, there was no direct responsible party that could have taken measurements to prevent admixture in the future.

What were the chances of introduction into the environment in The Netherlands?
Since the maize was processed into pellets and flour, there was no risk of introduction into the environment.

Sources

- Volkskrant 28 April 2007 “Vreemde genen in de boot”.
- Greenpeace, press release 28 April 2007: “Greenpeace stuit op illegale maïs bij steekproef”.
- Kamervragen van Velzen, 11 May 2007.

- Foodqualitynews.com, 11 May 2007,"Dutch to increase import checks following GM discovery".
- GM-Free Ireland, 23 May 2007 "Irelands genetically modified food scandal".
- Pioneer and Dow Agrosciences, Factsheet Herculex RW Rootworm, general characteristics and safety.
- DuPont press release 24 October 2007: "EU approves Herculex RW Corn for food, feed , import and processing".
- VWA, press release, 9 May 2007 "VWA verhoogt importcontroles op maïsproducten uit de VS".
- Personal communication with stakeholders.

LLRICE601 Rice

Who found the admixture and how?
On July 31st 2006, Bayer CropScience informed the FDA that trace amounts of a bioengineered variety of rice were detected in samples of commercial rice seed, and may have entered the food and feed supply in the United States. The bioengineered variety of rice, called LLRICE601, expresses the phosphinothricin-N-acetyltransferase (PAT) protein which provides tolerance to glufosinate-ammonium herbicide. This rice variety, not intended for commercialization, was not submitted to FDA for evaluation under the Agency's voluntary biotechnology consultation process. However, crops containing the PAT protein have previously been evaluated for safety by FDA on a number of occasions through the Agency's voluntary biotechnology consultation process. Bayer has informed the Agency that LLRICE601 is present in some samples of commercial rice seed at low levels.

Which company developed the GMO and where in the chain is this company located?
Bayer Crop Science is a seed producing company and therefore is at the beginning of the supply chain.

What happened at the company?
Aventis CropScience conducted small scale field trials with LLRICE601 rice between 1998 and 2001. Aventis CropScience was taken over by Bayer in 2002. Some of the tests were conducted in collaboration with The Agricultural Centre of the Louisiana State University, an important rice breeding station in the USA. On August 31st 2006, this Centre stated that they found trace amounts of LLRICE601 in the 2003 foundation seed of one of their long-grain rice varieties. Somehow varieties were mixed.

Riceland Foods Inc. of Stuttgart, the world's largest rice miller, who sold much of the mixed rice, is said to be failing to inform its member-farmers about the fact that the then-illegal rice variety had entered their fields in “wanton and in conscious disregard to it consequences”. Some of the farmers think that Riceland officials knew when the GMO contamination was discovered in January that it had to be trace amounts of LLRICE601. A rice export customer in Europe found the contamination and asked Riceland for an explanation. Riceland, which says it cannot comment on the situation now because of the litigation, said when the story broke that it thought the GMO was a grain of biotech corn or a biotech soybean that had accidentally been mixed in with the rice and it took time to track down and find the exact source.

Riceland says that when it first learned of the contamination, it was unable to determine the nature of the GMO contaminant, though the company knew it was somehow linked to Liberty herbicide. Riceland then asked Bayer to identify the organism. After several weeks of testing, Bayer determined the material was LLRICE601 but said it didn't know the source of the contaminated rice.

For its part, Bayer CropScience said in a press release in September, “The reason why LLRICE601 was discovered to be present in commercial rice samples in the USA is not clear.”

What was the cause of the incident?
USDA investigators were able to determine that the presence of LLRICE601 was limited to the long-grain rice variety of 2003 Cheniere. No short- or medium-grain rice varieties tested positive for LLRICE601. Investigators had hoped to identify how each GM rice line entered the commercial rice supply, but the exact mechanism for introduction could not be determined. Aphis recognized at the start of the investigation that it faces a difficult task given that the field tests for these GE lines were conducted between 1998 and 2001. In addition, during the investigation, it was discovered that some records that might have been pertinent had not been maintained and were not available.

What actions did the institutions involved take to trace the GMOs and/or get them back?
The USDA devoted considerable resources to the investigation to ensure that it was conducted in a thorough and extensive manner. The investigation involved more than 8,500 staff hours gathering information across 11 States and Puerto Rico, and site visits to more than 45 locations

in 25 counties in 6 States. USDA officials tested 396 samples from 57 rice varieties that had been harvested between 2002 and 2006. Because rice seed is not normally held for more than 2 years, the oldest samples that could be obtained were form 2002.
The LSU AgCenter in Louisana investigated whether the traces of LLRICE601 were also present in other varieties grown by the centre. This was not the case.

Was there already a test available for this GMO, or was reference material released to develop a test?
GIPSA, the Grain Inspection, Packers and Stockyards Administration verified two analytical methods that Bayer CropScience provided to detect LLRICE601. Both tests are real-time polymerase chain reaction (PCR) methods. One detects the 35SBar DNA sequence found in LLRICE601, and the other detects the DNA sequence specific to the LLRICE601 trait.

At what scale did the mixture take place?
Six kernels in 10,000 kernels of rice (0.0006%) (unofficial sources).

How far did this GMO get through in the chain?
Traces of LLRICE601 were found 31 countries: in Africa (Ghana, Sierra Leone), Asia (China, Japan, Philippines), Europe (Austria, Belgium, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Norway, Poland, Slovenia, Sweden, the Netherlands, the UK), the Middle East (Kuwait, United Arab Emirates), North America (USA, Canada), and South America (Guatemala, Mexico, Nicaragua). Not in all countries specifically LLRICE601 was identified, but at least GM long grain rice has been reported in these countries during the period LLRICE601 rice was discovered in other countries (August – November 2006). According to a Greenpeace report (Rice industry in crisis), 24 countries worldwide were affected by LLRICE601.

In some countries, the rice had to be withdrawn from the supermarkets, while in other countries the GM rice was intercepted in the harbor. LLRICE601 was found in food as well as in feed.

What happened after the incident? (extra controls, stop the trade, recalls?)
Based on the available data and information, FDA concluded that the presence of this bioengineered rice variety in the food and feed supply poses no food or feed safety concerns.

In November 2006, USDA decided to down regulate the LLRICE601. This rice was compared with other GM rice varieties, that also were inserted with the *bar* gene: LLRICE62 and LLRICE06. It was concluded that the three rice varieties were similar. Because 62 and 06 were already deregulated (but not marketed), the 601 variety was deregulated as well.

In September 2006 the European Commission decided that “Member States shall allow the first placing on the market of the products referred to in Article 1 only where an original analytical report based on a suitable and validated method for detection of genetically modified rice ‘LL RICE 601’ and issued by an accredited laboratory accompanying the consignment demonstrates that the product does not contain genetically modified rice ‘LL RICE 601’.” Besides that, Member States should take appropriate measures to verify the absence of ‘LL RICE 601’and to ensure that the products containing ‘LL RICE 601’ are not placed on the market.

A draft Commission Decision imposing mandatory counter testing for unauthorized GMOs in all imports of US long grain rice was endorsed in October 2006 by Member State experts in the Standing Committee on the Food Chain and Animal Health. The decision follows the lack of agreement by the USA authorities to a common sampling and testing protocol which would ensure a high level of consistency and accuracy in the tests for the unauthorized GM rice LLRICE601 in consignments to the EU. On 4 October, the European Commission gave Commissioner Kyprianou the mandate to introduce this counter testing, but first allowed 15 days to seek USA agreement on a common approach to sampling and testing. Despite extensive discussions between both sides, the USA were unable to agree on the proposed protocol. In addition to this certification requirement, all consignments of US long-grain rice will also be sampled and tested at the point of entry to the EU by Member State authorities according to the EU testing protocol attached to the proposed decision.

EFSA considered that traces of LLRICE601 are not likely to pose an imminent safety concern to humans or animals. On August 19 2006 , the Japanese Ministry of Health, Labor and Welfare announced a restriction of the import of long grain rice from the USA. Later, Japan widens its testing of US rice for unauthorized GMOs to small and medium grain rice. Other countries banned the import of US long grain rice as well, affecting the USA rice market considerable.

A lot of farmers and rice millers filed a lawsuit against Bayer Crop Science and against Riceland Foods. In November 2007 Greenpeace claims that trace amounts of genetically modified varieties of rice that were found commingled in the USA rice supply in 2006 caused more than $1.2 billion in damages and additional costs. The USA rice federation says it is impossible to know what the cost is.

After the incident, the USDA formulated lessons learnt from this incident and from its 20 years of experience in the regulation of biotechnology. The following points are abstracted from these lessons, but more generalized.

1. Make sure records are of good quality and complete to facilitate traceability.
2. Saving representative seed samples of new events may be useful in this process as well, so consider the obligatory delivery of seeds and saving them for a longer period of time.
3. Consider to ask the applicants to set up a contingency plan that addresses the unauthorized release of regulated articles, including dispersal, commingling, and persistence due to climate, animal incursion or human error. In the LLRICE601RICE case the applicants were unclear about their responsibilities.
4. The responsibility for corrective actions to be taken in the event of unauthorized releases should be with the researchers, that have the greatest level of expertise with the plant line involved. When the federal government is responsible, the time required to determine the correct action can cause delays.
5. To make sure the samples are handled in a scientifically sound way, scientific institutions might need to work together. This requires institutional awareness, links and agreements, preferably prior to an event of unauthorized release.
6. Valid contractual relationships are necessary between researchers and/or research institutes in order not to hinder investigations.
7. Always keep up to date with the latest scientific developments, for example for isolation distances, pollen flow, and out crossing.
8. Set up a robust quality management system for the biotechnology R&D community that may reduce the likelihood of compliance problems.
9. Consider the option to electronically store all information associated with permits and notifications. This would enhance the ability to respond to an incident.

Sources

- Arkansas Business, “Tainted rice testing state farmers' trust: bioengineered variety threatens finances”, December 4 2006.
- Bayer CropScience Press release “Comments of Bayer CropScience on LLRICE601”, September 19 2006.

- Commission decision on emergency measures regarding the non-authorized genetically modified organism 'LL RICE 601' in rice products, September 5 2006.
- Greenpeace market report, "Rice industry in crisis", January 2007.
- Japanese Ministry of Health, Labor and Welfare, "Contamination by the US transgenic rice whose safety has not been examined yet", August 19 2006.
- LSU AgCenter, "More tests show Louisiana rice GM free", August 9 2006.
- Reuters, "U.S. GMO rice caused $1.2 bln in damages – Greenpeace", November 5 2007.
- Third World Network, "American GM rice found in Africa", December 1 2006.
- USDA, Lessons Learned and revisions under Consideration for APHIS' Biotechnology Framework, October 2007.
- USDA, Report of Liberty Link Rice Incidents, October 4 2007.
- USDA/APHIS, In response to Bayer CropScience Petition 06-234-01P seeking Extension of Determination of Non-regulated Status for Glufosinate Resistant Rice, *Oryza sativa*, event LLRICE601, 2006.