Survey of Field trials with Genetically Modified Plants

Global trends and developments

August 2014

COGEM Report CGM 2014-04

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Disclaimer

Foreword

In the recent past, COGEM has published at regular intervals reports on the numbers and content of the field trials with Genetically Modified Plants as granted and performed in Europe and elsewhere. These reports sought to give insight in the current developments and to identify any trends in application of biotechnology into the field of GM Plants in order to facilitate pro-active discussions of governmental bodies, COGEM members and other relevant persons and organisations. Apart from their stand-alone information value, these reports served also as input for the "Trendanalyse Biotechnologie" [Trend analyses Biotechnology], which were on formal request delivered on a 5-year basis to the Dutch parliament.

This report "Survey of Field trials with Genetically Modified Plants" is the sequel of the earlier reports with inventories of field trials with GM Plants.
Earlier surveys were mainly based on the parallel reports published by OECD from which the data were collected by COGEM office staff members.
However, COGEM preparing the production of this update was of the opinion that the global situation with respect to the development of field trials is increasingly complex, and that a different approach then before was justified.

Because of this increased complexity, the current report was commissioned to PERSEUS, a private company specialised in biosafety and biotechnology regulations. The targets given comprised 1) to broaden the survey to all available (state and official) data in the world, which would give data beyond the scope of the OECD reports, and, 2) -as usual-, to compare the new data with those from the former reports, and 3) to identify any trends.

This report gives an exhaustive and concise overview of the enormous amount of globally performed field trials (almost 40.000 retrieved!) for the period 2009-2013 (the last OECD report on the subject covered the period up to 2009). The report also discusses at length the difficulties encountered in defining "field trials", since due to differences in legislation across the world there is no common definition, which renders a proper comparison of the data difficult.

Herewith, we deliver this update and we fully trust that it will help to get insight into the current developments in GM Plants in the world and that it will also serve to identify any trend or new development direction by comparison with the earlier COGEM reports as mentioned in the reference list.

Dr. Hans C.M. den Nijs,
Chair of Advisory Committee.

Summary

This study surveyed confined field trials (CFTs) with genetically modified (GM) plants in the period 2009-2013 as a basis to investigate developments in plant biotechnology, more specifically the development of GM crops. CFTs are seen as an indication of a scientific interest and of developments towards commercial/large-scale introduction.

In contrast to previous studies, this study elaborated a more comprehensive survey methodology:

- The geographical scope included a far broader range of countries (all EU member states, all OECD members, all parties to the Cartagena Protocol on Biosafety, Argentina and the Russian Federation), for which data can be retrieved.
- The basic unit of the CFT was defined and publically available information was adjusted to allow comparison between countries. Still some inherent differences in reporting result in an underestimation of numbers for some countries and an overrepresentation for others.

When discussing methodology, diverging views on which “GMOs” (or similar concept) are regulated became an issue during the study period. This can be illustrated by two components:

- In contrast to the EU, many authorities do not subject breeding stacks of previously approved GMOs to regulatory scrutiny. In consequence, CFTs with such stacks may or may not be recorded as CFT depending on the regulatory situation in the country.
- New breeding techniques are evaluated to see if their products will be regulated. If authorities reach different conclusions, then it is likely that a trial with the same product may be recorded in one country as a GMO CFT and not recorded at all in another country.

Further methodological challenges included:

- not all countries systematically reporting on CFTs with GM;
- the need to adjust information to allow comparison;
- dealing with data gaps.

The database established on this basis includes data on nearly 41000 CFTs conducted in 55 countries. In general, the number of CFTs per year worldwide remained constant over the survey period. On the other hand, regional differences are observed. In Europe, the amount of trials continues to decline. Also a slight decrease is seen for North America in 2013. In Africa and Asia, there is a rising interest, but numbers are still very low.

Maize is the most widely tested crop. Also soybean, oilseed rape and cotton continue to be important. Again, regional differences are noticed. In Canada oil crop trials are the most prevalent, in Australia these are cotton CFTs followed by oil crops. In Latin America cotton trials are as frequent as maize trials.

Accounting for 96% of all CFTs, the major commodity crops obviously continue to dominate. While it is difficult to speculate on the underlying mechanisms, there are probably different influencing factors:

- Big markets justify the important investments that are required for development and regulatory approvals. Smaller, niche crops may not present the same financial opportunities.
- Global commodities actually require a global programme with many repetitive local CFTs. In this respect, it is likely that products that have been approved in a first market enter regulated CFTs in other potential markets and thereby remain included in the survey.
- For most of the big arable crops, GM products have been approved and thereby a regulatory track has been established. Follow-on products can rely on this experience and it is therefore more attractive to develop a next product in a crop, where a GM pipeline has been established.

- As indicated in this survey, big crops are usually developed by industry. In particular companies with a global network and experience in bringing products to market, may be better placed to tap into a CFT infrastructure.

The variety of smaller crops is decreasing especially in the USA and Europe. In spite of the technical potential, regulatory hurdles might partly be at the origin. However, it is also possible that for smaller crops and/or developments in local markets, less CFTs are required. In this case it would be more important to look at repetition of the same CFT over years, rather than increasing number of CFTs in order to evaluate the likelihood for market realisation. Also it must be taken into account that for crops with a longer generation time (such as trees), changes (*e.g.* new CFTs) will possibly occur at lower frequency. **While a broad diversity of GM crops is being deployed in CFTs, the data seem to indicate that -with some minor exceptions- the main products will remain limited to the major commodities**.

Herbicide tolerance remains the most studied agronomic trait on all continents. Similarly, GM traits for biotic stress protection remain predominantly oriented on insect pests. This does not mean however that only first-generation traits are successful:

- First-generation traits are further deployed beyond the primary markets. In those countries, they may still be regulated and require CFT approvals and would therefore remain included in this survey.
- Seed productions for export (*e.g.* counter-season production) contribute as the products may not have been approved for those markets and therefore still require a field trial permit.
- As data are reported here on trait types, improvements within each trait type may be missed. *E.g.* stacking and combinations of different modes of actions further expand the insect resistance trait. These developments will not show separately as they all relate to the same trait.
- Given the success of these first-generation traits, it seems likely that new traits/products are offered in combination with them. They have become a basic feature. Therefore, if a new GM line is tested, the CFT is likely to include in addition the herbicide tolerance and/or insect resistance.

Other pest and disease resistances are investigated to a much lower extent, vastly dependent on plant species. The growing numbers of field trials for agronomic traits are sustained. The abiotic stress tolerances concern mainly drought tolerance and nitrogen use efficiency. Both traits are predominantly present in the USA, Canada and to a much lesser extent in Australia. Alterations in plant biology ultimately intend to lead to higher yields, either by modifying plant development, architecture, or fertility traits to produce hybrids. Once more, the centre of research and development is North America, but products are mainly intended for global commercialisation. Product quality like altered oil, protein and starch composition slightly loose position relative to the whole array of traits. Very few trials are dedicated to the production of pharmaceuticals or other industrial compounds.

A wide range of traits continue to be developed and some reach the pre-commercial level (drought tolerant and nitrogen use efficient crops, cold tolerant *Eucalyptus*), the dominant traits remain and are likely to remain for some time herbicide tolerance and insect resistance.

The CFTs for the main field crops are handled by industry. Smaller crops are mainly studied by universities or governmental research institutes. Involvement of public research and public-private partnerships are evolving in Asia and in Africa. These provide interesting step-wise introductions of GM handling capacity.

Whereas in the past concern has been expressed over the possible fall-back of developing countries in relation to the use of plant biotechnology, many of these countries have since established legal frameworks. In different cases, these were inspired by an interest to conduct CFTs. In fact, some countries in Africa and Asia already have conducted more CFTs than some European countries. While there are still important hurdles, in particular in relation to intra-regional and international trade, these examples illustrate that a country can tap into biotechnology opportunities provided that a genuine interest is present.

The key centre for second-generation GM plants in terms of number of CFTs remains North America. Drought tolerant and nitrogen use efficient crops are closest to the market. Africa and Asia are mainly developing crops and traits for local markets. Latin America has relatively less local research dedicated to the national needs. With these exceptions all crop/trait combinations are still in early phase development.

Whereas big commodity crops reach a global market and therefore will also be presented for authorisations in the EU (albeit for import), it is less clear how this situation will be handled for smaller crops and/or products not developed by industry.

The declining number of CFTs in Europe furthermore illustrates that the continent is no longer considered as an important direct market for GM seeds and plants. European based research and development contributes to CFTs in other parts of the world in crops and varieties that are of relevance in these markets. The ”declining influence of the EU on global developments” seems to be confirmed.

Samenvatting

Dit rapport inventariseert gereguleerde veldproeven met genetisch gemodificeerde (GG) planten voor de periode 2009-2013 om de ontwikkelingen in de plantenbiotechnologie te kunnen nagaan, meer bepaald de ontwikkeling in GG-gewassen. Dit soort veldproeven wordt beschouwd enerzijds als een indicatie van interesse op wetenschappelijke vlak, anderzijds als een voorloper van marktintroductie.

In tegenstelling tot eerdere studies, werd hier uitgebreider en diepgaander te werk gegaan:

- Geografisch gezien werden meer landen onderzocht (alle EU-lidstaten, alle OESO-leden, alle landen die partij zijn bij het Protocol van Cartagena inzake bioveiligheid, alsmede Argentinië en Rusland) waarvoor gegevens kunnen gevonden worden.
- De meeteenheid is de veldproef en publiek toegankelijke gegevens werden aangepast om een vergelijking tussen landen mogelijk te maken. Toch leiden inherente verschillen in rapportering tot onderschatting van de aantallen voor sommige landen en een oververtegenwoordiging voor andere.

Bij de uiteenzetting van de methodologie, kwamen de uiteenlopende visies over wat nu een GGO is naar voren. Twee voorbeelden kunnen dit verduidelijken:

- In tegenstelling tot de EU onderwerpen vele autoriteiten kruisingen tussen eerder toegelaten GGO's niet aan de GGO-regelgeving. Als gevolg daarvan worden veldproeven met dit materiaal wel of niet gereguleerd afhankelijk van de vigerende wetgeving.
- Nieuwe veredelingstechnieken worden bestudeerd om vast te stellen of hun producten al of niet gereguleerd moeten worden. Als autoriteiten tot uiteenlopende conclusies komen, kan het zijn dat een proef met hetzelfde materiaal in het ene land worden geregistreerd als een GGO-veldproef en in een ander land niet.

Andere uitdagingen op vlak van methodologie zijn:

- het niet altijd systematisch rapporteren van proeven door sommige landen;
- de noodzaak om informatie aan te passen om te kunnen vergelijken;
- het ontbreken van informatie.

De inventarisatie die zo werd opgesteld bevat data van bijna 41000 gereguleerde veldproeven uitgevoerd in 55 landen. In het algemeen blijft het aantal veldproeven wereldwijd in de onderzochte periode constant. Nochtans zijn er regionale verschillen. In Europa blijft het aantal proeven dalen. Ook in Noord-Amerika wordt een lichte daling opgemerkt voor het jaar 2013. In Afrika en Azië neemt de belangstelling toe, maar de aantallen zijn nog laag.

Maïs wordt wereldwijd het meest beproefd. Verder blijven soja, koolzaad en katoen belangrijk. Ook hier zijn regionale verschillen te bespeuren. In Canada komen veldproeven met oliehoudende gewassen het meest voor. In Australië zijn dat katoen gevolgd door oliehoudende gewassen. Katoenproeven komen in Latijns-Amerika even vaak voor als maïsproeven

De grote veldgewassen blijven met een aandeel in veldproeven van 96% domineren. Hoewel het moeilijk speculeren is over de onderliggende oorzaken, zijn er naar alle waarschijnlijkheid verschillende factoren in het spel:

- Een grote markt kan belangrijke investeringen, nodig voor ontwikkeling en toelatingen, verantwoord maken. Kleinere, nichegewassen hebben niet diezelfde financiële armslag.
- Veldgewassen die wereldwijd geteeld worden, vragen een globaal programma met vele en herhaalde lokale veldproeven. Op die manier is het mogelijke dat voor producten die al goedgekeurd zijn in een eerste markt, toch nog gereguleerde veldproeven worden aangelegd in andere potentiële markten en die blijven als gevolg daarvan opduiken in de inventarisatie.

- Voor de meeste grote veldgewassen zijn er GG-producten toegelaten waardoor al een weg op vlak van registratie is doorlopen. De volgende producten kunnen steunen op die ervaring. Daarom is het aantrekkelijker om een volgend product te ontwikkelen, daar waar er al een GG-pijplijn bestaat.
- Zoals aangegeven in deze studie worden de grote gewassen ontwikkeld door de industrie. Meer bepaald zullen bedrijven met een wereldwijd netwerk en commerciële ervaring beter in staat zijn om een infrastructuur voor veldproeven uit te bouwen.

De verscheidenheid aan kleinere gewassen neemt af vooral in de Verenigde Staten en Europa. Ondanks het technisch potentieel, kunnen obstakels in de regelgeving deels oorzaak zijn. Het kan natuurlijk ook zijn dat kleinere gewassen en/of ontwikkelingen voor lokale markten minder veldproeven vereisen. In dat geval zou er naar herhalingen van dezelfde proeven over de jaren moeten worden gekeken, eerder dan naar een toenemend aantal veldproeven, om de kans op commercialisatie in te schatten. Ook moet rekening gehouden worden met het feit dat voor gewassen met een lange generatietijd (zoals bomen) wijzigingen (bv. nieuwe proeven) minder frequent zullen voorkomen. **Hoewel een brede waaier aan GG-gewassen wordt opgetekend bij GGO-veldproeven, lijken de gegevens er toch op te wijzen dat -op enkele uitzonderingen na- de hoofdproducten beperkt blijven tot de grote gewassen**.

Herbicidetolerantie blijft de meest bestudeerde landbouwkundige eigenschap en dat in alle continenten. GG-eigenschappen ter bescherming van het gewas blijven voornamelijk gericht o bescherming tegen insectenplagen. Dit betekent niet dat alleen eerste-generatie kenmerken succesvol zijn:

- Eerste-generatie kenmerken worden wijder geëxploiteerd dan in de oorspronkelijk markten. In die nieuwe landen zijn ze mogelijk nog gereguleerd en vereisen ze veldproefvergunningen. Daarom zijn ze nog terug te vinden in de inventarisatie.
- Zaadproducties voor export (bv. producties in het tegenseizoen) dragen bij aan de aantallen omdat die producten mogelijk nog niet toegelaten zijn voor de binnenlandse markt en dus een veldproefvergunning vereisen.
- De gegevens die worden gerapporteerd gaan over typen van eigenschappen. Verbeteringen in een eigenschap worden op die manier gemist. Bv. het kruisen en combineren van verschillende werkingsmechanismen verbreedt de resistentie-eigenschap. Dergelijke ontwikkelingen worden niet opgemerkt omdat het om hetzelfde type eigenschap gaat.
- Gezien het succes van die eerste-generatie kenmerken, ligt het voor de hand dat nieuwe eigenschappen/producten worden aangeboden in combinatie met deze. Ze zijn een standaard geworden. Dus, als een nieuwe GG-lijn wordt getest, zal de veldproef ook gaan over herbicidetolerantie en/of insectresistentie.

Andere plaag- en ziekteresistenties worden in veel mindere mate bestudeerd en worden vooral bepaald door de plantensoort. Het aantal veldproeven dat agronomische eigenschappen test blijft groeien (tweede-generatie eigenschappen). De abiotische stresstoleranties bestaan voor het merendeel uit droogtetolerantie en efficiënt stikstofgebruik. Beide eigenschappen worden vooral in de Verenigde Staten en Canada beproefd en in mindere mate in Australië. Wijzigingen in de biologie van de plant zijn bedoeld om uiteindelijk de opbrengst te verhogen, ofwel door wijzigingen in de ontwikkeling en de opbouw van de plant aan te brengen, of om hybriden te maken via fertiliteit/steriliteitsgenen. Opnieuw ligt het centrum van onderzoek en ontwikkeling in Noord-Amerika, maar zijn de producten bedoeld om wereldwijd te vermarkten. Productkwaliteitseigenschappen zoals vetzuur-, aminozuur- en zetmeelsamenstelling verliezen lichtjes aandeel. Erg weinig veldproeven zijn gewijd aan de productie van farmaceutica of andere industriële componenten.

Een grote verscheidenheid aan eigenschappen wordt ontwikkeld en sommige bereiken het precommerciële niveau (droogteresistentie, gewassen met efficiënt stikstofgebruik,

koudetolerantie bij *Eucalyptus*). Waarschijnlijk blijven de dominante eigenschappen herbicidetolerantie en insectenresistentie dat nog geruime tijd.

De veldproeven voor de grote veldgewassen worden uitgevoerd door de industrie. Kleinere gewassen worden vooral door universiteiten en onderzoeksinstellingen van de overheid bestudeerd. In Azië en Afrika komen de publieke sector en publiek-private samenwerkingen meer tussen in het onderzoek. Op die manier wordt stapsgewijze de capaciteit om GGO's te behandelen opgebouwd.

Waar er in het verleden bezorgdheid is geuit over een mogelijke achterstelling van ontwikkelingslanden i.v.m. biotechnologie, hebben vele landen een wettelijk kader ingesteld. In verscheidene gevallen was dit ingegeven door de belangstelling om GGO-veldproeven uit te voeren. Feitelijk hebben sommige Afrikaanse en Aziatische landen al meer proeven aangelegd dan sommige Europese landen. Hoewel er nog belangrijke obstakels zijn, meer bepaald i.v.m. intraregionale en internationale handel, geven deze voorbeelden aan dat een land opportuniteiten in de biotechnologie kan benutten op voorwaarde dat er interesse is.

In termen van aantallen veldproeven met tweede-generatie GG-planten spant Noord-Amerika de kroon. Droogtetolerantie en efficiënt stikstofgebruik door de plant staan het dichts bij commercialisatie. Afrika en Azië ontwikkelen wel al gewassen met eigenschappen voor de lokale markt. In Latijns-Amerika wordt relatief minder gewerkt aan lokale gewasnoden. Maar op enkele uitzonderingen na gaat het nog om vroege fases in de ontwikkeling.

Terwijl de grote veldgewassen wereldwijd op de markt komen en dus ook zullen aangeboden worden voor toelating in Europa (zij het voor import), is het minder duidelijk hoe dit zal opgelost worden voor de kleinere gewassen/producten die niet door de industrie zijn ontwikkeld.

Het afnemend aantal veldproeven in Europa maakt duidelijk dat het niet langer wordt beschouwd als een belangrijke directe markt voor GG-zaden en –planten. Onderzoek en Ontwikkeling dat in Europa wordt uitgevoerd leidt tot gereguleerde veldproeven in andere delen van de wereld in gewassen en variëteiten die relevant zijn in die markten. Die "afnemende invloed van de EU op ontwikkelingen in de wereld" lijkt te worden bevestigd.

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Abbreviations

APHIS-USDA	Animal and Plant Health Inspection Service, United States Department of Agriculture
BNYVV	*Beet necrotic yellow vein virus*
CFT	Confined field trial
COGEM	Commissie Genetische Modificatie
EU	European Union
GG	Genetisch Gemodificeerd
GGO	Genetisch Gemodificeerd Organisme
GM	Genetically Modified
GMO	Genetically Modified Organism
ISAAA	International Service for the Acquisition of Agri-biotech Applications
NBT	New Breeding Techniques
OECD	Organisation for Economic Co-operation and Development
OESO	Organisatie voor Economische Samenwerking
PNT	Plant with Novel Traits
USA	United States of America

1 Introduction

COGEM has published several trend analyses identifying issues and challenges related to biotechnology developments to support policy makers in their evaluation of the regulatory framework (COGEM 2007, 2010). When considering evolutions in plant biotechnology, more specifically the development of genetically modified (GM) crops, reference was made to information from OECD surveys (van Beuzekom & Arundel, 2006, 2009). As these surveys have not been repeated since 2009, this project was established to provide an update and to allow a comparison with previous OECD data.

Figure 1 provides a schematic overview of the typical research, development and marketing stages of a product of biotechnology. In a preparatory phase (phase 0) basic research might be conducted in a model species. In a subsequent phase, “proof of concept” is the result of a demonstration that the planned strategy delivers the intended trait in a crop of economic relevance. This can be the trigger to embark on a full-scale development project, aiming for commercial introduction of an elite event in locally adapted germplasm.

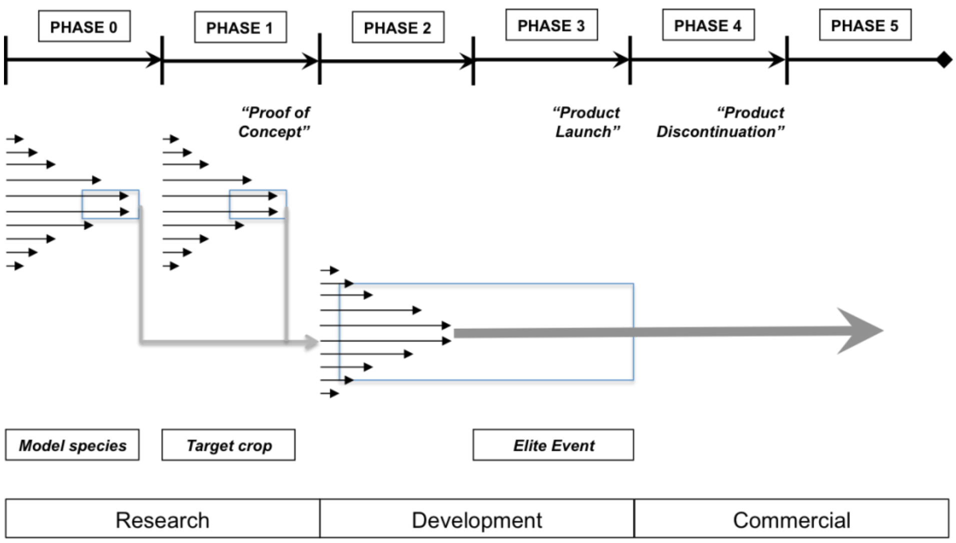


Figure 1 Schematic overview of the development of a biotechnology product (boxes indicate parts of the life cycle when confined field trials might be conducted)

Most of the early phase activities are performed in laboratories, growth rooms and greenhouses. Next small-scale proof-of-concept field trials are performed, followed by larger trials to further characterise and multiply the transformation events. These trials take place in different growing areas and growing seasons to test the performance under diverse growing conditions. Each step involves a rigorous selection of the single elite event that may be ready for market introduction.

Confined field trials (CFT, *i.e.* field trials with some form of regulatory restriction and need to confine the GM material) are therefore seen as an indication of a scientific interest. On the other hand, repetition of CFTs, with an increasing number of trials and acreage, typically indicate a development programme that is intended for a commercial/ large-scale introduction. While information on the actual performance of CFTs is not systematically available, in most countries with GMO legislation, some information on regulatory applications for CFTs is publically available. An inventory of CFT applications can thus provide insight on which trait/crop combinations to expect for commercial release in the next 5 to 10 years.

Aim and scope
This study aims to establish a survey of CFTs with GM plants for all countries were data are available, to map the traits that are currently investigated and that may be presented for commercialisation in 5-10 years. On this basis, and in comparison with previous reports, trends or trend changes are analysed.

The scope of the study includes all GM higher plants and CFTs conducted or applied for in the period 2009-2013.

The report follows on earlier studies by the OECD on biotechnology statistics as far as GM plant CFTs are concerned (van Beuzekom & Arundel, 2006, 2009). Results are compared with these studies.

More precisely, the analysis concentrates on the following questions:

- What is the worldwide evolution of CFTs with GM plants, and how is the evolution in the countries were trials are performed?
- How do the different crops compare?
- How do the identified traits compare?
- Do types of crops and/or traits evolve over time? Do countries differ in that respect?
- How do early type research CFTs compare to more advanced development CFTs?
- Who applies for CFTs (research institutes, companies)?
- Do CFTs support local development or worldwide programmes? If the latter is true are the targeted GMOs already commercially available in some countries? Will they be submitted for commercial approval?

Approach
This report starts with a description of the methodology. Methodological challenges (*e.g.* divergences in the definition of GMO, approaches to regulating stacks, ...) are indicated as well as the consequence for establishing the inventory in a methodological approach and as much as possible uniform way.

As for previous reports, traits were classified as agronomic properties among which abiotic stress resistance and herbicide tolerance, resistance to pests and diseases and product specifications. The results are discussed per group of countries and per crop.

Finally the results of this survey are evaluated comparing these –as far as possible- with the results of earlier reports.

2 Methodology

2.1 Scope of the survey

2.1.1 Geographical scope

The 2006 OECD Biotechnology Statistics (van Beuzekom & Arundel, 2006) included data for 23 OECD member countries and 3 other countries. However, the section on field trials with GM plants, only focused on publicly available databases from Australia, Canada, the European Union, Japan and the United States. The survey on CFTs in the 2009 edition (van Beuzekom & Arundel, 2009) covered information for 26 of the 30 OECD member countries, plus non-OECD members of the European Union.

At the onset of this study, it was assumed that one of the trends could be that more countries (including countries that were outside of the scope of the 2009 OECD survey) might be engaging in CFTs. If in addition these countries would be markets for local crops, then they had to be included. In consequence, the scope of this study was set to cover all OECD member states and/or parties to the Cartagena Protocol on Biosafety.

The following countries were included in the survey although they are neither an OECD member nor have they ratified the Cartagena Protocol on Biosafety:

- Argentina was included as it has a long history of conducting CFTs with GM plants.
- The Russian Federation was for many years discussing the possibility for CFTs with GM plants.

2.1.2 Period

The 2009 OECD Biotechnology Statistics included information up to 31 December 2008. This survey therefore covers all CFTs in the period starting 1 January 2009 and ending 31 December 2013. Public databases and other information sources were also searched for CFTs submitted and/or approved before this period, but intended to be conducted in the period 2009-2013.

2.1.3 Confined field trials (CFTs) with GMOs

Limiting the scope to CFTs automatically imposes a focus on trials with regulated GMOs. Whenever and wherever a GM plant is approved for commercial introduction, field use would no longer be considered a CFT. Yet, as commercial approval may not be obtained in every country at the same time or as commercially approved GM plants may be used as comparator for the evaluation of other regulated GM plants, they may still be recorded.

The survey covers GM higher plants, including arable crops, vegetables, non-agronomic higher plants, shrubs and trees. Care was taken to include applications for scientific interest, for food and feed, as well as for industrial purposes (*e.g.* energy crops, pharmaceuticals). The study excluded algae, mosses or other than higher plants.

2.2 Information gathering

2.2.1 Sources of information

For each country in the geographical scope, a search was made for information on CFTs. In this search, a step-wise approach was followed:

- Consultation of databases established by the competent authority;
- Review of information for the public;
- Analysis of decision documents of advisory committees and/or authorities;
- Verification of communications through the Biosafety Clearing-House (BCH) set up by the Cartagena Protocol on Biosafety.

In cases where this approach did not reveal any information on a possible CFT, other literature and publications were searched. Examples are the attaché reports on biotechnology of the USDA Foreign Agriculture Service or communications via Seedquest and Crop Biotech Update service by ISAAA. When possible, people involved in the CFT (researchers, authorities) were contacted. This additional effort provides no guarantee to give a complete picture, as it is influenced by the ability to trace initiatives and by the responsiveness of the involved people. However, it was felt that it was required to ensure that also information from countries that have not yet set up systems to routinely provide information on CFTs, would be included.

2.2.2 Processing information

Authorities use different units for approving and reporting field trials with genetically modified plants. In consequence, the methodology for integrating these data in a single dataset may significantly influence the result. In order to ensure comparability with previous reports (van Beuzekom & Arundel, 2006, 2009), the authors contacted the involved researchers. However, neither from the reports, nor through these contacts information could be obtained on the methodology that was used.

A new dataset structure was then established (Table 1), taking into account the limited indications from the previous reports.

Table 1: Information structure of the dataset gathered for this study

Dataset topic	Information	Specification
Reference	• Internal specific reference • Official reference from authority	References to identify applications. As one authority reference can contain different CFTs in the context of this study (see later) also an internal reference was included.
Applicant	• Applicant name • Applicant type	Type may be non-profit (public) research organisations or industry
Developer	• Developer name • Developer type	Type may be non-profit (public) research organisations or industry
Approving authority	• The country agency that approves CFT applications	
Application year	• The year the CFT application was submitted	
Approval year	• The year the CFT application was approved	
Validity period	• The period for which the approval is valid	Expressed in months
Information source	• The source from which the data are retrieved	
High level geography	• Group to which the country belongs	This can be Europe, North America, Latin America, Africa, Asia, Australia & New Zealand

Dataset topic	Information	Specification
Trial country	• Country in which the trial is to take place	
Trial In country region	• Region within the country	This can be a province, state or agronomic region
Trial site #	• The number of trials within a region	
Trial year	• Year in which the trial started	
Trial period	• The duration of the growing season	Expressed in months
Trial area	• The surface of a trial	With more than 1 trial per region an average trial area is included
Trial number	• Amount of plants/seeds	E.g. the amount of trees or the weight of seeds
Receptor	• The scientific name of the GM plant species • The common name of the GM plant species	
Feature class aggregated	• Indication of all trait classes & types	See subsequent section on trait classification.
Individual traits	• Trait • Gene	The trait type is specified

The scientific name of the plant species is indicated whenever there was no doubt on identity. In other cases only the genus name is mentioned.

2.2.3 Trait classification

In the previous OECD studies (van Beuzekom & Arundel, 2006, 2009), the authors applied the classification system of USDA-APHIS (2011) for grouping types of traits. Examples of this classification are provided in Table 2.

It was felt that this classification is no longer useful for getting a high level overview. In consultation with the Advisory Committee for the project, a tiered structure was established (Table 3). All trait classes are provided with examples in Table 4.

Table 2: Classification of traits used in the previous studies (based on USA-APHIS categories) with examples

Trait	Examples of specifications
Agronomic properties (AP)	• Drought tolerance • Cold tolerance • Tolerance to specific environmental stresses • Nitrogen use efficiency • Male sterility
Bacteria resistance (BR)	• Bacterial leaf blight resistance
Fungus resistance (FR)	• *Sclerotinia* resistance • *Botrytis cinerea* resistance
Herbicide tolerance (HT)	• Glyphosate tolerance • Dicamba tolerance
Insect resistance (IR)	• Lepidoptera resistance • Coleoptera resistance
Marker genes (MG)	• β-glucuronidase • Neomycin phosphatase
Nematode resistance (NR)	• Soybean cyst nematode resistance

Trait	Examples of specifications
Other (OO)	• Pharmaceutical protein • Recombinase gene • Genetic studies
Product quality (PQ)	• Delayed ripening of fruit • Altered amino acid profile • Modified seed storage proteins • Enhanced floral characteristics (ornamentals) • Increased solids in fruit
Virus resistance (VR)	• Cucumber Mosaic Virus resistance • *Potato virus Y* resistance

Table 3: Tiered trait classification used in this report.

Level	Description	Example
Trait class	High level classification of the trait	Agronomic properties
Trait type	General description of the trait	Herbicide tolerance (HT)
Trait	Specific description of the trait or phenotype	Glyphosate tolerance
Function	Where possible, details on the gene or mode of action were included	*CP4-epsps*

Table 4: Trait categories used in this report.

Trait class	Trait type (examples)	Traits/phenotypes (examples)
Agronomic properties	Abiotic stress (AS)	• Drought tolerance • Cold tolerance • Tolerance to specific environmental stresses • Nitrogen use efficiency
	Plant biology (PB)	• Male sterility • Yield increase • Altered growth rate
	Herbicide tolerance (HT)	• Glyphosate tolerance • Dicamba tolerance
Biotic stress resistance	Bacteria resistance (BT)	• Bacterial leaf blight resistance
	Fungus resistance (FR)	• *Sclerotinia* resistance • *Botrytis cinerea* resistance
	Insect resistance (IR)	• Lepidoptera resistance • Colepotera resistance
	Nematode resistance (NR)	• Soybean cyst nematode resistance
	Virus resistance (VR)	• *Cucumber mosaic virus* resistance • *Potato virus Y* resistance
Product specifications	Product quality (PQ)	• Delayed ripening fruits • Altered amino acid profile • Modified seed storage proteins • Enhanced floral characteristics • Increased solids in fruits
	Product systems (PS)	• Pharmaceutical protein

Trait class	Trait type (examples)	Traits/phenotypes (examples)
Other traits	Breeding aids (BA)	• Recombinase gene
	Marker genes (MG)	• Screenable marker • Selectable marker
	Other (OO)	• Genetic studies

2.3 Analysis

Data were retrieved from the various databases. Regulatory documents were searched for as much data as possible and entered, possibly with corrections, into the dataset. The dataset was provided to COGEM as an electronic file to allow verification, additional analysis and for future reference together with the final report.

All calculations used the "CFT" as the unit. Calculations were made per country where the trials were conducted instead of according to the countries of the main offices of the applicants as is the case in the previous OECD studies (van Beuzekom & Arundel, 2006, 2009). Trait classes and types were slightly adapted as explained in 2.2.3. The distributions of the trait types was analysed per crop and per trial. They were calculated as aggregated trait types as opposed to individual types, since one gene may result in one or more trait specifications. Likewise, the distribution of companies versus public research institutions is based on the number of trials instead of individual traits.

3 Methodological challenges

Before discussing the results of the survey, it is necessary to report methodological challenges and how they were addressed. In fact, the way they were addressed likely influenced the results.

3.1 Challenge: Not all countries systematically report on CFTs with GM

Some authorities make information on CFTs publically available. In most of these cases, this is part of the legal framework and may *e.g.* be integrated in a public consultation.

On the other hand, there are many countries that have dealt with CFTs, that haven't established (yet) a way to share related information with the public. In consequence, other indirect access to information had to be pursued. Sometimes information was obtained via direct contacts with authorities and/or developers. Without a formal official endorsement, such information is handled as indicative.

Of course, countries that have not yet handled applications for CFT with GM plants, have no information to share. The main issue was then to obtain some level of confirmation that the lack of information indeed reflected an absence of CFTs.

3.2 Challenge: extracting information that is presented in different forms

When information is provided *e.g.* by authorities, it can be in very different forms:

- Databases and official lists issued by the competent authorities themselves or commissioned by the authorities.
  Data may be presented as simple lists with one record per trial or event as is the case in *e.g.* Argentina or Canada.
- Documents
  These documents contain details on the GMO and the envisaged trial including a summary of the environmental risk assessment (ERA) as *e.g.* is the case in the European Union (EU) or Australia.
- Decision documents
  In Latin America (*e.g.* Colombia and Uruguay) information often comes in the form of resolutions ('Resoluciones') amidst other decisions taken by the authorities.

When performing this survey, information had to be extracted from the different types of documents in order to obtain the data needed for the analysis. Even in cases where official lists were available this required careful verification as not all entries automatically match with the dataset design for this study. It is more difficult if only documents are available in a local language, which is not readily understood by the performers of the study. In such cases, translation tools have been used.

3.3 Challenge: Dealing with data gaps

The available data range from very detailed descriptions of plants, genes and location of the trial to as little information as the plant and location without any indication of trait (*e.g.* Chile). Table 5 gives a comparison of data made available in different countries.

Table 5: Overview of information available in public databases.

Country	Plant species	Applicant	Site	Area	Application year	Trial year	Gene	Promoter./ terminator.	Trait	Application/ permit number	Event name	OECD unique identifier
Argentina	√	√							√		√	√
Australia	√	√	√	√	√	√	√	√	√	√	±	
Brazil	√	√	√	√	√		√		√	√	±	√
Canada	√	√	√			√			√			
Chile	√	√	√	√		√						±
Colombia	√	√	√				√	√	√	√		√
EU	√	√	√	√	√	√	√	√	√	√	±	±
India	√	√				√	√		√		√	√
Japan	√	√	√			√			√		√	√
Kenia	√	√				√			√			±
Mexico	√	√	√	√	√	√			√	√		√
New Zealand	√	√	±		√	√			√	√		
Philippines	√	√			√	√			√	√		
South Africa	√	√		# seed		√			√		√	√
Uruguay	√	√				√						√
USA	√	√	√	±	√	√	±	±	√	√		

√: available
±: sometimes available

Some key differences:

- The trial site may be specified as detailed as the village (*e.g.* EU) or even GPS coordinates (*e.g.* Chile) to a more general indication of region or state (*e.g.* Canada, USA).
- The trial surface is not always indicated. Even when indicated, it is often not clear whether *e.g.* border rows are included or excluded. South Africa only mentions the amount of seed that is permitted.
- Most countries list the submissions for field trial approval; others list the field trials that actually were performed (*e.g.* Canada, Chile). As a result the application and trial year are not always known and the survey may result in an overestimation for those countries that list approvals (an approval is no guarantee that the trial will be performed).
- Information on the genes and regulatory sequences is often not disclosed because of confidentiality, as is often the case for developers with a commercial intention. Public researchers usually list all genes with (*e.g.* Australia, EU) or without regulatory sequences (*e.g.* USA). Sometimes information may be acquired indirectly if not indicated in the public databases. Indeed, more advanced material may already be approved for commercialisation in some countries and therefore bears an OECD unique event identification code. That code allows searching for detailed information on the introduced genetic material. Databases for commercial events are: the CERA GM crop database and the ISAAA GM Approval Database. Traits are mentioned or can be derived from the description of the GM plant. Canada only provides a general trait class without further specification.

- While every permit will have some identification code, this code is not always presented.
- Event names or unique identifiers are not always available.

Information gaps were addressed as follows:

- When no number of sites was provided, a single CFT (value = 1) was indicated.
- When the trial year was unknown, the year of approval or in some cases the application year (*e.g.* Brazil) was taken as reference.
- Absence of other information was left open.
- CFTs for which no traits were specified were not included in the calculations for trait distribution.

3.4 Challenge: Discrepancies in GMO definition

A GMO is generally defined in the distinct legislations of the different countries. Differences exist leading to differences in the type of plants that require a permit or notification for a field trial. This is illustrated by the following comparison of the 3 fundamentally different approaches of the EU, USA and Canada. As it was impossible for the authors to trace all the differences in the details of the databases, all information was included as reported according to the applicable legislation.

European Union
In Europe Directive 2001/18 (EC, 2001) defines a genetically modified organism (GMO) as *an organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination*. Techniques that are included as leading to a GMO are listed in Annex I A, Part 1.

(1) recombinant nucleic acid techniques involving the formation of new combinations of genetic material by the insertion of nucleic acid molecules produced by whatever means outside an organism, into any virus, bacterial plasmid or other vector system and their incorporation into a host organism in which they do not naturally occur but in which they are capable of continued propagation;
(2) techniques involving the direct introduction into an organism of heritable material prepared outside the organism including micro-injection, macro-injection and micro-encapsulation;
(3) cell fusion (including protoplast fusion) or hybridisation techniques where live cells with new combinations of heritable genetic material are formed through the fusion of two or more cells by means of methods that do not occur naturally.

Techniques that are excluded appear in Annex I A, Part 2 and concern

(1) in vitro fertilisation;
(2) natural processes such as: conjugation, transduction, transformation;
(3) *polyploidy induction*.

Furthermore techniques/methods listed in Annex I B are excluded:

(1) Mutagenesis.
(2) cell fusion (including protoplast fusion) of plant cells of organisms which can exchange genetic material through traditional breeding methods.

In the EU breeding stacks, *i.e.* genetic modifications that are combined through conventional breeding, are considered “new” GMOs. Even if the parent GMOs have been approved, CFTs with a breeding stack would require a permit and will therefore be included in the survey.

Another aspect that has evolved over most recent years is how so-called New Breeding Techniques (NBT) are considered. In 2008 the European Commission established a working group to evaluate a set of new techniques used in plant breeding. The goal was to clarify if products obtained via these techniques are subject to the GMO legislation. So far, this evaluation has not been concluded. However, CFTs of products of cisgenesis (*e.g*. B/NL/10/05 on cisgenic scab resistant apple trees) have been subject to the GMO legislation although some argue that cisgenesis products should not be considered GMOs.

United States of America

In the USA a plant is regulated on the basis of potentially being a regulated article, related to a plant pest (Code of Federal Regulations, Title 7 § 340.1).

> *Regulated article. Any organism which has been altered or produced through genetic engineering, if the donor organism, recipient organism, or vector or vector agent belongs to any genera or taxa designated in 340.2 and meets the definition of plant pest, or is an unclassified organism and/or an organism whose classification is unknown, or any product which contains such an organism, or any other organism or product altered or produced through genetic engineering which the Administrator determines is a plant pest or has reason to believe is a plant pest. Excluded are recipient microorganisms which are not plant pests and which have resulted from the addition of genetic material from a donor organism where the material is well characterized and contains only non-coding regulatory regions*).

Genetic engineering is defined as:

> *The genetic modification of organisms by recombinant DNA techniques.*

In the USA breeding stacks do not need to go through the regulatory process provided that each of the components has been positively assessed for cultivation and that by stacking no new concerns are generated.

For NBT products, USDA issues case-by-case opinions taking into account their mandate under the Plant Protection legislation.

Canada

In Canada all plants with novel traits are regulated.

> *Plant with Novel Traits (PNT) is a plant that contains a trait which is both new to the Canadian environment and has the potential to affect the specific use and safety of the plant with respect to the environment and human health. These traits can be introduced using biotechnology, mutagenesis, or conventional breeding techniques.*

Directive 94-08 (Dir 94-08) Assessment Criteria for Determining Environmental Safety of Plants With Novel Traits dictates that:

> *A new variety of a species is subject to the notification and authorization requirements of the Seeds Regulations when it possesses trait(s) novel to that species in Canada, i.e.,*
>
> *i) the new trait is not present in stable, cultivated populations of the plant species in Canada, or*
>
> *ii) the trait in the plant species is present at a level significantly outside the range of that trait in stable, cultivated populations of that plant species in Canada.*

Canada has a product-based regulatory system for PNTs. It is the presence of a novel trait in a plant, irrespective of the method used to introduce it, which will trigger the notification and authorisation requirements under the Seeds Regulations. PNTs may be developed through mutagenesis, somaclonal variation, intra-specific and inter-specific crosses, protoplast fusion, recombinant DNA technology, or other techniques. The consequence for this study is that field trials with GM plants cannot be distinguished from trials with otherwise modified plants or new traits. Therefore the number of trials is possibly an overestimation of the actual amount of GM trials.

For scientific research purposes or technical data gathering, CFTs do not require a notification for stacks, *i.e.* plant lines developed by conventional crossing of two or more authorised PNTs, provided that the trial size is less than regular confined research field trial size restrictions as specified in Section 3.2 of the Directive Dir2000-07.

3.5 Challenge: Determining CFT units

When performing a comparative analysis, it must be clear what the unit of comparison is that is systematically used throughout the survey. However different authorities allow different ways of grouping CFTs in one application or permit and, if this is not corrected for, this could be an important cause for error:

- Some countries require one application per trial regardless of the number of events or gene constructs that are tested within that trial (*e.g.* USA). Others require a notification per gene construct (*e.g.* Japan, Romania, Spain, Sweden, etc.) resulting in as many applications as gene constructs used even if in one trial. In this report one trial is defined as one location were certain events are tested together in a certain year. For practical reasons no distinction is made between events or gene constructs as this cannot always be retrieved from the databases. The APHIS-USDA database for example mentions traits and trait specifications, sometimes genes, but it is not clear whether they are present in one event or several or in which combinations. Where it is known that several gene constructs with separate permits are taken together in one trial, they together are counted as one trial.
- Also, no distinction is made between *e.g.* efficacy trials and trials for regulatory purposes, if conducted in the same location. They are counted as one trial.
- When only the trial region or state is mentioned, it cannot be excluded that more than one location is chosen within the region or state. In this case only one trial is counted, most probably resulting in an underestimation of the number of field trials (*e.g.* Brazil, Colombia, USA). When multi-location trials are mentioned, but the exact number is not indicated, these are counted as 2, again likely leading to an underestimation of the number (*e.g.* India). Apart from a few exceptions, in the EU Member States the exact location (municipality) is mentioned. Consequently, counting the locations gives an accurate number of trials. In the databases of Argentina, the Philippines, South Africa and Uruguay, no location is provided. Every field trial application/permit is counted as one trial. However, this way of counting is certainly an underestimation. The Mexican list mentions the state and only sometimes the municipality, causing an unbalanced calculation. For Chile every single field that has been used, is described by its coordinates. Therefore, only for this country the exact number of trial sites is known. At the same time this results in an over-representation of Chilean trials compared to other Latin American countries and even the world.
- The trial year is as indicated in the application or permit if available. If only the year of the permit application is known as for Brazil, this is the year to work with, causing a shift of potentially one year compared to the actual trial year. For trials conducted in the southern hemisphere or around the equator and even in Puerto Rico and Hawaii (counter-season applications) where annual crops span two calendar years, only the year of sowing or planting is taken into account. Also, for perennial crops like trees and some forage crops the year of planting is the reference year. The same is true for winter-grown crops like wheat. In sugarcane and banana a ratoon crop is not counted as a new trial, only when cuttings are newly planted a new trial starts.
- While it is possible for some crops to grow 2-3 generations in one year, this is not visible from the databases and therefore still counted as one trial.
- Trait classes and types are inventoried per trial. As a trait type may have different compounds within a trial, this may induce an underestimation. They are mostly crop specific and are therefore analysed per plant species.
- Most countries list CFT notifications, permit applications or issued permits. This does not mean that the trial has actually taken place. Only Canada and Chile list performed trials.

However, this does not interfere with the purpose of this report as research and development intentions are central.

To compare early phase field trials to late phase trials the acreage and the number of locations is taken into account where available. In the databases, no distinction is made between these phases (no indication of small vs. large-scale trials, as is the case in the Netherlands). As there is no clear-cut boundary between the research and development phases, the limits are somewhat arbitrarily chosen and also depend on the plant species.

For the comparison between research institutes and companies, again the unit of field trial is the reference.

Traits are counted as aggregated trait types per CFT. This means that for one trial *e.g.* the trait 'plant biology' can only be present once, as it is not always clear how many different trait/gene combinations are being tested for this trait type.

3.6 Conclusion

While the survey methodology should be straightforward, different challenges required adjustments to the way the dataset was collected and interpreted. These adjustments and their consequences on the results were discussed in advance with the Advisory Committee of this project. Understanding that in turn each adjustment may lead to an over- or underestimation, it was concluded that overall they would not significantly influence the purpose of the survey. Nevertheless, they were included in this section in order to allow future reference and alternative approaches.

4 Results 2009 - 2013 survey

Annex 1 indicates for which countries information on CFTs was retrieved and which sources were used in the survey. The number of countries that were investigated was extended compared to the previous OECD survey to include also parties to the Cartagena Protocol on Biosafety and Argentina. A total of **55 countries** yielded CFT data compared to 22 in the 2009 OECD survey. Figure 2 shows the number of countries with CFTs for EU Member states (17 out of 27) , OECD members (24 out of 34), and the Parties to the Cartagena Protocol on Biosafety (49 out of 167).

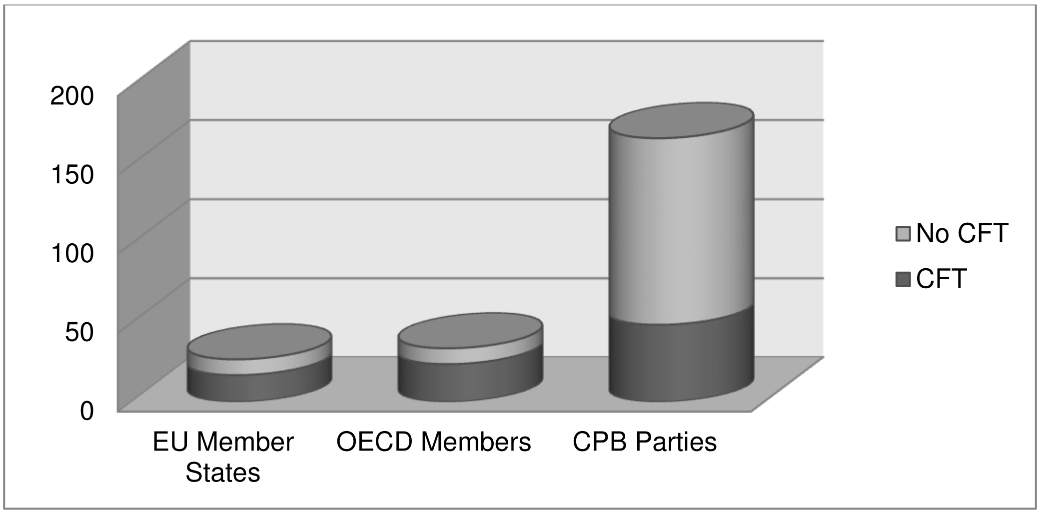


Figure 2 Distribution of countries of the various organisations with and without CFTs

After introducing the corrections as described in previous sections, a total of **40894 CFTs** were identified.

4.1 Worldwide

4.1.1 Number of CFTs

The number of trials/year worldwide remains stable through the survey period (Figure 3). The result for 2013 is lower due to the figures for Argentina for the 2103/2014 growing season not being available; the temporary suspension in Mexico of GM maize CFTs, the biggest crop; and the lack of complete data on Chile for the same season.

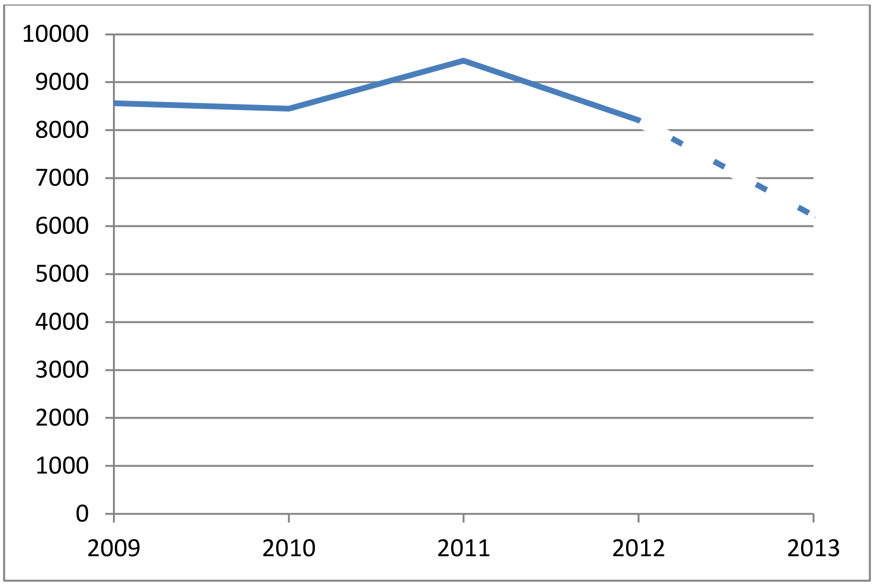


Figure 3 **Total number of field trials per year (the results of 2013 are not fully equivalent as data from some countries are missing)**

In Europe the number of CFTs continues to decrease (Figure 4). In Africa, the number of CFTs remains low, although more countries are gradually implementing the necessary infrastructure. In Asia China is a big player in GM crop development. But since few data are available the total numbers for this continent remain low. Except for India exact numbers of field trials are not mentioned. Also, for some other countries knowledge is obtained indirectly, *i.e.* not via authorities websites, and as a consequence conservative estimates are made resulting in low figures.

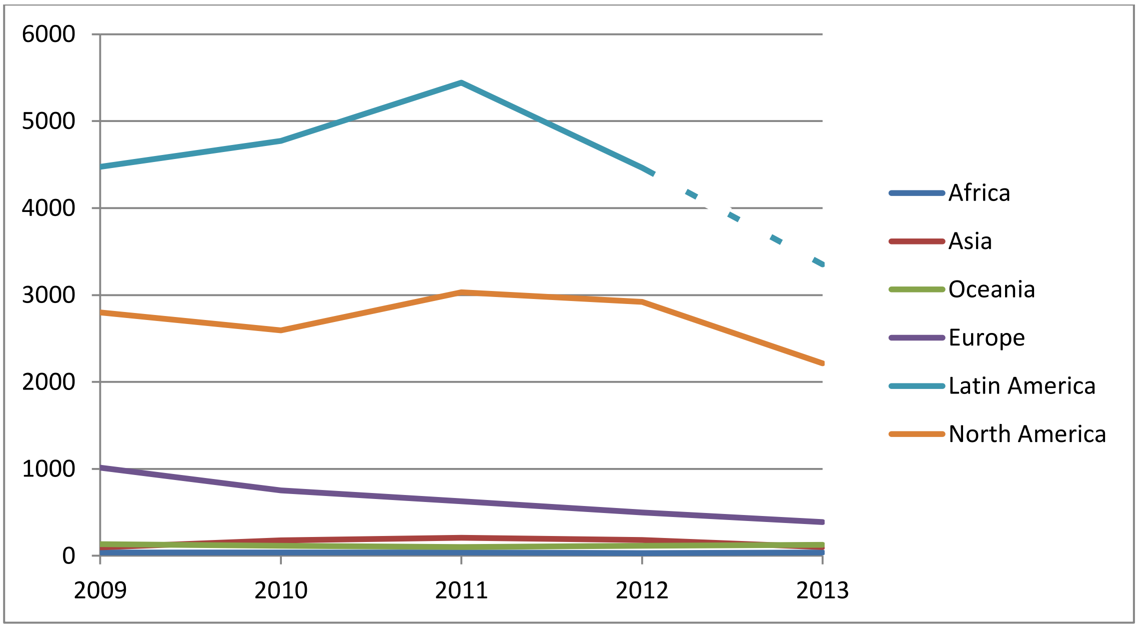


Figure 4 **Total number of field trials by country groups, 2009-2013**

4.1.2 Crops

Maize is the dominant crop for GM field testing (Figure 5) followed by soybean, oilseed rape and cotton. Other commodity crops like potato, rice and sugarbeet are less trialled.

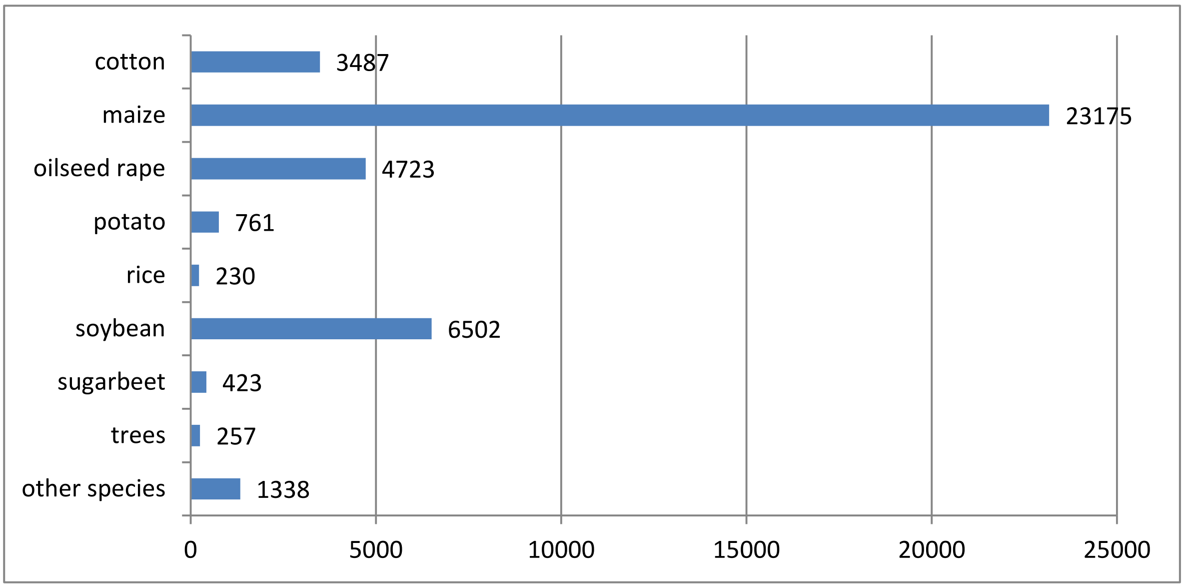


Figure 5 Total number of field trials per crop, 2009-2013
Cotton (*Gossypium hirsutum*), maize (*Zea mays*), oilseed rape (*Brassica napus*), potato (*Solanum tuberosum*), rice (*Oryza sativa*), soybean (*Glycine max*), sugarbeet (*Beta vulgaris*)
Trees and Other species: see text

The tree species involve American chestnut (*Castanea dentata*), American elm (*Ulmus americana*), apple (*Malus domestica*), banana (*Musa* sp.), birch (*Betula pendula*), *Eucalyptus* spp., grapefruit (*Citrus × paradisi*), grapevine (*Vitis* sp.), loblolly pine (*Pinus taeda*), orange (*Citrus sinensis*), papaya (*Carica papaya*), pear (*Pyrus communis*), persimmon (*Diospyros* sp.), poplar (*Populus* spp.), plum (*Prunus domestica*), rubber (*Hevea brasiliensis*), sweetgum (*Liquidambar* sp.), and walnut (*Juglans* sp.).
Other species concern alfalfa (*Medicago sativum*), *Anthurium* sp., *Arabidopsis thaliana*, aubergine (*Solanum melongena*), baby's breath (*Gypsophila paniculata*), barley (*Hordeum vulgare*), bean (*Phaseolus vulgaris*), bent grass (*Agrostis* sp.), black nightshade (*Solanum nigrum*), *Brassica oleracea*, brown mustard (*Brassica juncea*), calla (*Zantedeschia* sp.), camelina (*Camelina sativa*), carnation (*Dianthus caryophyllus*), cassava (*Manihot esculenta*), castor bean (*Ricinus communis*), chickpea (*Cicer arietinum*), chincherinchee (*Ornithogalum x thyrsoides*), chrysanthemum (*Chrysanthemum × morifolium*), cowpea (*Vigna unguiculata*), crambe (*Crambe abyssinica*), creeping bentgrass (*Agrostis stolonifera*), cucumber (*Cucumis sativus*), Cypress vine (*Ipomoea × sloteri*), Easter lily (*Lilium longiflorum*), Ethiopian mustard (*Brassica carinata*), fodder beet (*Beta vulgaris*), groundnut (*Arachis hypogea*), Indian mustard (*Brassica juncea*), iris (*Iris* sp.), lettuce (*Lactuca sativa*), linseed/flax (*Linum usitatissimum*), *Miscanthus* sp., muskmelon/melon (*Cucumis melo*), narrow-leafed lupin (*Lupinus angustifolius*), *Nicotiana glauca*, *Nicotiana sylvestris, Nicotiana tabacum*, okra (*Abelmoschus esculentus*), onion (*Allium cepa*), pea (*Pisum sativum*), peanut (*Arachis hypogea*), pepper (*Capsicum annuum*), peppermint (*Mentha × piperita*), perennial ryegrass (*Lolium perenne*), *Petunia* spp., pigeonpea (*Cajanus cajan*), radiata pine (*Pinus radiata*), rose (*Rosa* sp.), safflower (*Carthamus tinctorius*), sorghum (*Sorghum bicolor*), squash (*Cucurbita* sp.), sugarcane (*Saccharum officinarum*), sweet potato (*Ipomoea batatas*), sweet worm (*Artemisia annua*), switchgrass (*Panicum virgatum*), tall fescue (*Festuca arundinacea*), tomato (*Solanum lycopersicum*), triticale (x*Triticosecale Wittmack*), watermelon (*Citrullus lanatus*), wheat (*Triticum aestivum*), and white clover (*Trifolium repens*).

4.1.3 Traits

Figure 6 presents the distribution of the distinct traits. The figures are based on 23380 trials for which information on traits could be retrieved. The trials performed in Chile are excluded, as little or no information on the traits is available. Trait percentages are calculated as the percentage of trials with a certain trait. Several traits may be trialled in one experiment, resulting in percentages exceeding 100% when summed up. Looking at the traits as a whole herbicide tolerance is by far the most encountered trait. About 3/4 of all trials has material containing a herbicide tolerance gene (73.1%). Other agronomic properties are abiotic stress tolerances (drought, salt, heat, cold, frost and low nutrients) present in 17.7% of the trials, and plant biology traits (yield increase, biomass increase, plant architecture, fertility, growth rate, etc.) in a fifth of the trials (20.5%). Among the biotic stress resistances insect resistance is the most common trait (35.5%). Product quality (13.7%) deals with type and level of fatty acids, carbohydrates and other compounds. Less than 1% is dedicated to plants as a production system for pharmaceutical and industrial proteins.

The figure for marker genes (18.2%) is an underestimation, as often these genes are not mentioned in the databases. Moreover, herbicide tolerance genes may function as well as selectable marker in the *in vitro* phase. It is not always clear what the exact function in a particular trial is.

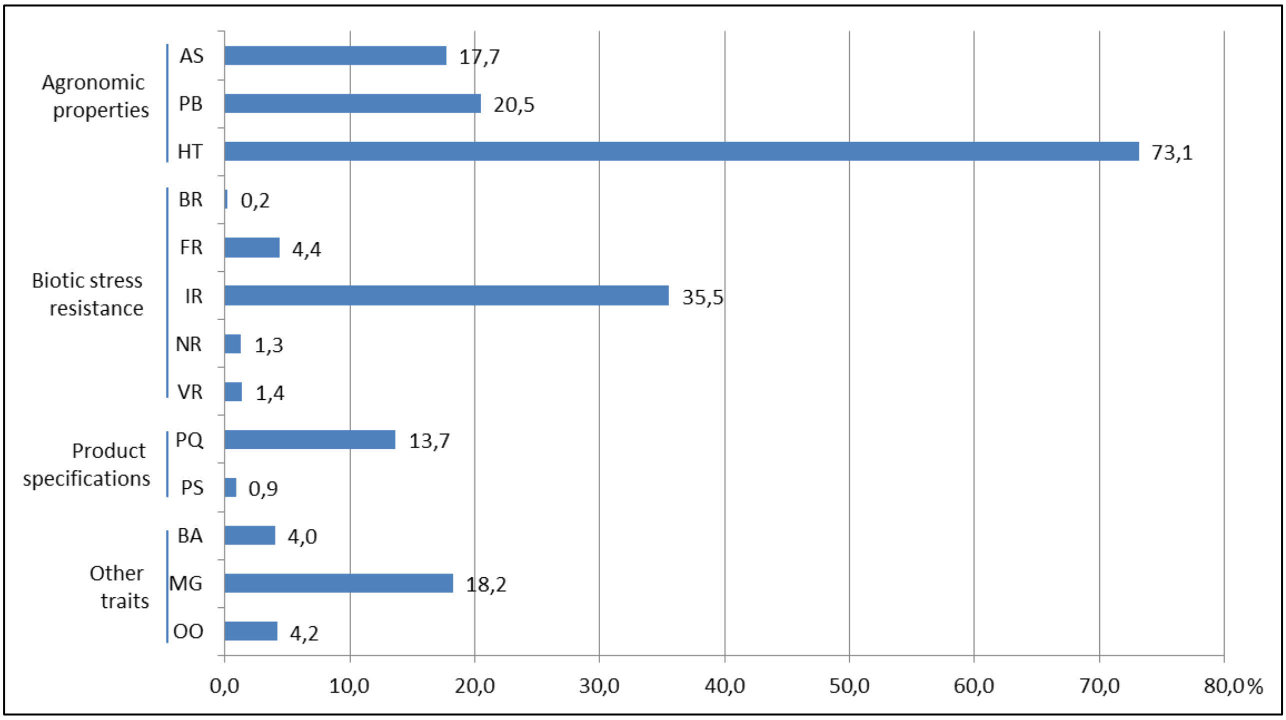


Figure 6 Percentage of all trials by class and type of trait, 2009-2013

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other

4.1.4 Applicants

In the previous OECD reports, two types of applicants were discerned. Following the same approach, research institutes were identified as non-profit research organisations such as universities and government-owned institutes. They account for 7.4% of all CFTs. Consequently, industry organised 92.6% of all CFTs. Research institutes usually act locally, whereas industry has multinational players and smaller enterprises that perform trials in one or a few countries.

4.2 European Union

4.2.1 Number of CFTs

Looking at the total number of field trials in the EU (including Iceland as member of the European Free Trade Association), a decline is noticed in the period 2009-2013 (Figure 7).

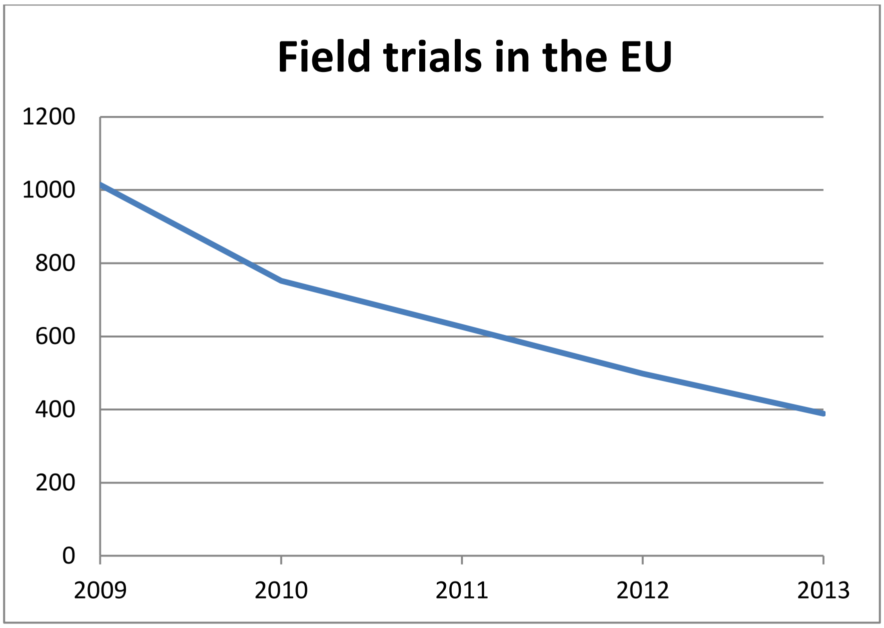


Figure 7 Total number of trials in the EU, 2009-2013

Most of the trials are performed in Spain immediately followed by Romania (Figure 8). However, the actual number of trials that are conducted is much lower. Often applications are valid for up to 5, sometimes even 10 years. Permits obtained before 2009 may remain valid into the studied period, but this is no guarantee that the CFTs are also performed. Relatively few new applications are submitted in the more recent years. This is *e.g.* the case in France, Germany, the Netherlands and Sweden. But also in Spain a strong decline is seen.

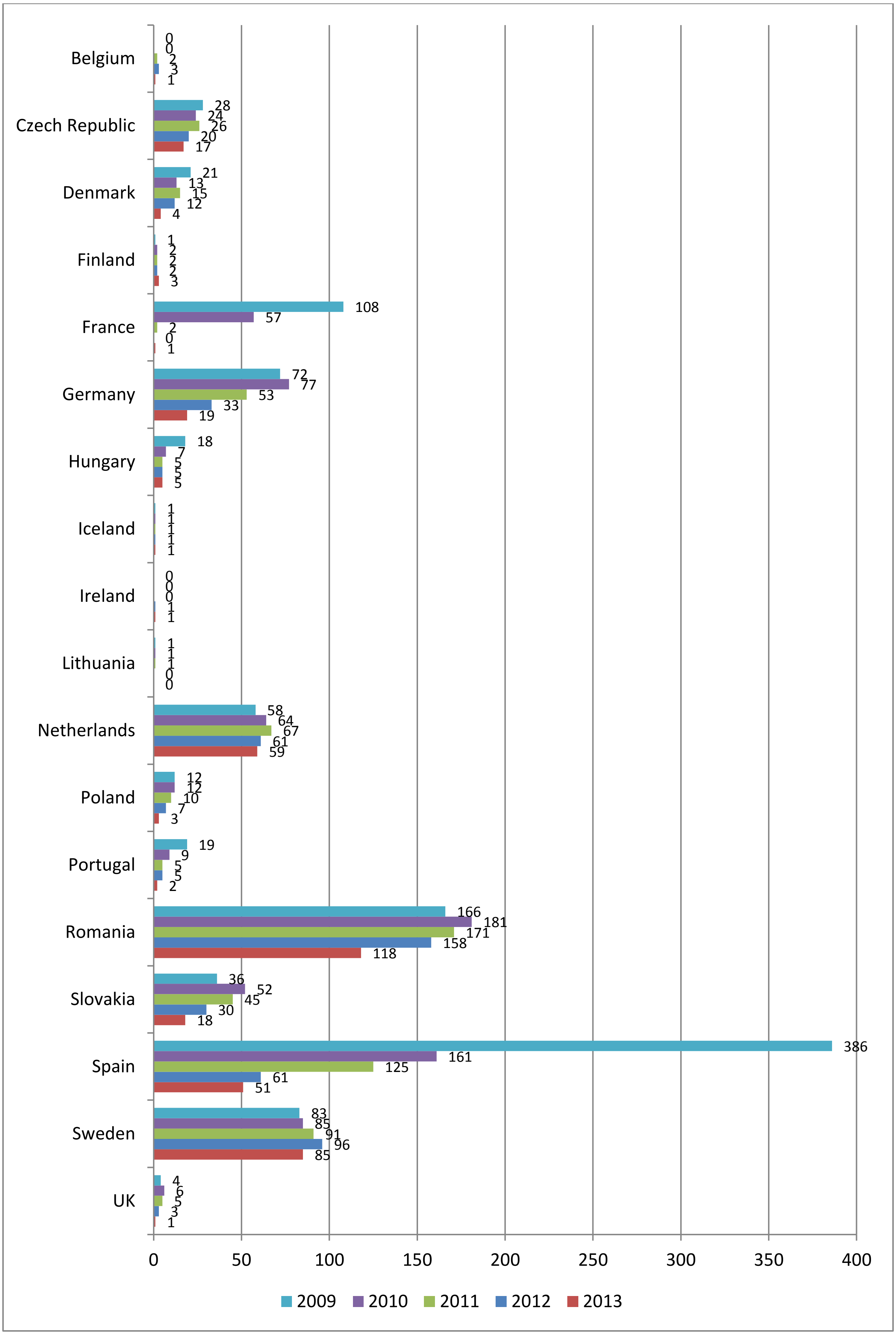


Figure 8 **Number of trials per European country per year, 2009-2013**

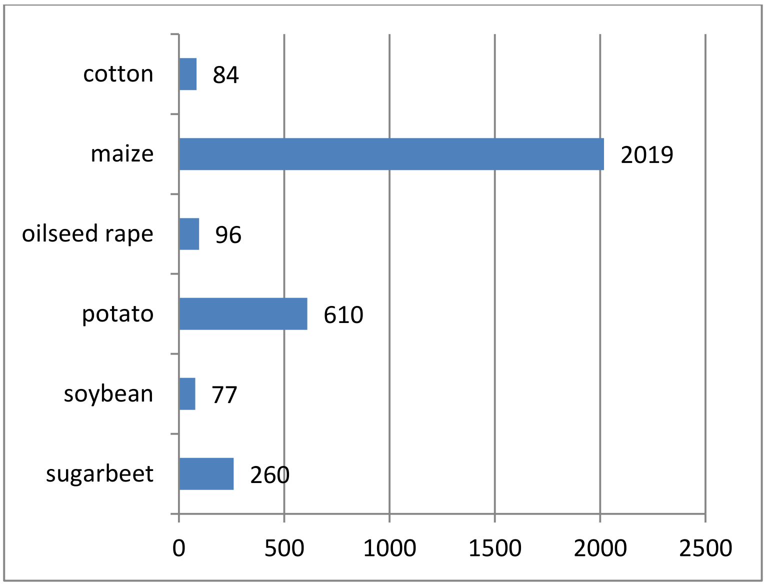
With regard to other countries on the European continent, no indications on CFTs with GM plants were found (confirmed via FAS/GAIN reports):

- Switzerland has implemented a moratorium on plant biotechnology CFTs since November 2005 for five years, extended by referendum for an additional three-year period
- In Bosnia and Herzegovina and Serbia no field trials are performed.
- For Macedonia, Moldova and Montenegro no data are available.
- In Belarus CFTs are legally possible, but no records are found.
- The Russian Federation allows food/feed registrations, but they are cumbersome. In the study period, no CFTs or cultivation of GM crops has taken place. Currently Russia has a *de facto* ban on the cultivation of genetically engineered plants, because the appropriate legal framework has not been completed.
- Ukraine does not allow GMOs as food/feed or cultivation. The legal framework remains unfinished.
- Kazakhstan (Europe/Asia) has declared itself to be GM-free and there are no records of CFTs.
- Finally, Turkey (Europe/Asia) has a stringent legislation that discouraged any GMO development, hence no CFTs.

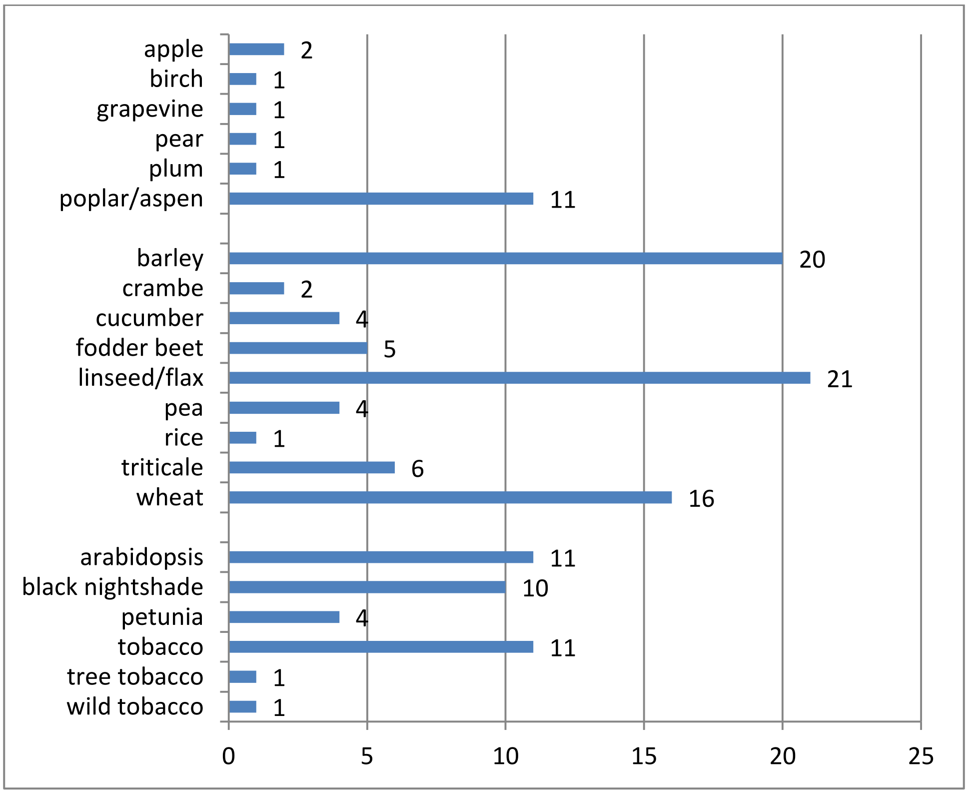
4.2.2 Crops

Maize is the most widely tested plant species (Figure 9, panel A). Often companies test their material in 10 to 30 locations per year resulting in this high trial number. Potato is tested predominantly in Northern and Western Europe, sugarbeet in central and Southern Europe and cotton in the growing areas in Spain. The oilseed rape permits were obtained before 2009 and concern Sweden. Likewise, soybean trials were requested before 2009 to be performed mostly in Romania.

The smaller crops are presented in Figure 9, panel B. Often they are still in proof-of-concept phase or early development, hence the small numbers. The first group are the tree species, both fruit-bearing and for biomass production. Other field and vegetable crops are presented in the middle group. The last group are the model plant species that are typically used in fundamental research.



A



B

Figure 9 Total number of trials per crop in the EU, 2009-2013

Cotton (*Gossypium hirsutum*), maize (*Zea mays*), oilseed rape (*Brassica napus*), potato (*Solanum tuberosum*), soybean (*Glycine max*), sugarbeet (*Beta vulgaris*)

Apple (*Malus domestica*), birch (*Betula pendula*), grapevine (*Vitis vinifera*), pear (*Pyrus communis*), plum (*Prunus domestica*), poplar/aspen (*Populus alba x Populus tremula, Populus deltoides, Populus tremula, Populus tremula x Populus tremuloides*)

Barley(*Hordeum vulgare*), crambe (*Crambe abyssinica*), cucumber (*Cucumis sativus*), fodder beet (*Beta vulgaris*), linseed/flax (*Linum usitatissimum*), pea (*Pisum sativum*), rice (*Oryza sativa*), triticale (x*Triticosecale Wittmack*), wheat (*Triticum aestivum*)

Arabidopsis (*Arabidopsis thaliana*), black nightshade (*Solanum nigrum*), petunia (*Petunia petunia x Petunia hybrida*) tree tobacco (*Nicotiana glauca*), tobacco (*Nicotiana tabacum*), wild tobacco (*Nicotiana sylvestris*)

4.2.3 Traits

The trait types that are of interest are summarised in Figures 10-11 (Annex 2, Table 1). Each type is looked at individually. The Figure does not include combinations of traits, as is often seen in maize for example where herbicide tolerance and insect resistance are frequently present in one plant. Again, trait percentages are calculated as the percentage of crop trials with a certain trait, resulting in percentages when summed up exceeding 100%.

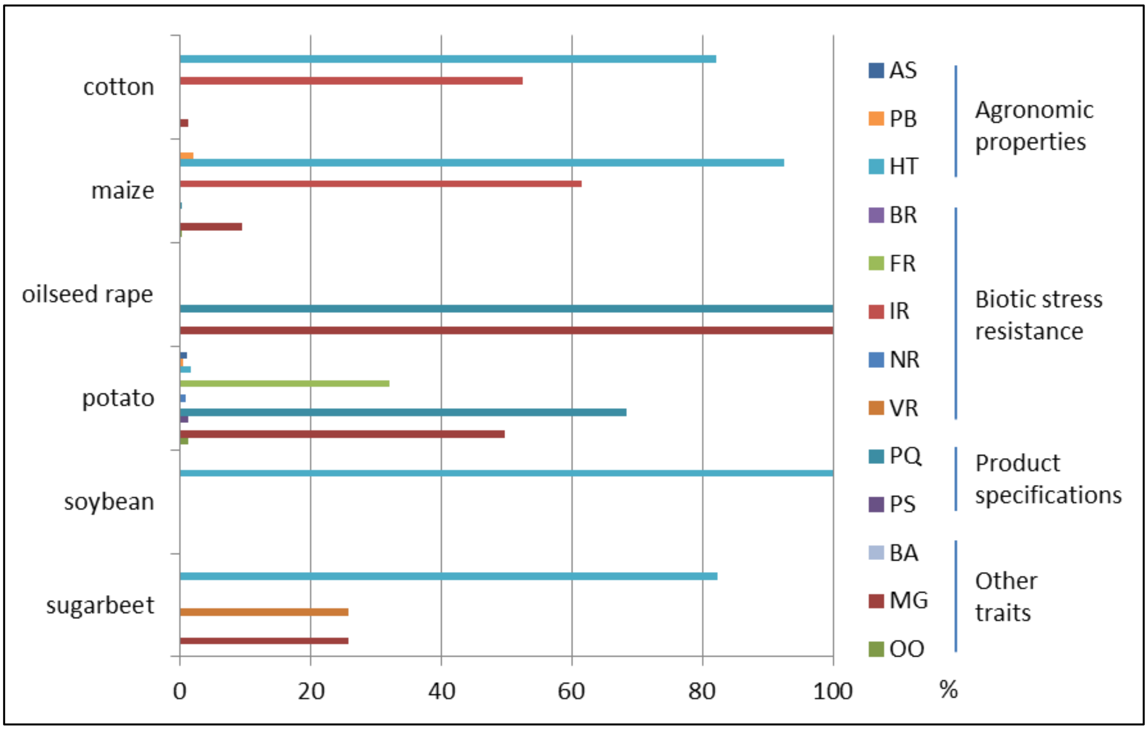


Figure 10 Percentage of all trials in the EU by class and type of trait per crop, 2009-2013 (Main crops) (Annex 2, Table 1)
AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Cotton (*Gossypium hirsutum*), maize (*Zea mays*), oilseed rape (*Brassica napus*), potato (*Solanum tuberosum*), soybean (*Glycine max*), sugarbeet (*Beta vulgaris*)

Most CFTs in cotton include herbicide tolerance traits (glyphosate, glufosinate ammonium) and Lepidoptera resistance (Figure 10).

In maize CFTs the most prominent trait is herbicide tolerance (tolerance to glyphosate, glufosinate ammonium or sulfonylurea herbicide). Insect resistance traits are targeted against coleopteran and lepidopteran insects. A very small amount of trials concern product quality with traits like increased digestibility, biofortified endosperm and increased starch levels.

Oil composition and oil level are CFT objectives in oilseed rape.

The potato CFTs can be divided into two classes. The smaller part deals with *Phytophthora infestans* resistance, the biggest part investigates altered starch metabolism (amylopectine). A very small number is dedicated to frost and heat tolerance, herbicide tolerance and potato cyst nematode resistance. GM potatoes are also used to produce pharmaceuticals (vaccins).

In sugarbeet, CFTs address herbicide tolerance (glyphosate tolerance). Second comes resistance to *Beet necrotic yellow vein virus* (BNYVV, rhizomania).

In CFTs of soybean, glyphosate tolerance is the only trait.

Only a small number of CFTs, 134 out of a total of 3279, are conducted for all other species. Figures 11A, B and C provide a schematic presentation of the traits per species. CFTs for disease resistance are recorded in fruit-bearing trees: apple (scab), grapevine (*Grapevine fanleaf virus*) and plum (*Plum pox virus*) (Figure 11). Also root growth is a CFT topic in apple and pear. GM aspen and poplar are investigated for their ability to produce biomass for energy production.

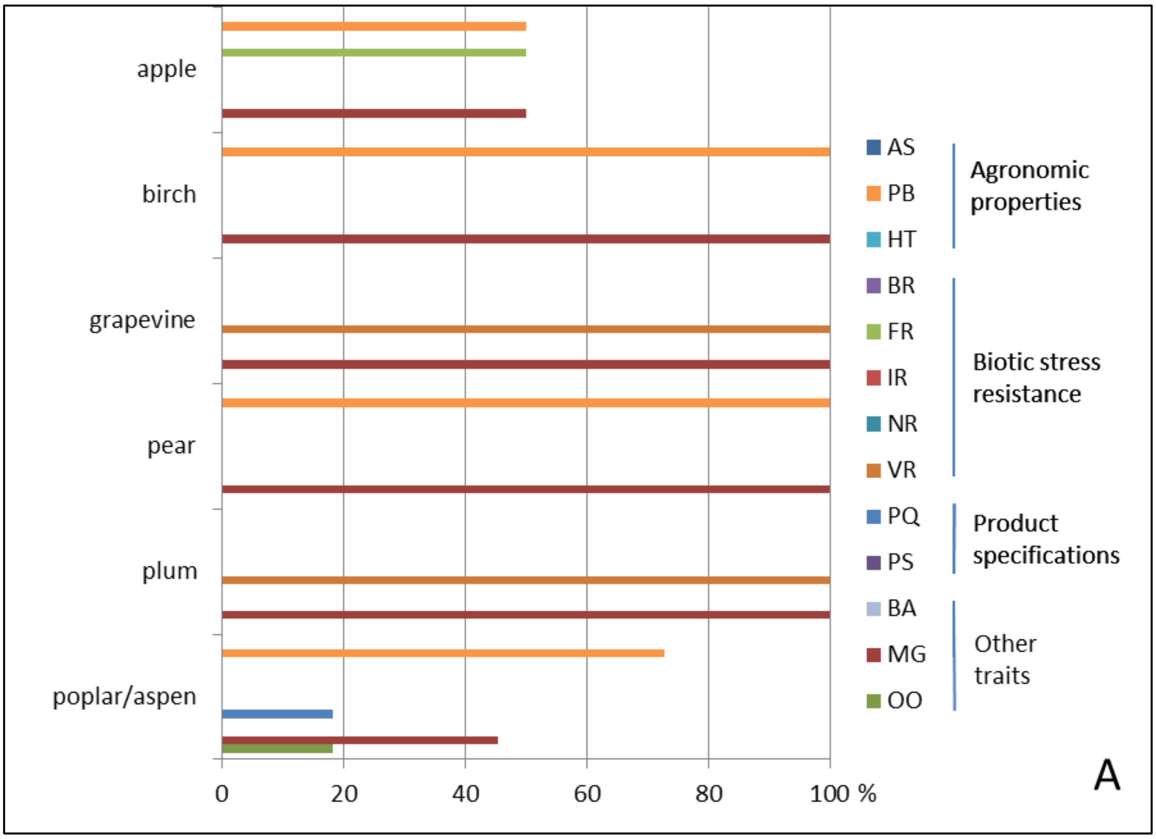


Figure 11A Percentage of all trials in the EU by class and type of trait per crop, 2009-2013 (tree species) (Annex 2, Table 1)
AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 9.

In barley increased nitrogen use efficiency, phytase activity, and *Rhizoctonia* resistance are studied (Figure 12). GM potato, barley and rice are also used to produce pharmaceuticals, resp. mammalian growth factor and the human enzyme acid β-glucosidase. For wheat, disease resistance (resistance against *Ustilago tritici and resistance to Puccinia graminis*) and pest resistance (against aphids) are the most important traits. GM triticale is used in pollen dispersion experiments. Oil quality is central for crambe and linseed. For linseed/flax also thermoplastic properties of the fibre are mentioned. In cucumber an improved taste is aimed for (thaumatin). Fodder beet is tested for tolerance to glyphosate. Finally pea is tested that has been modified with fungal and viral diseases and seed protein quality.

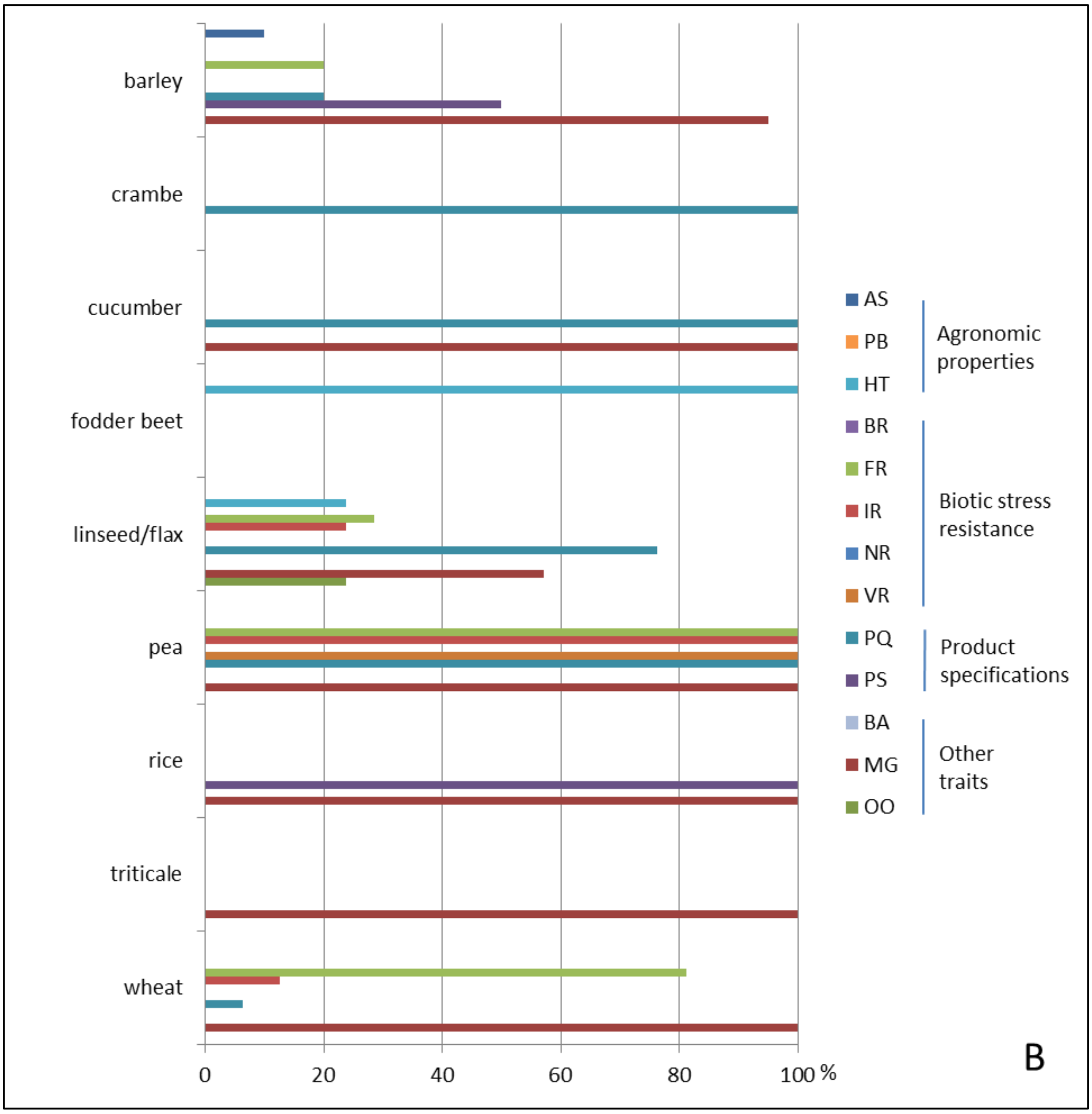


Figure 11B Percentage of all trials in the EU by class and type of trait per crop, 2009-2013 (other species) (Annex 2, Table 1)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 9.

Arabidopsis, petunia, tobacco, tree tobacco and black nightshade are used as model crops (Figure 13). Wild tobacco is used to produce a taxane diterpenoid.

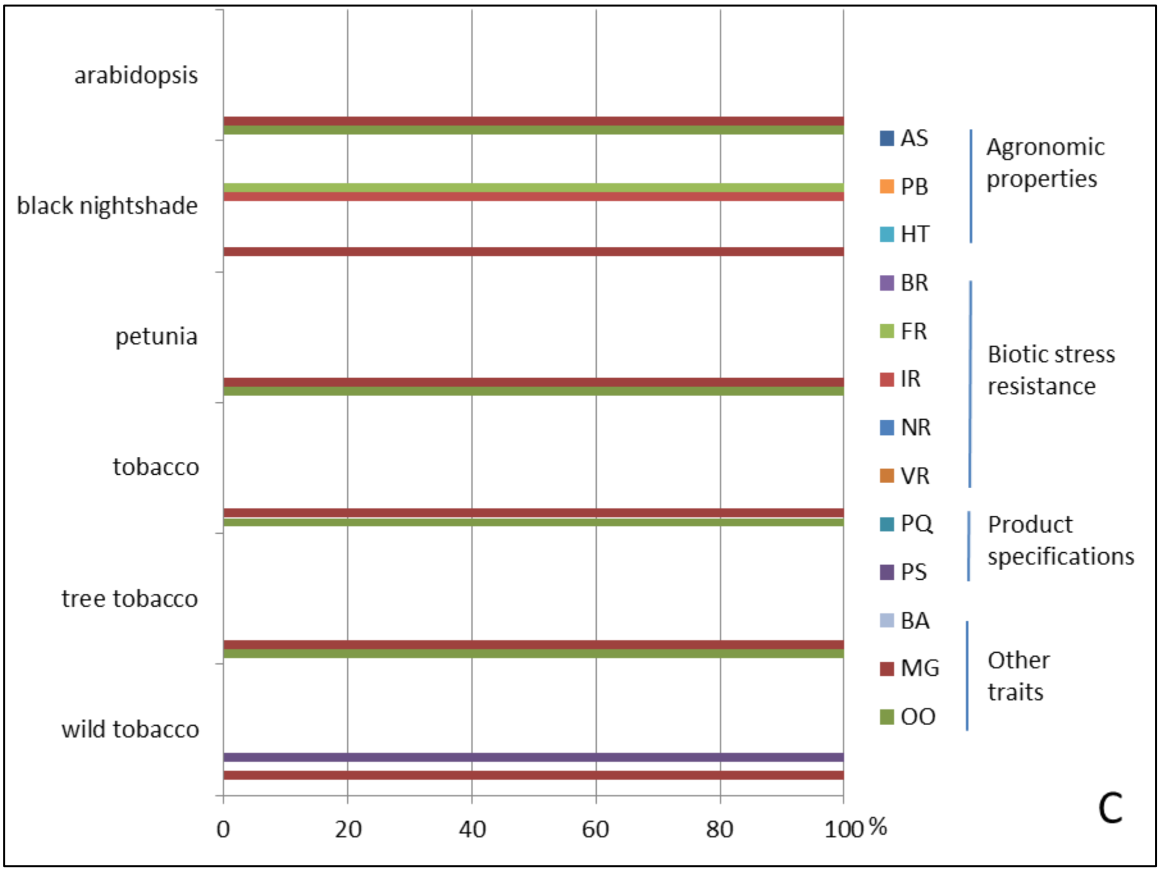


Figure 11C Percentage of all trials in the EU by class and type of trait per crop, 2009-2013 (model species) (Annex 2, Table 1)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 9.

4.2.4 Applicants

Figure 12 depicts the type of applicant (industry vs. research institutes) per plant species as a percentage of the total number of species trials (Annex 3, Table 1).

In the EU CFTs for the main agricultural crop are performed by industry (developers, seed companies). They are mostly multi-location trials (up to 30 locations for one event) with a relatively large surface. They are intended for regulatory purposes to produce data for a regulatory dossier and variety registrations and material for crop composition analysis (maize, cotton, sugarbeet). Also seed production is envisaged (*e.g.* Amflora potato in Germany).

The other plant species are studied in a single or a few trials on relatively small fields.

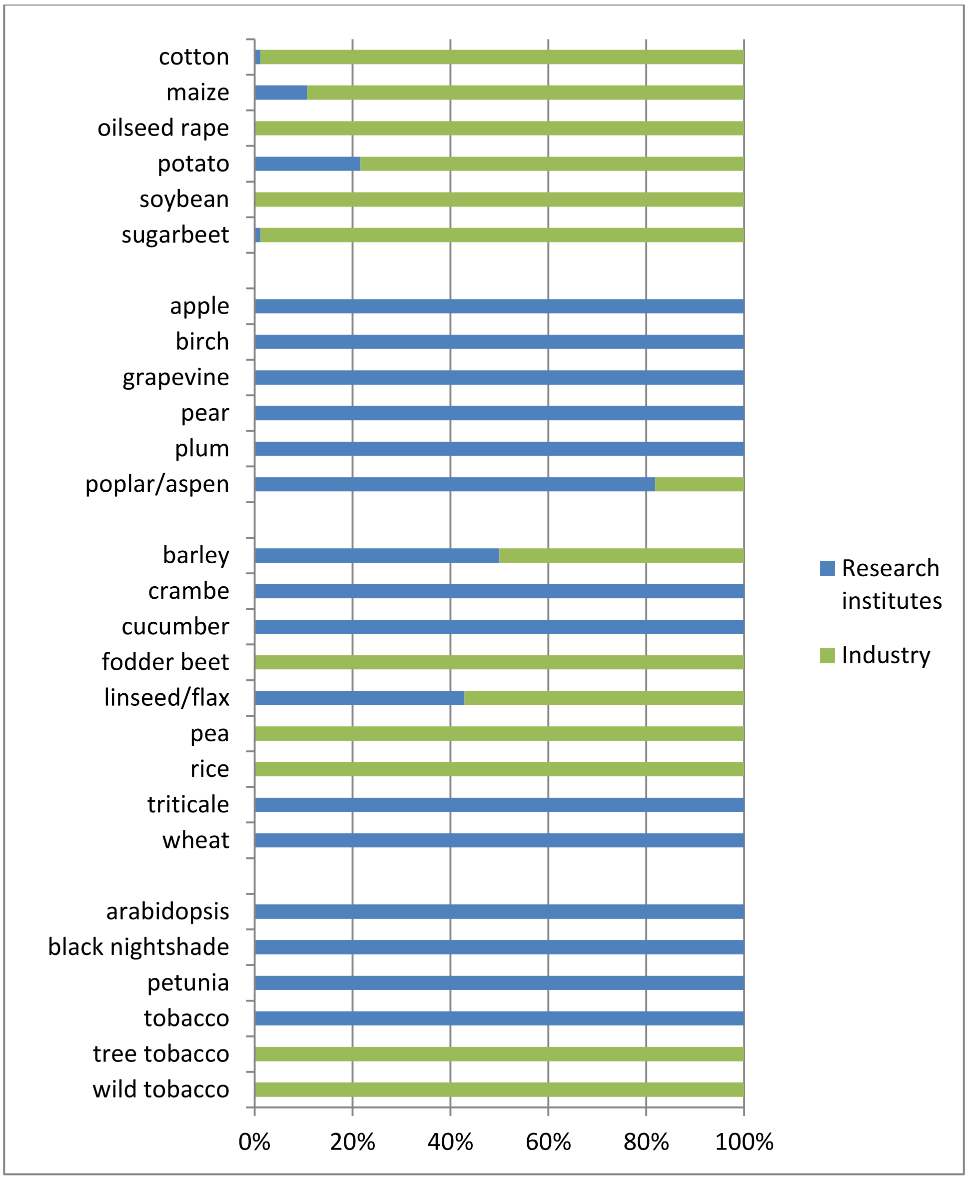


Figure 12 Percentage of all trials in the EU by applicant per crop, 2009-2013 (Annex 3, Table 1)
Plant species as in Figure 9.

4.3 North America

4.3.1 Number of CFTs

The numbers for North America, being Canada and the USA, are presented in the next Figures. Figure 13 shows the total number of field trials in both countries. For each USA state mentioned in the databases one trial is counted, which is probably an underestimation of the real number of field trials requested. On the other hand the figures for Canada may also include CFTs for non-GMO crops, since any method to obtain novel traits is regulated. In both countries the amount of trials remains more or less constant except for a decline in Canada in 2013.

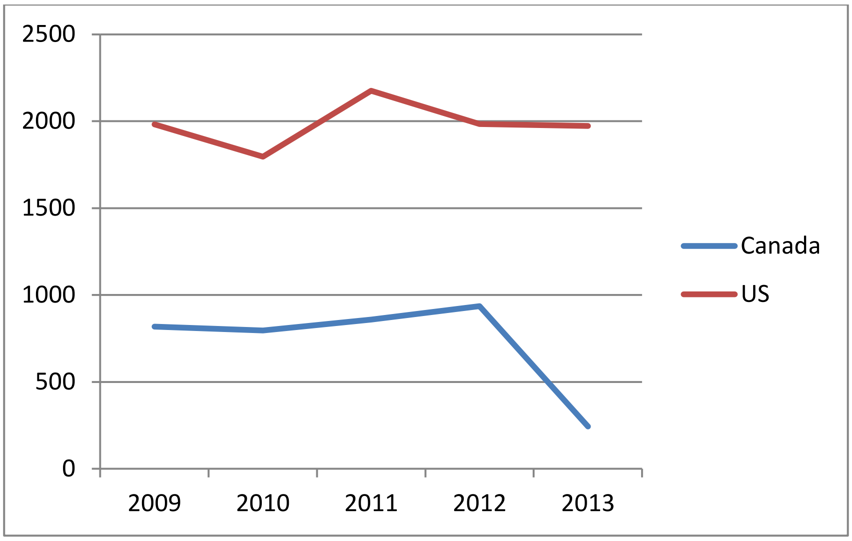


Figure 13 Total number of trials in Canada & USA, 2009-2013

Most CFTs in Canada are located in Saskatchewan, Manitoba and Ontario, and to a lesser extent in Alberta and Quebec. In the USA trials are performed predominantly in the main crop growing regions of the Mid-west and South-eastern United States and in the states at the Pacific coast.

4.3.2 Crops

Oilseed rape (canola) is the most important crop in Canada, while maize, closely followed by soybean dominates the field trials in the USA (Figure 14).

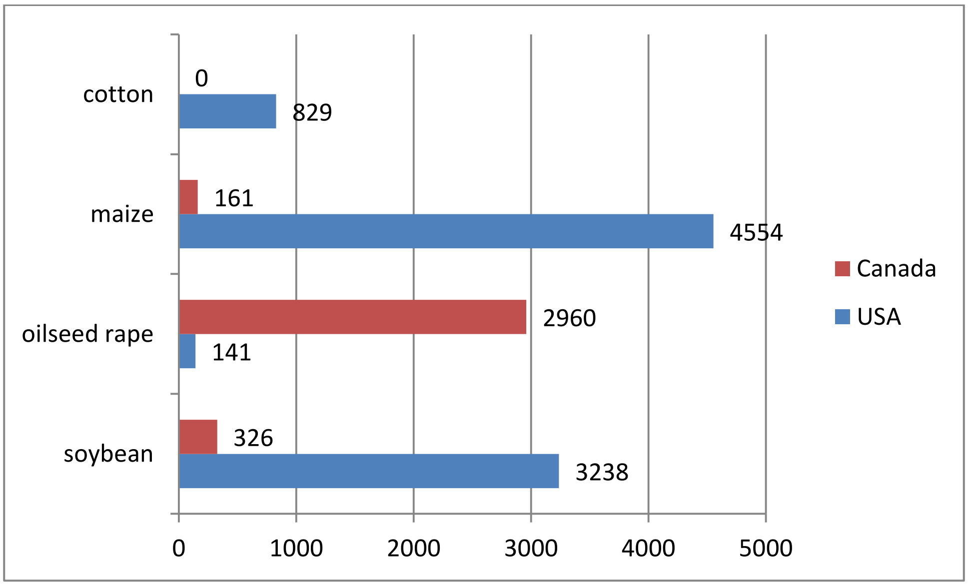


Figure 14 Total number of trials per crop in Canada & USA, 2009-2013 (Main crops)
Cotton (*Gossypium hirsutum*), maize (*Zea mays*), oilseed rape (*Brassica napus*), soybean (*Glycine max*)

Other crops in Canada are given in Figure 15.

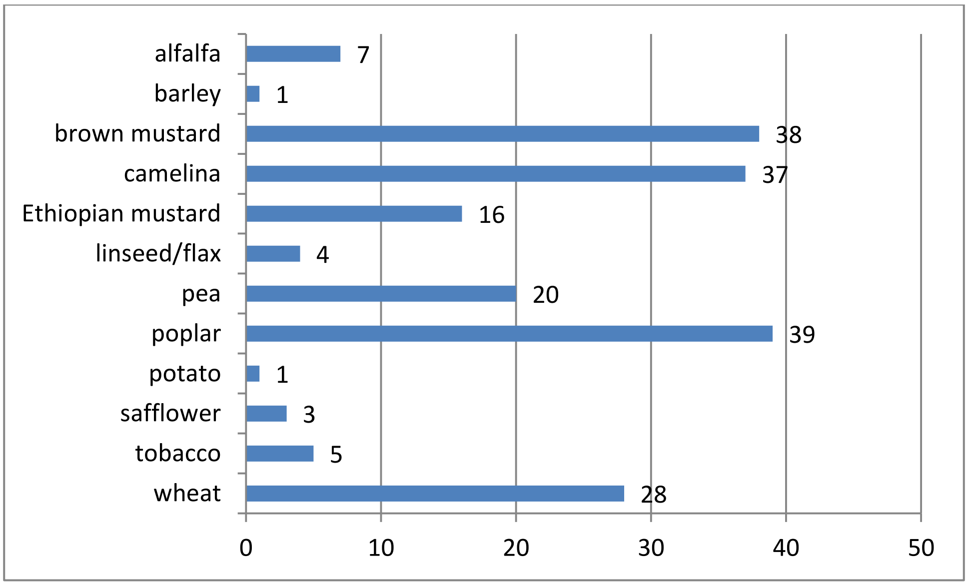


Figure 15 Total number of trials per crop in Canada, 2009-2013 (Other species)
Alfalfa (*Medicago sativa*), barley (*Hordeum vulgare*), brown mustard (*Brassica juncea*), camelina (*Camelina sativa*), Ethiopian mustard (*Brassica carinata*), linseed/flax (*Linum usitatissimum*), pea (*Pisum sativum*), poplar (*Populus* spp.), safflower (*Carthamus tinctorius*), tobacco (*Nicotiana tabacum*), wheat (*Triticum aestivum*)

Figure 16 shows all other crops or groups of crops that are mentioned in the USDA database.

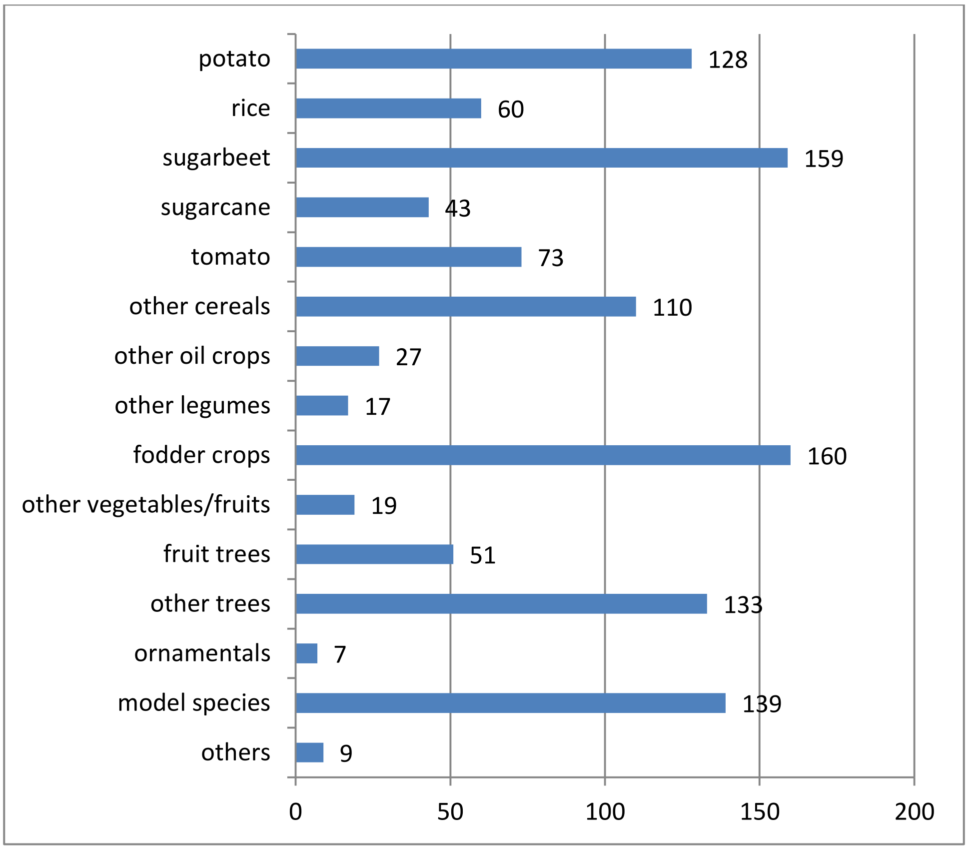


Figure 16 Total number of trials per crop in USA, 2009-2013 (Other species)

Potato (*Solanum tuberosum*), rice (*Oryza sativa*), sugarbeet (*Beta vulgaris*), Sugarcane (*Saccharum officinarum*), tomato (*Solanum lycopersicum*)

Other cereals: barley (*Hordeum vulgare*), wheat (*Triticum aestivum*)

Other oil crops: camelina (*Camelina sativa*), crambe (*Crambe abyssinica*), safflower (*Carthamus tinctorius*)

Other legumes: cowpea (*Vigna unguiculata*), peanut (*Arachis hypogea*)

Fodder crops: alfalfa (*Medicago sativa*), creeping bentgrass (*Agrostis stolonifera*), tall fescue (*Festuca arundinacea*), perennial ryegrass (*Lolium perenne*), sorghum (*Sorghum bicolor*), switchgrass (*Panicum virgatum*)

Other vegetables/fruits: lettuce (*Lactuca sativa*), muskmelon/melon (*Cucumis melo*), onion (*Allium cepa*), sweet potato (*Ipomoea batatas*)

Fruit trees: American chestnut (*Castanea dentata*), apple (*Malus domestica*), banana (*Musa* sp.), European plum (*Prunus domestica*), grapevine (*Vitis* sp.), grapefruit (*Citrus × paradisi*), orange (*Citrus sinensis*), papaya (*Carica papaya*), persimmon (*Diospyros* sp.), walnut (*Juglans* sp.)

Other trees: American elm (*Ulmus americana*), *Eucalyptus* sp., loblolly pine (*Pinus taeda*), *Populus* spp., sweetgum (*Liquidambar* sp.)

Ornamentals: *Anthurium* sp., Cypress vine (*Ipomoea × sloteri*), Easter lily (*Lilium longiflorum*), iris (*Iris* sp.)

Model species: *Arabidopsis thaliana*, black nightshade (*Solanum nigrum*), *Nicotiana* spp., *Petunia* sp.

Others: cassava (*Manihot esculenta*), *Miscanthus* sp., peppermint (*Mentha × piperita*)

4.3.3 Traits

Canada gives only very general information on the type of traits that are investigated. The results are shown in Figure 17 (Annex 2, Table 2).

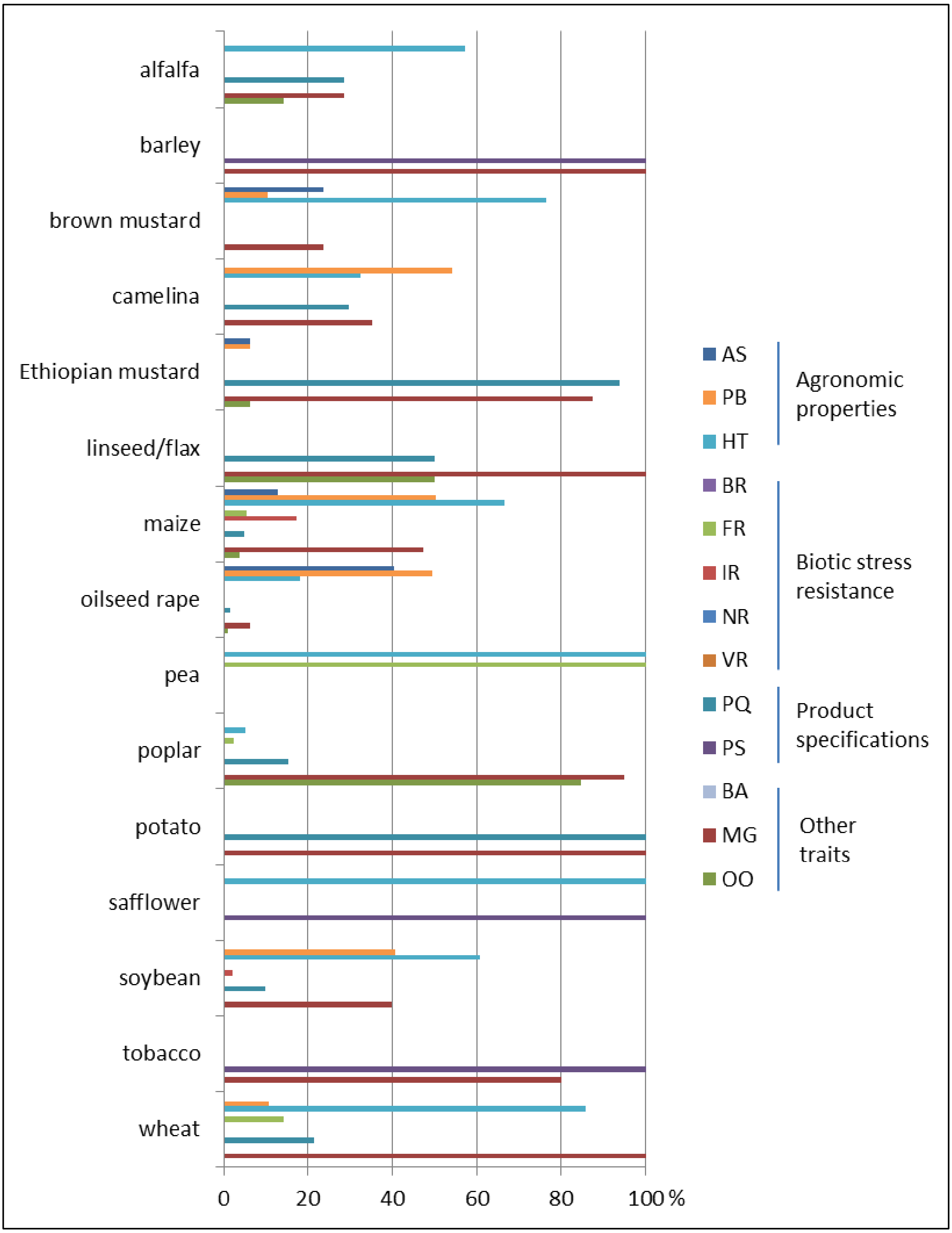


Figure 17 Percentage of all trials in Canada by class and type of trait per crop, 2009-2013 (Annex 2, Table 2)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Species as in Figures 14 and 15.

For oilseed rape the most frequently studied traits are stress tolerance, nitrogen use efficiency, water use efficiency, yield increase and male sterility. To a lesser extent a modified oil composition or nutritional change is listed.

For maize and soybean herbicide tolerance is prominent, but also yield increase. Furthermore in maize stress tolerance, insect resistance, fungal resistance, nutritional change, male sterility and altered maturity are investigated.

The composition of the oil fraction in the seed is important for soybean, camelina, Ethiopian mustard (*Brassica carinata*) and linseed/flax. Camelina is furthermore listed for yield increase and herbicide tolerance.

In brown mustard (*Brassica juncea*) stress tolerance, male sterility and herbicide tolerance are central.

Poplars are used for genetic research and safflower for the production of pharmaceuticals. Also barley and tobacco are cited as a producer for pharmaceuticals, commercial and industrial compounds. It is not known whether the latter species is used as a model crop.

In pea both herbicide tolerance and fungus resistance are studied. Finally, wheat is modified predominantly for herbicide tolerance, and to a lesser extent to increase yield, resist fungi and modify its carbohydrates.

In the USA, the trait classes indicated in Table 2 are used to describe the field trials, often with further specification. However, applicants frequently use the right to keep further information confidential, making classification less precise. Also trait types may be mentioned several times in one notification, but are counted only once, as the number of genes and gene constructs are not known. Therefore, in the following crop descriptions a bias may be introduced to the trait specifications.

Herbicide tolerance is important for cotton (tolerance to glyphosate, glufosinate ammonium or dicamba), maize (tolerance to glyphosate, glufosinate ammonium, dicamba, or sulfonylurea), oilseed rape (tolerance to glyphosate, glufosinate ammonium, or imidazolinone) and soybean (tolerance to glyphosate, dicamba, or sulfonylurea) (Figure 18A) (Annex 2, Table 3).

In the class of agronomic properties drought resistance is mostly listed for cotton. Next Hemiptera and Lepidoptera resistance followed by nematode resistance (not specified) and fungal resistance (*Alternaria, Aspergillus, Fusarium, Phytium, Rhizoctonia* and *Verticillium*) appear in the database.

For maize the number of field trials with one or more agronomic properties under investigation is as important as the group for herbicide tolerance. They concern yield increase, drought and cold tolerance, nitrogen use efficiency, plant development and maturity traits. A smaller group are the trials with Lepidoptera and Coleoptera resistance. Also fungus (stalk rot, ear rot) and virus resistance (not specified) are measured.

Yield increase, nitrogen use efficiency and water use efficiency are the most important agronomic properties for oilseed rape as is the case in Canada. A small number of trials mentions improved seed composition.

For potato carbohydrate metabolism, processing characteristics and also carotenoid content as product quality traits come first followed by *Phytophthora* resistance. To a lesser extent cold and drought tolerance, increased tuber set and nitrogen use efficiency are studied. Pests are, the potato tuber worm, the Colorado beetle and the viruses *Potato virus A*, *Potato virus Y* and *Potato leafroll virus*.

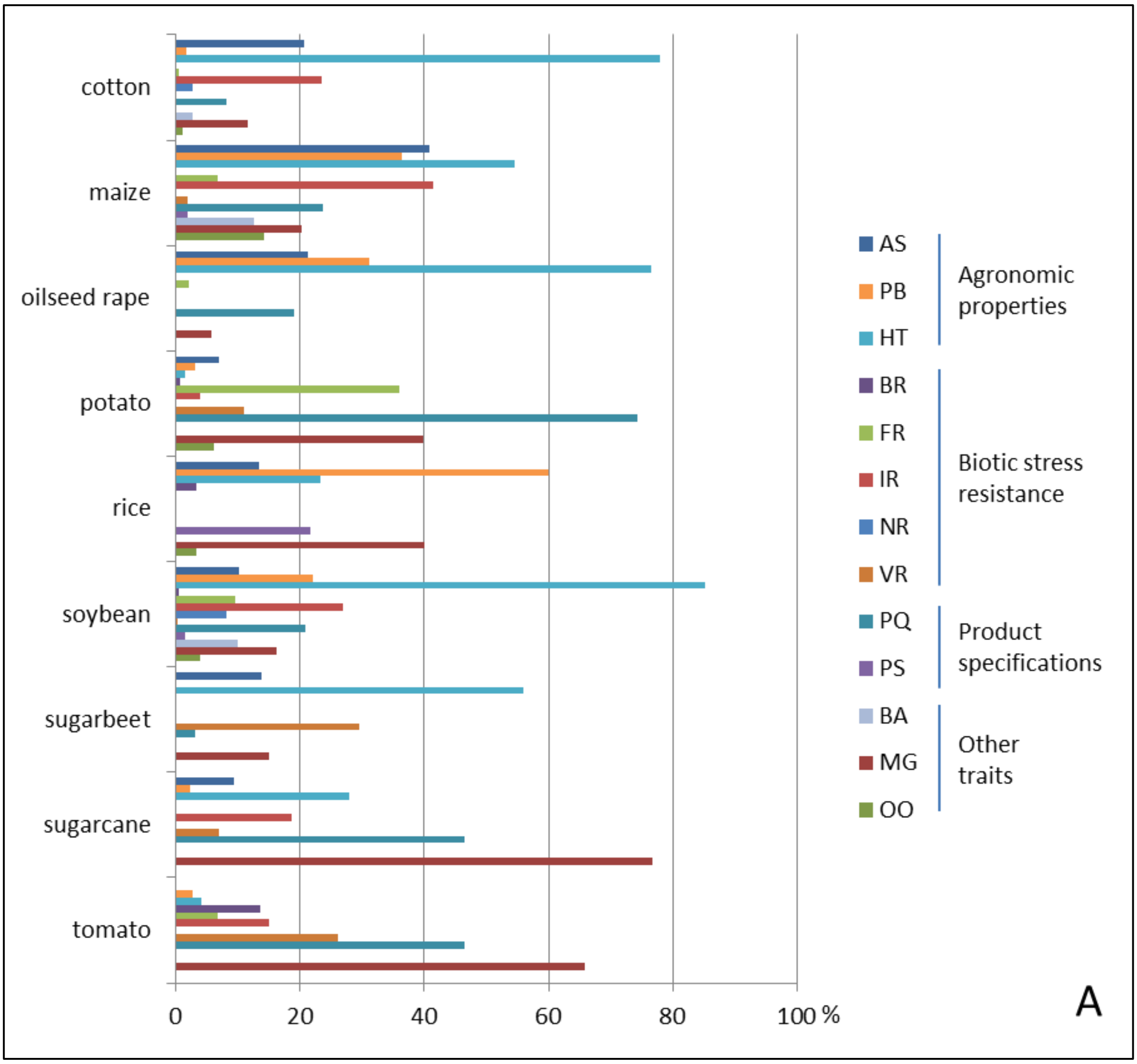


Figure 18A Percentage of all trials in USA by class and type of trait per crop, 2009-2013 (Annex 2, Table 3)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figures 14 and 16.

In rice mostly yield increase, but also nitrogen use efficiency and drought tolerance are investigated. Also, pharmaceuticals are produced in rice.

The second most important group in soybean is the insect resistance trait conferring Lepidoptera resistance. Agronomic properties are about yield increase, stress, drought and cold tolerance, nitrogen use efficiency, water use efficiency, plant development and maturity traits.

In sugarbeet most trials have a herbicide tolerance trait (glyphosate), followed by BNYVV resistance. Also nitrogen use efficiency is important.

Next to cold tolerance scientist also work on insect and virus resistance (*Sugarcane mosaic virus*, *Sugarcane yellow leaf virus*) in sugarcane. Most trials are dedicated to what is described as 'altered sugar storage'. The type of genes is not disclosed.

The product quality traits like fruit ripening characteristics, fruit flavour, food quality and amino acid composition are followed by virus resistance (*Cucumber mosaic virus*, *Potato virus Y* and others) in tomato. Insect resistance is against Lepidoptera, fungus resistance against *Botrytis cinerea*. Bacteria resistance is not further specified.

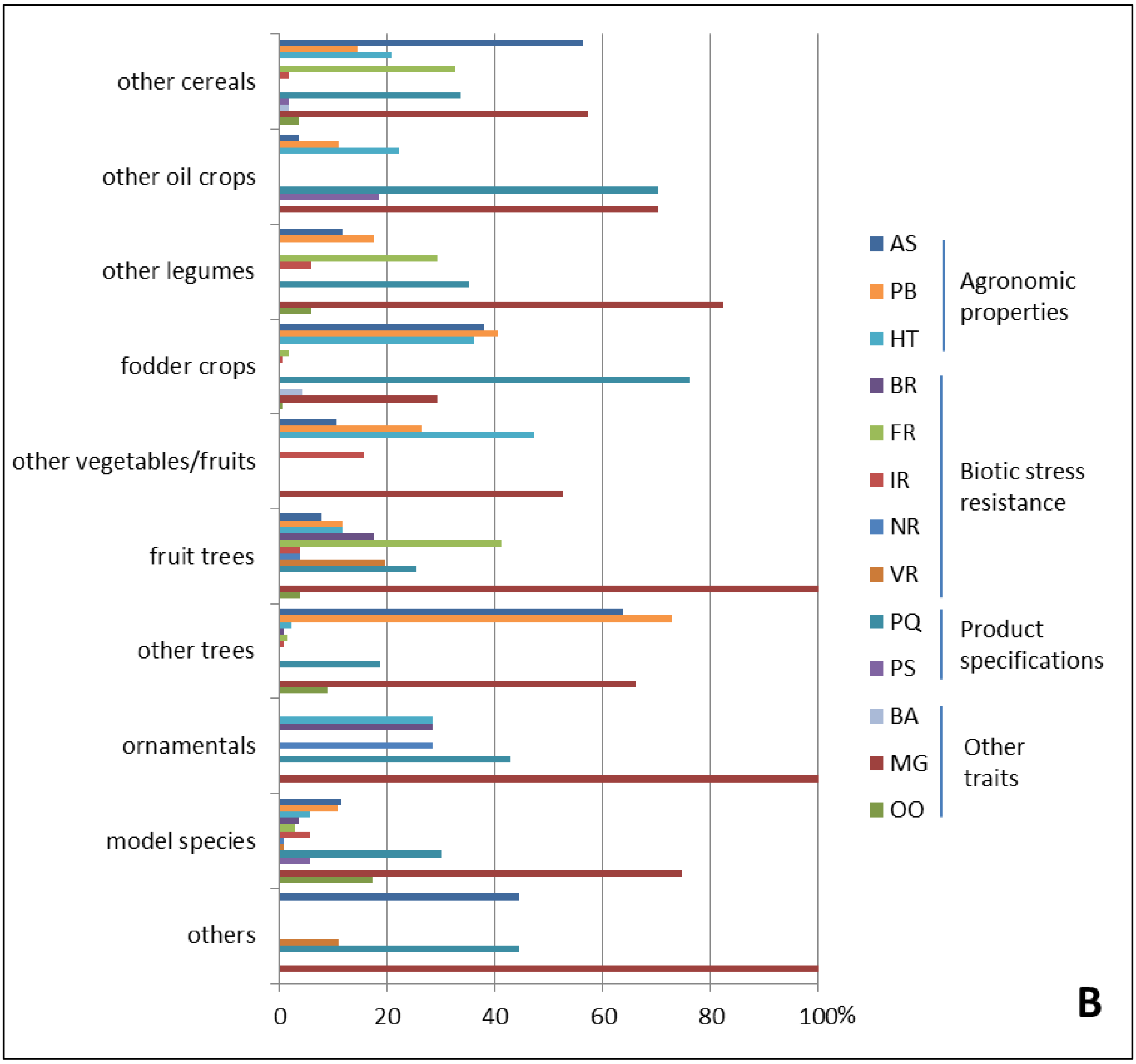


Figure 18B Percentage of all trials in USA by class and type of trait per group of plant species, 2009-2013 (Annex 2, Table 3)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 16.

For the cereals barley and wheat drought tolerance and nitrogen use efficiency are the traits most worked on (Figure 18B) (Annex 2, Table 3). Also fungus resistance (*Fusarium, Rhizoctonia*) and quality traits (carbohydrate, protein and oil composition) are tested. In two barley trials the production of lactoferrin and lysozyme was tested.

The oil crops camelina, crambe and safflower are modified for their oil composition. Safflower is also a producer of pharmaceuticals and an industrial protein.

The few trials in the legume crop peanut are dedicated to fungus resistance and product quality (high folate, storage protein composition and reduction of allergens). The single cowpea trial concerns Lepidoptera resistance.

Digestibility is the main trait for fodder crops. The agronomic properties drought tolerance, nitrogen use efficiency, yield increase, and herbicide tolerance are equally important.
The number of vegetable and fruit species applied for in trials in the USA is clearly decreasing. Lettuce, melon, onion and sweet potato are the only ones next to the already mentioned tomato.

Most trait types are encountered in the fruit tree CFTs taken together. The emphasis differs per species: cold tolerance for apple trees; dwarf growth in plum trees; fertility traits in plum, apple and papaya; bacteria resistance in walnut (*Agrobacterium tumefaciens*) and grapevine (*Xylella fastidiosa*); fungus resistance in American chestnut (chestnut blight, *Phytophthora*), in plum (*Ralstonia, Phytophthora*) in grapevine (*Colletotrichum*, powdery mildew); aphid resistance in grapefruit; root knot nematode resistance in plum; and virus disease resistances in several species, quality traits like a reduction of polyphenol oxidase levels in apple and walnut and seedlessness in grapevine.

Other tree species (*Eucalyptus* sp., loblolly pine, *Populus* spp., sweetgum) are used for their wood or as energy crops. Cold tolerance is noticed for *Eucalyptus* species. Most important are biology traits such as biomass, plant stature, growth rate and fertility. Product quality is about altered lignin biosynthesis.

Ornamental species trials are about *Xanthomonas campestris* resistance in *Anthurium* and flower colour (cypress vine, iris).

In the group of model crops are *Arabidopsis*, *Nicotiana* sp. and petunia, although it is not always clear whether they are actually used as model crop. *Nicotiana attenuata* and *N. tabacum* may as well be intended as a crop. *E.g. N. tabacum* is listed as producer of pharmaceuticals and other compounds. Also, the herbicide tolerance may be used as selectable marker in the *in vitro* stage of research.
For the energy crop *Miscanthus* nitrogen use efficiency is key. GM cassava is expected to cope with *Cassava mosaic virus* and has increased carotene levels. Peppermint was improved for essential oil yield and composition.

4.3.4 Applicants

Industry accounts for most of the GM plant CFTs. The relative amount of trials per applicant type per crop is presented in Figure 19 for Canada (Annex 3, Table 2). Linseed/flax and pea are studied by research institutes only. Poplar is examined by the Laurentian Forestry Centre, which is a Canadian Forest Service research centre. Agriculture Canada (London) deals with all tobacco trials.

For the USA the distribution of applicant types is given in Figure 20 (Annex 3, Table 3). All government trials are performed by the United States Department of Agriculture/Agricultural Research Service. The figure shows that companies manage the main agricultural crops. For the smaller crops academia becomes more prominent.

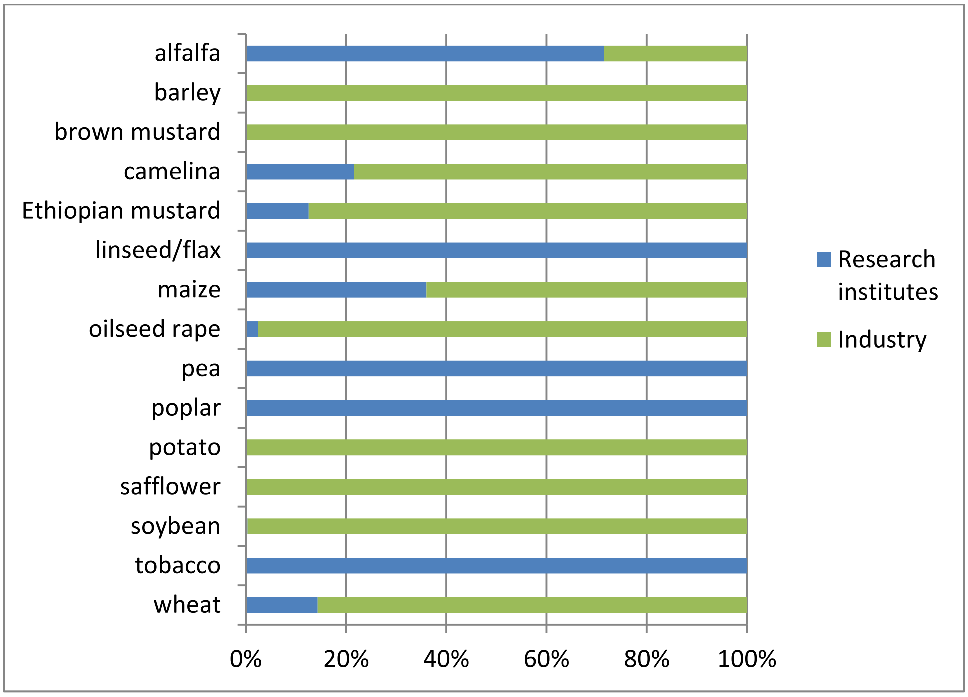


Figure 19 Percentage of all trials in Canada by applicant type per crop, 2009-2013 (Annex 3, Table 2)
Plant species as in Figures 14 and 15.

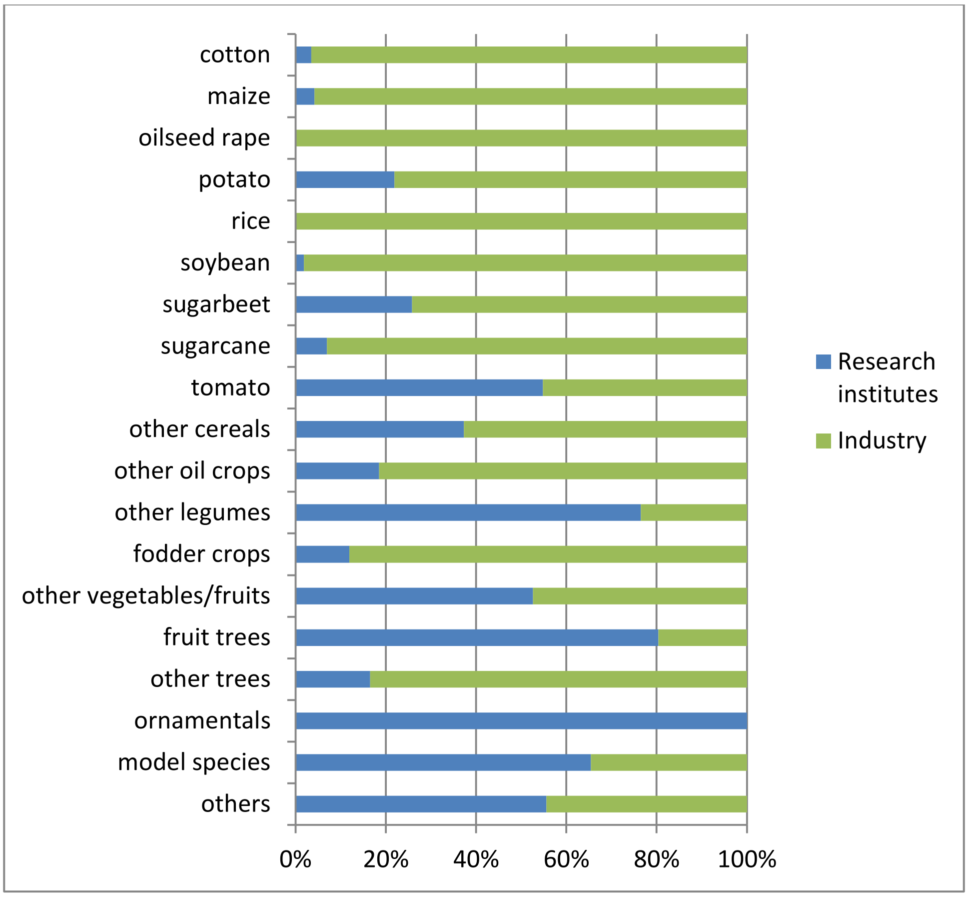


Figure 20 Percentage of all trials in the USA by applicant type per crop or group of plant species, 2009-2013 (Annex 3, Table 3)
Plant species as in Figures 14 and 16.

The size of the trial together with the number of sites may give an estimate of the stage of development of a certain GM crop. The Canadian database does not disclose trial sizes. In the USA the picture is mixed for the big crops. Both large scale and small scale CFTs are observed. The high number trials (from 8 states onwards) are only seen for maize, cotton and soybean. Next to herbicide tolerance and insect resistance abiotic stress tolerance and plant biology traits are tested. The smaller crop trials are performed usually in one or sometimes a few states. Trial sizes may vary from relatively small (up to 1 ha) to large (up to 120 ha for wheat) and very large (up to 600 ha for safflower).

Other crops that are relatively intensively studied are *Phytophthora* resistant potato, BNYVV resistant sugarbeet, oilseed rape with an improved seed composition and alfalfa with a low lignin content.

Tree trials are by nature larger (up to 95 ha for *Eucalyptus*), although very small trials are seen too (32-400 m^2 for apple, chestnut and *Populus*). *Eucalyptus* hybrids are already extensively trialled (up to 7 states) for altered lignin biosynthesis, cold tolerance, altered fertility and altered growth rate. A petition for deregulating freeze tolerant *Eucalyptus* is submitted in 2011 (USDA-APHIS, Petitions).

4.4 Latin America

4.4.1 Number of CFTs

In Latin America the most important countries in terms of numbers of CFTs are Argentina, Chile, Brazil and Mexico. Field trials are performed for regulatory purposes for domestic marketing, but also as a counter-season opportunity for companies based in the northern hemisphere. The latter is certainly the case for Chile. Chile takes a special place as it only allows trials if seeds are re-exported afterwards. Next to Chile, also Argentina and Uruguay have extensive counter-season seed productions of events that are in the regulatory process for commercialisation or even that are already on the market in other countries.

The numbers of CFTs for Latin America are given in Figures 21 and 22. Chile is presented separately as in the government statistics every single field is counted, whereas in other countries only regions or states are indicated without exact locations. In Argentina and Uruguay that is even not the case: one permit is counted as one trial. In these countries the number of CFTs is underestimated. To illustrate this imbalance: in the period 2009-2012 Chile counts 14570 single fields, compared to 972 CFTs in Argentina.

For Argentina no data are available for the 2013/2014 season. In Mexico maize applications were put on hold since mid-2012. These two facts are the main cause for the decrease seen in Latin America. For Chile the data for the last planting season are not complete. Seed productions in Uruguay are automatically extended without being published on the government's website since 2012.

In Figure 25 only those countries are presented for which data could be retrieved from government's databases. Other countries allow field trials as well but data are collected from other sources and are therefore fragmentary and less accurate.

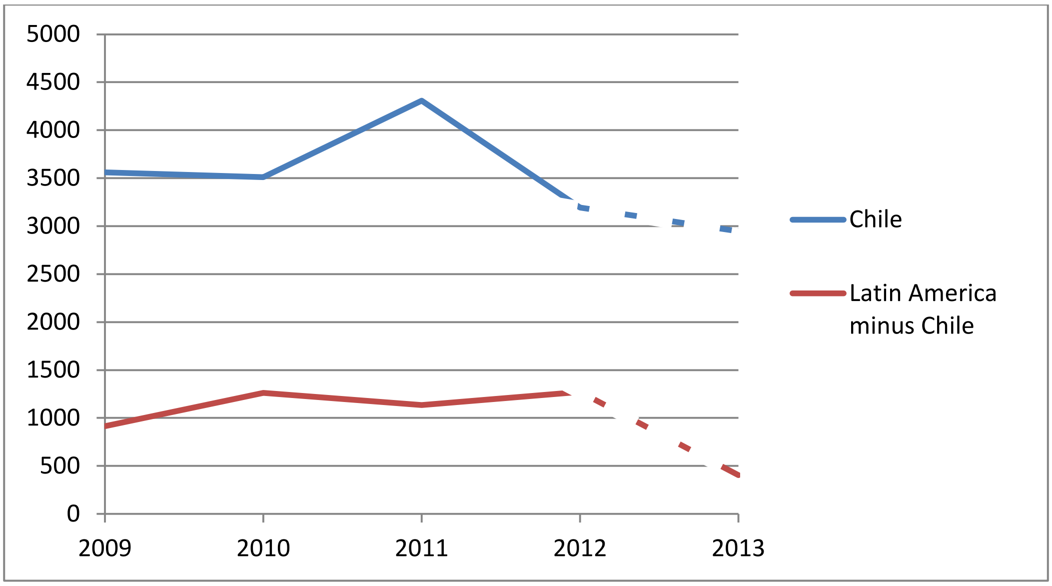


Figure 21 Total number of trials in Latin America, 2009-2013

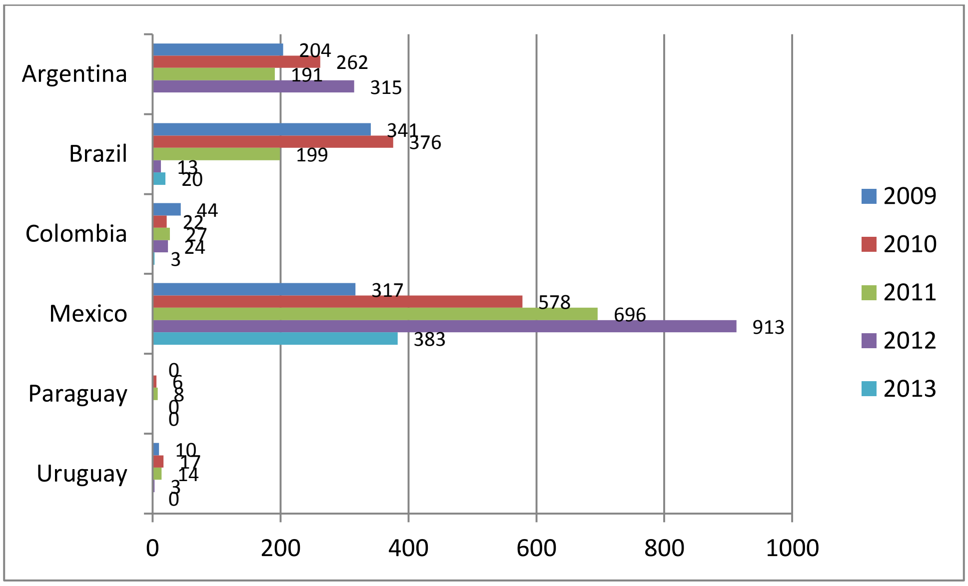


Figure 22 Number of trials per country in Latin America per year, 2009-2013

For Bolivia two cotton events were tested in 2012. Cuba had at least one insect resistant maize trial in 2012. For Honduras a trial with herbicide tolerant rice was reported for 2011. Costa Rica allow CFTs on condition that all harvested material is either destroyed or exported. Trials were done for rice, banana and pineapple. Panama conducted 2 CFTs on maize.

4.4.2 Crops

The most prominent crops tested are maize and soybean (Figure 23).
With a few exceptions most of the events are at the end of development and even commercialised elsewhere.

Figure 24 depicts the situation in Chile. Again maize trials are the majority. Soybean and also oilseed rape follow. Other crops are sugarbeet, tomato, squash/zucchini and grapevine.

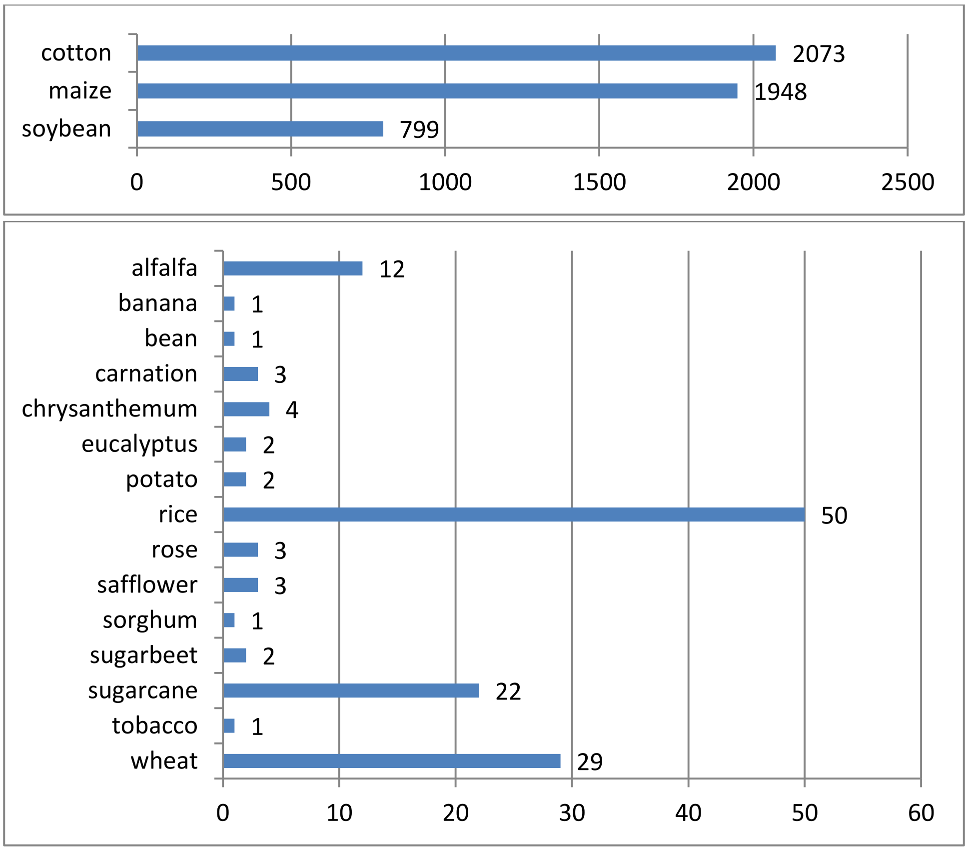


Figure 23 Total number of trials per crop in Latin America except Chile, 2009-2013

Cotton (*Gossypium hirsutum*), maize (*Zea mays*), soybean (*Glycine max*)
Alfalfa (*Medicago sativa*), banana (*Musa* sp.), bean (*Phaseolus vulgaris*), carnation (*Dianthus caryophyllus*), chrysanthemum (*Chrysanthemum × morifolium*), eucalyptus (*Eucalyptus* sp.), potato (*Solanum tuberosum*), rice (*Oryza sativa*), rose (*Rosa* sp.), safflower (*Carthamus tinctorius*), sorghum (*Sorghum bicolor*), sugarbeet (*Beta vulgaris*), sugarcane (*Saccharum officinarum*), tobacco (*Nicotiana* sp.), wheat (*Triticum aestivum*)

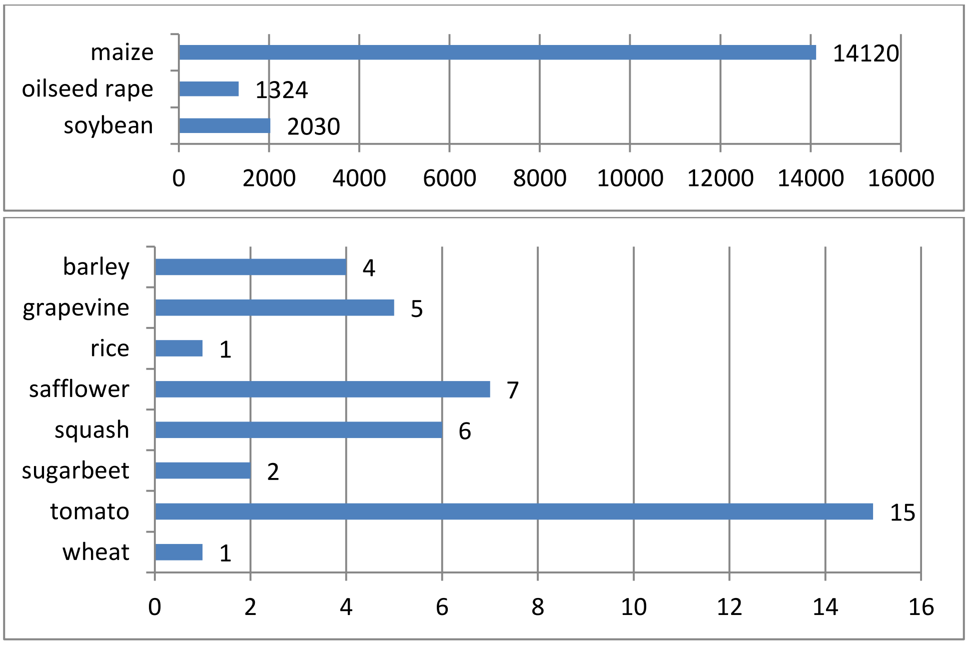


Figure 24 Total number of trials per crop in Chile, 2009-2013

Maize (*Zea mays*), oilseed rape (Brassica napus), soybean (*Glycine max*)
Barley (*Hordeum vulgare*), grapevine (*Vitis* sp.), rice (*Oryza sativa*), safflower (*Carthamus tinctorius*), squash (*Cucurbita* sp.), sugarbeet (*Beta vulgaris*), tomato (*Solanum lycopersicum*), wheat (*Triticum aestivum*)

4.4.3 Traits

Maize is the dominant crop in most countries with herbicide tolerance and insect resistance as the most common trait type (Figure 25) (Annex 2, Table 4). Soybean is the second most prevalent crop in Argentina and Brazil, again with herbicide tolerance and insect resistance. Cotton is the second crop in Mexico.

Agronomic properties for maize are drought tolerance and fertility traits. Also mentioned are a high α-amylase content, improved digestibility and high oil content. Soybeans are made tolerant to drought, salt or unspecified abiotic stresses. Furthermore, a high oil content or high yielding lines are also seen. Apart from herbicide tolerance and insect resistance, a tiny fraction of the cotton trials is dedicated to nitrogen use efficiency and fibre quality.

Other crops are sugarbeet and sugarcane (herbicide tolerance), wheat (drought and salt tolerance), and alfalfa (drought tolerance, delayed senescence). In rice characteristics with the potential to improve yield are most tested. Most rice CFTs are in Brazil, followed by Argentina.

The field trial permits for the ornamental crops carnation, chrysanthemum and rose in Colombia are intermediate between development CFTs and commercial authorisations: the permits, called ‘controlled commerce’ permits, are meant for the production of cut flowers for export only.

Safflower trialled in Argentina produces pro-chymosin. Up to 8 ha are also sown in Chile.
The values for marker genes are underestimated, because this information is not always available.

In Chile only the crop and location of the trial is disclosed. Almost no information on traits is available. More detailed lists only mention the use of oilseed rape events ACS-BN005-8xACS-BN003-6 and MON-00073-7, resp. glufosinate ammonium tolerant and glyphosate tolerant.

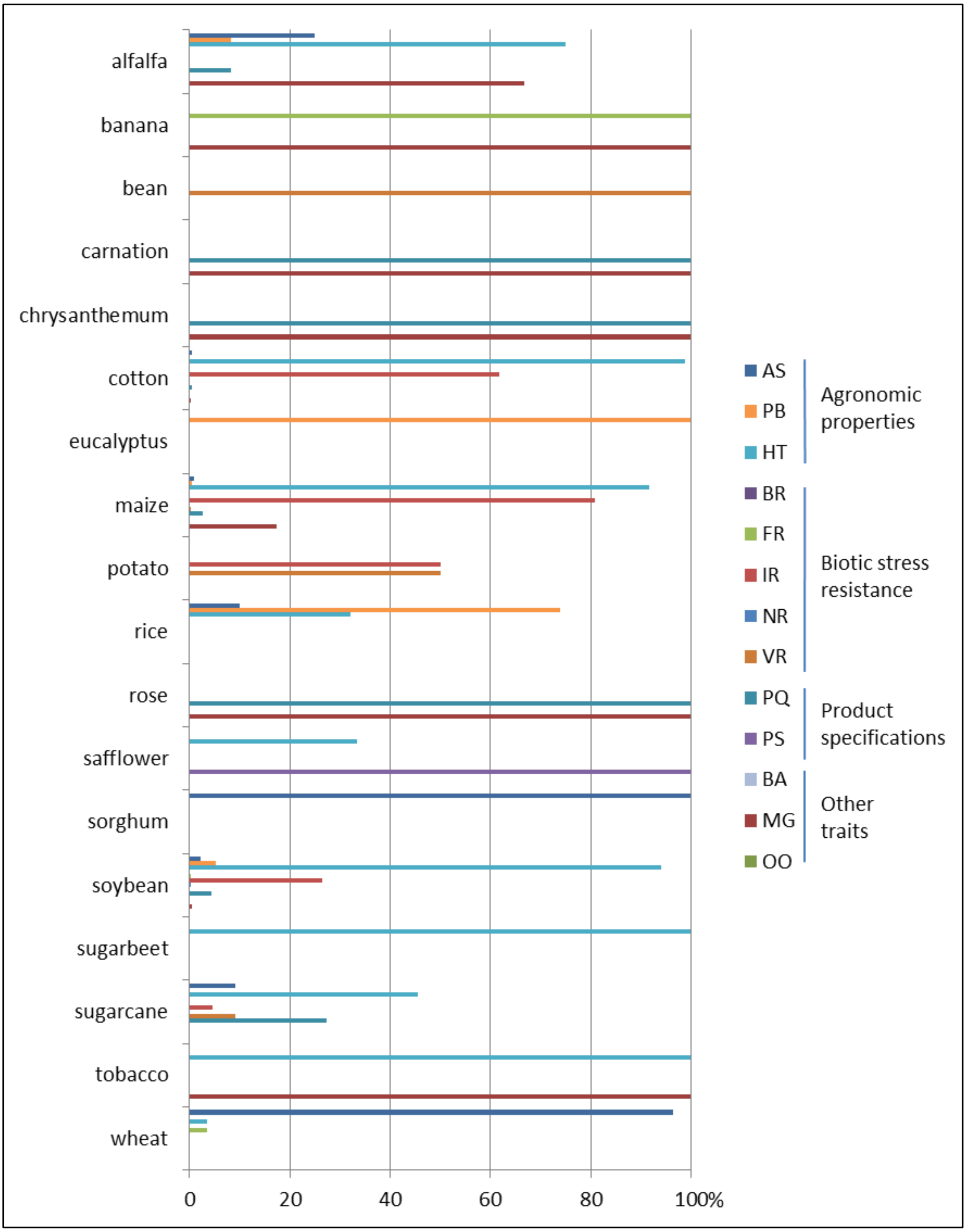


Figure 25 Percentage of all trials in Latin America except Chile by class and type of trait per crop, 2009-2013 (Annex 2, Table 4)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 23.

4.4.4 Applicants

Again, trials for the main agricultural crops are organised by private companies (Figure 26) (Annex 3, Table 4). Less research institutes are involved compared to other regions in the world. The many counter-season trials and seed productions by seed companies may account for this disproportion. The ornamentals are commercially produced by one private company. The CFT permit for beans was the last step before Embrapa (Ministry of Agriculture, Brazil) launched its *Bean golden mosaic virus* resistant event.

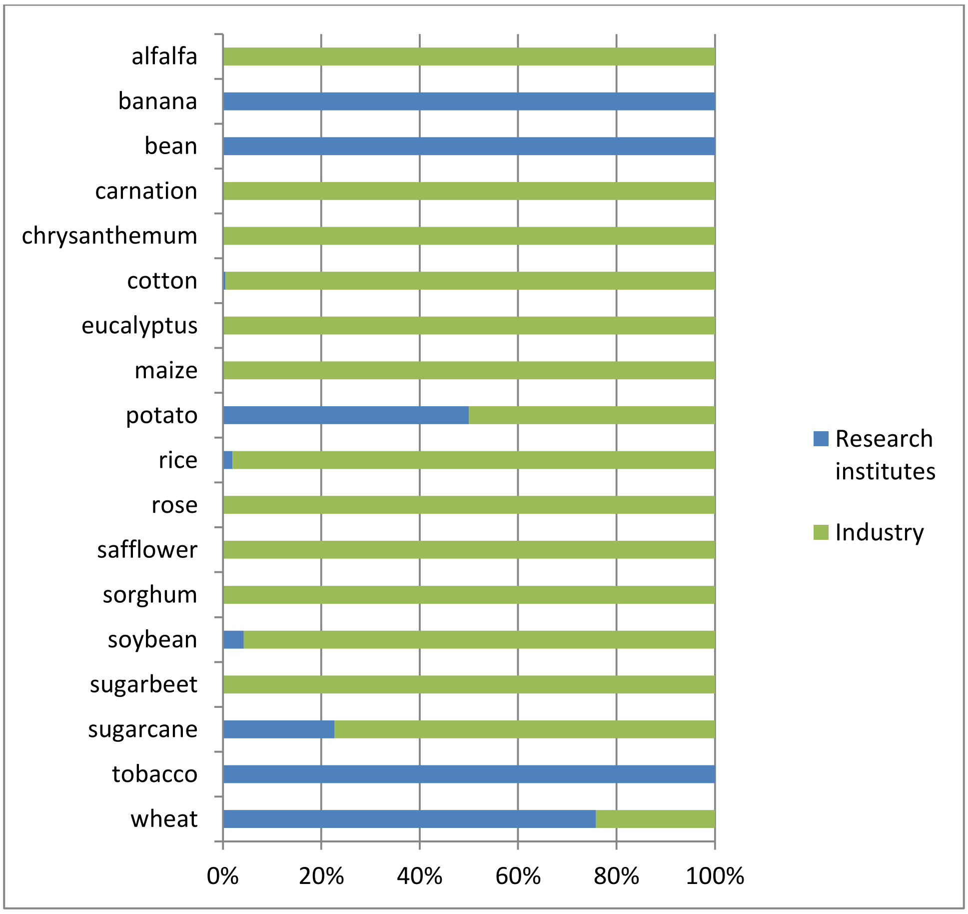


Figure 26 Percentage of all trials in Latin America except Chile by applicant type per crop, 2009-2013 (Annex 3, Table 4)

Cotton (*Gossypium hirsutum*), maize (*Zea mays*), soybean (*Glycine max*)

Alfalfa (*Medicago sativa*), banana (*Musa* sp.), bean (*Phaseolus vulgaris*), carnation (*Dianthus caryophyllus*), chrysanthemum (*Chrysanthemum × morifolium*), eucalyptus (*Eucalyptus* sp.), potato (*Solanum tuberosum*), rice (*Oryza sativa*), rose (*Rosa* sp.), safflower (*Carthamus tinctorius*), sorghum (*Sorghum bicolor*), sugarbeet (*Beta vulgaris*), sugarcane (*Saccharum officinarum*), tobacco (*Nicotiana* sp.), wheat (*Triticum aestivum*)

Both small-scale counter-season early development trials and large-scale seed productions take place. Relatively few research and development by local entities is seen. The many local companies may act as applicant for seed productions or field trial services for material that is developed elsewhere.

4.5 Africa

4.5.1 Number of CFTs

The number of African CFTs remains constant over the years (Figure 27).

The country conducting most field trials is South Africa (Figure 28). CFT numbers are even underestimated since no locations are made available in the country's database. Every permit is counted as one trial.

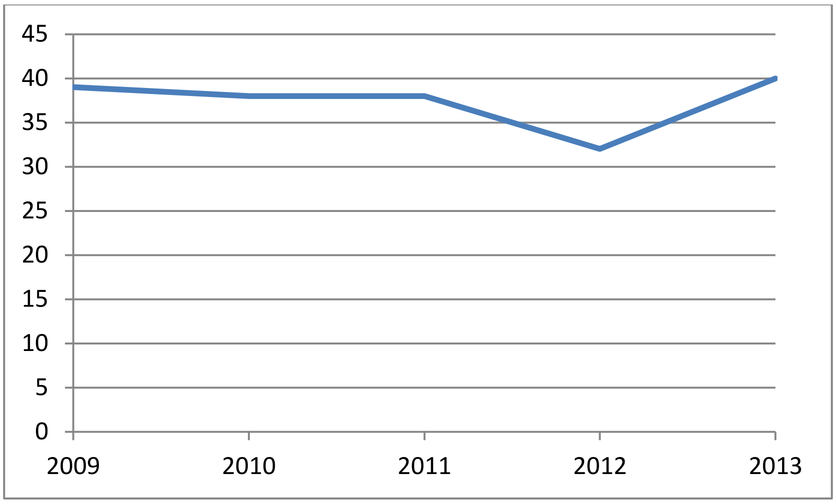


Figure 27 Total number of trials in Africa, 2009-2013

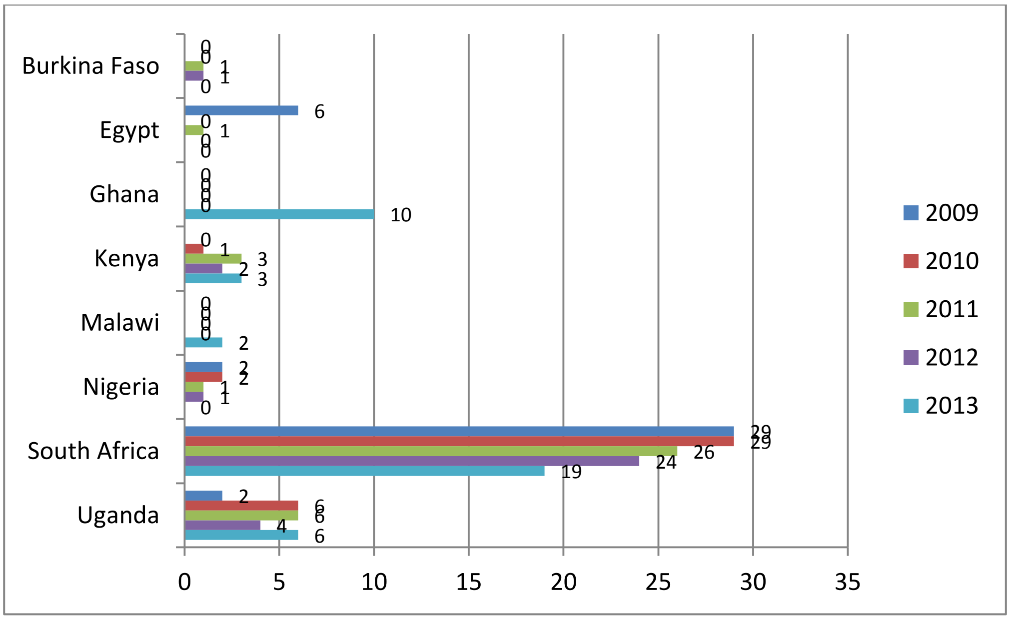


Figure 28 Number of trials per African country per year, 2009-2013

4.5.2 Crops

Maize is by far the most investigated agricultural crop (Figure 29). The next crop is cotton followed by cassava.

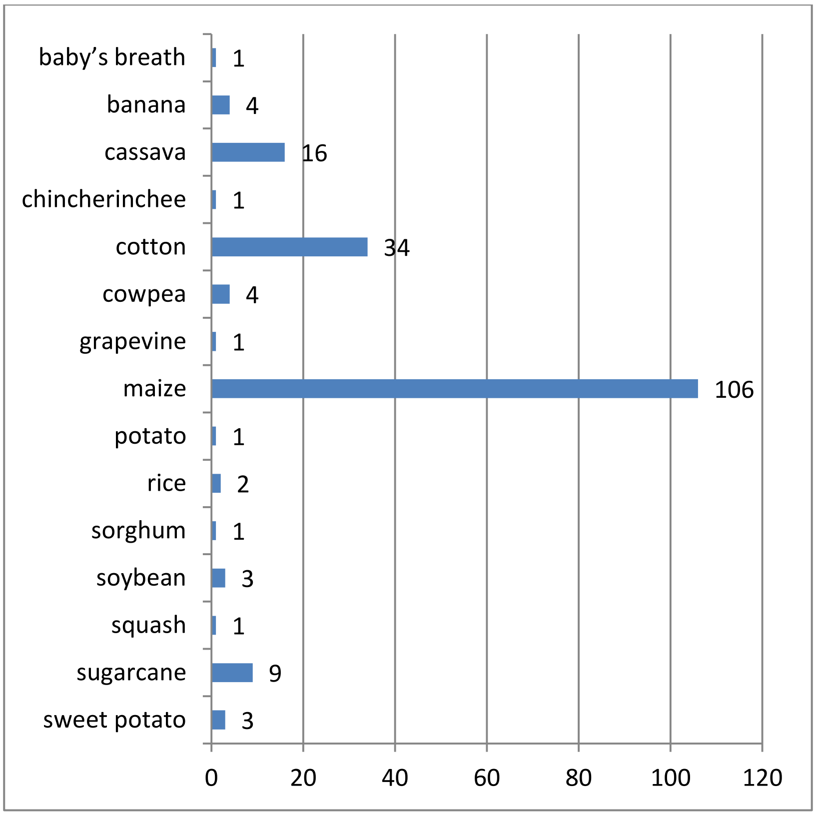


Figure 29 Total number of trials per crop in Africa, 2009-2013
Baby's breath (*Gypsophila paniculata*), banana (*Musa* sp.), cassava (*Manihot esculenta*), chincherinchee (*Ornithogalum x thyrsoides*), cotton (*Gossypium hirsutum*), cowpea (*Vigna unguiculata*), grapevine (*Vitis* sp.), maize (*Zea mays*), potato (*Solanum tuberosum*), rice (*Oryza sativa*), sorghum (*Sorghum bicolor*), soybean (*Glycine max*), squash (*Cucurbita* sp.), sugarcane (*Saccharum officinarum*), sweet potato (*Ipomoea batatas*)

4.5.3 Traits

Almost all maize trials are performed in South Africa with traits such as herbicide tolerance, insect resistance, drought tolerance, fertility traits (Figure 30) (Annex 2, Table 5). Again, in most cases advanced or even elsewhere-commercialised material is tested. In soybean trials herbicide tolerance and modified oil content are studied. Additionally, herbicide tolerance and insect resistance cotton and starch enhanced cassava are listed for South Africa. Sugarcane with improvements of yield, growth rate and sucrose yield are submitted to CFTs.

Burkina Faso has 2 cowpea trials for resistance to the legume pod borer (*Maruca vitrata*). Potato tuber moth resistant potato, lepidopteran resistant maize and cotton, and virus resistant squash is tested in Egypt. In Ghana the crops cowpea (*Maruca* resistance), cotton (lepidopteran resistant), rice (nitrogen use efficiency, drought tolerance) and sweet potato (high protein) are grown in trials. Maize trials in Kenya are about drought tolerance and lepidopteran resistance. Furthermore, permits are issued for virus resistant and pro-vitamin A enriched cassava and sorghum with improved protein quality and digestibility, enhanced iron and zinc availability and enriched with pro-vitamin A. Malawi conducted insect resistant cotton on 2 locations. In Nigeria again, pro-vitamin A and iron enriched cassava is trialled next to legume pod borer resistant cowpea. Finally, for Uganda trials with banana (vitamin A and iron bio-fortification, bacterial wilt and nematode resistance), cassava (virus resistance), cotton (insect resistance and herbicide tolerance), maize (drought tolerant, insect resistant), rice (nitrogen use efficiency, salt tolerance) and sweet potato (insect and virus resistance) are registered. Cameroon is testing GM cotton, but details are lacking (not included in the Figures).

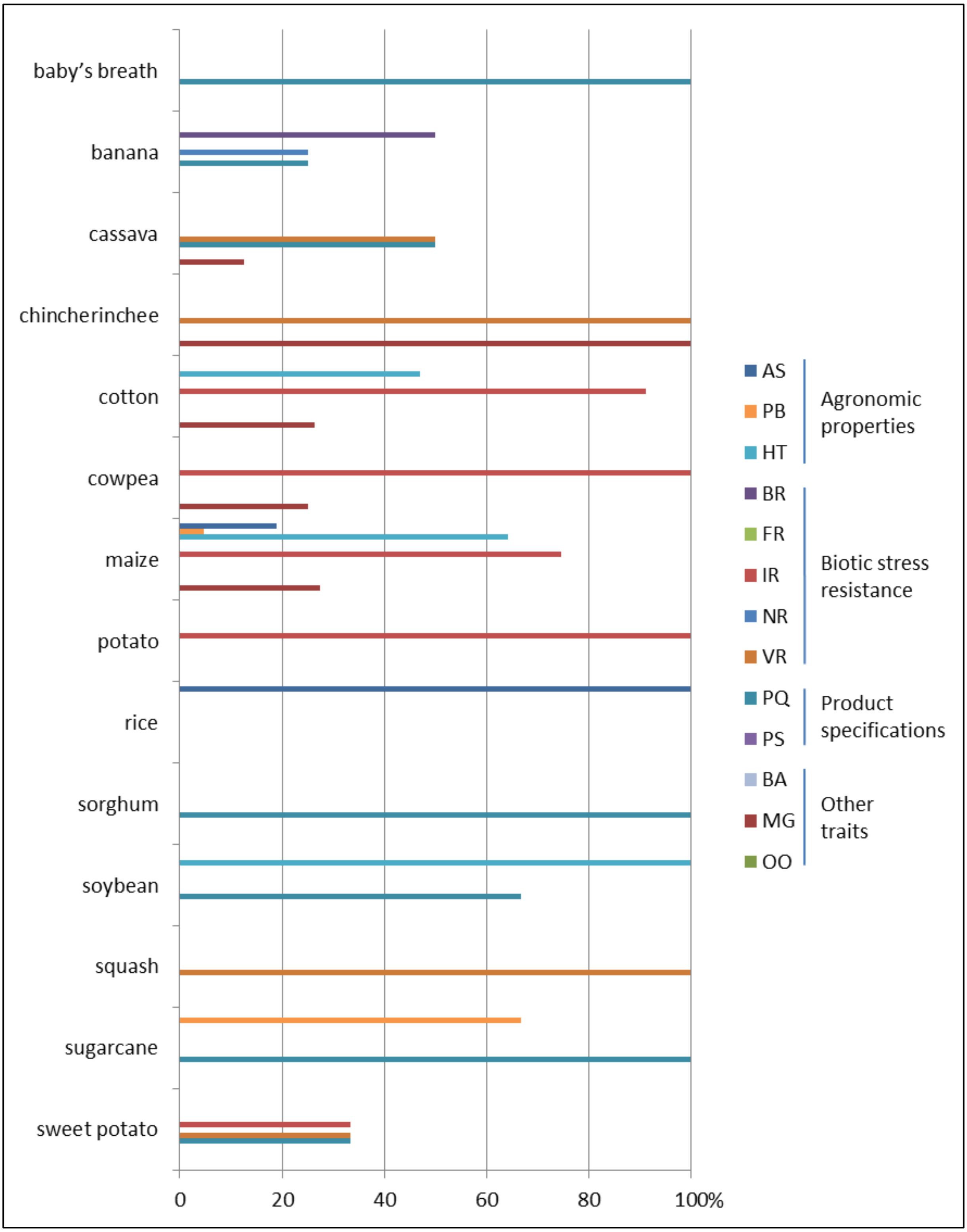


Figure 30 Percentage of all trials in Africa by class and type of trait per crop, 2009-2013 (Annex 2, Table 5)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 29.

Two ornamental species were genetically modified: baby's breath (*Gypsophila paniculata*) for flower colour in Kenya, and chincherinchee (*Ornithogalum x thyrsoides*) for virus resistance in South Africa.

4.5.4 Applicants

Industry is almost exclusively active in South Africa in maize, cotton and soybean. In Egypt industry works on cotton and maize. Most other trials in Africa are organised by governmental research institutions. Their research is focused on local crops with their specific needs. All these trials are still in proof-of-concept or early development phase.

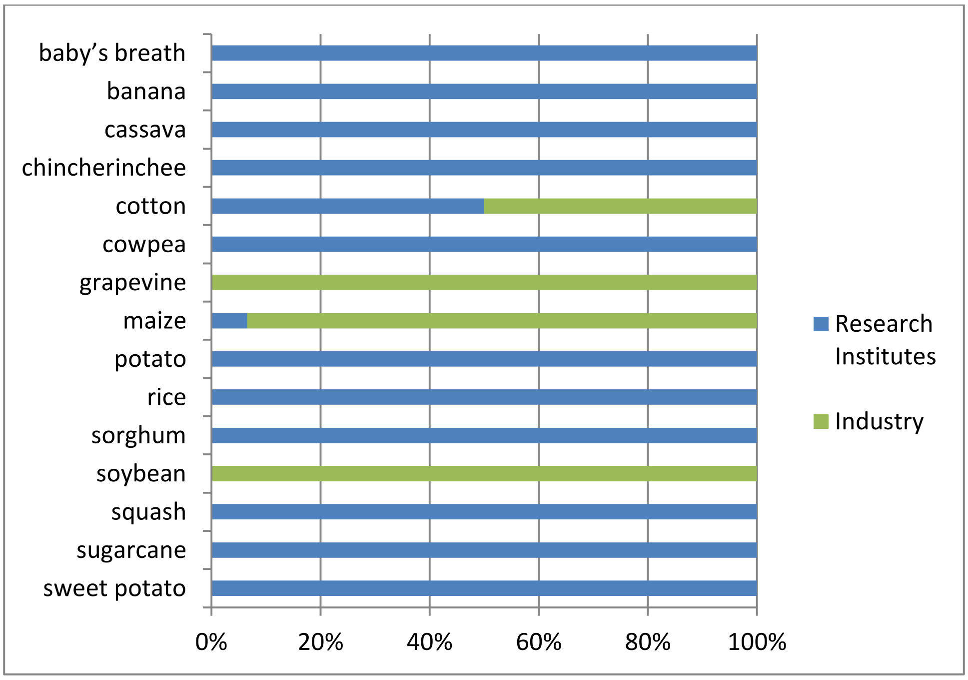


Figure 31 Percentage of all trials in Africa by applicant type per crop, 2009-2013 (Annex 3, Table 5)
Baby's breath (*Gypsophila paniculata*), banana (*Musa* sp.), cassava (*Manihot esculenta*), chincherinchee (*Ornithogalum x thyrsoides*), cotton (*Gossypium hirsutum*), cowpea (*Vigna unguiculata*), grapevine (*Vitis* sp.), maize (*Zea mays*), potato (*Solanum tuberosum*), rice (*Oryza sativa*), sorghum (*Sorghum bicolor*), soybean (*Glycine max*), squash (*Cucurbita* sp.), sugarcane (*Saccharum officinarum*), sweet potato (*Ipomoea batatas*)

4.6 Asia

4.6.1 Number of CFTs

In Asia there has been a rising interest to conduct GM CFTs (Figure 32). The decline in the most recent years is primarily due to the lower activity in India. In March 2012 the Genetic Engineering Approval/Appraisal Committee (GEAC), the competent authority for GM, held its last meeting before resuming activities in March 2014. Since mid-2011, states need to give their formal 'no-objection' to field trials. Some states refused. As a consequence, many trial applications are resubmitted for other locations. Counting all permits may therefore overestimate the actual number of trials.

Information is retrieved from authorities' databases for India, Japan and the Philippines. Other data have been obtained indirectly and may be less reliable. For that reason only data for India, Japan and the Philippines are shown in Figure 33.

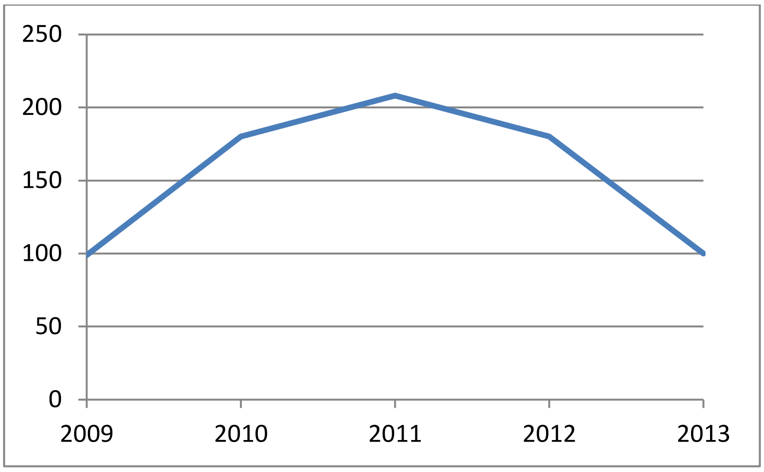


Figure 32 Total number of trials in Asia, 2009-2013

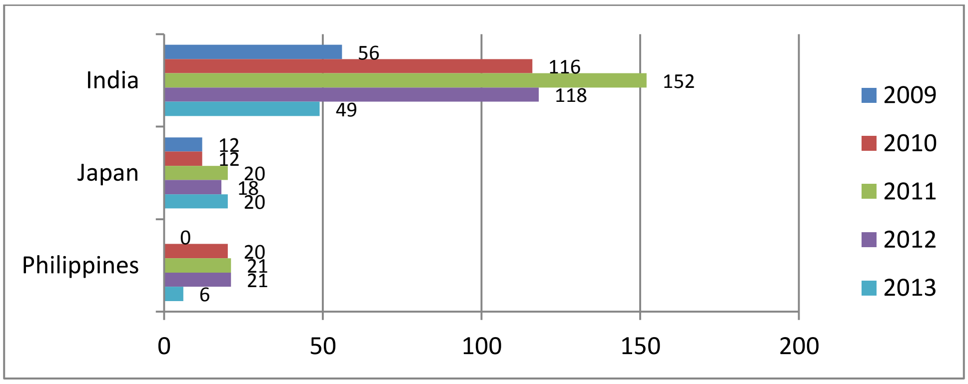


Figure 33 Number of trials per country per year, 2009-2013

4.6.2 Crops

Maize is the most important crop, next is cotton followed by rice (Figure 34). All three crops are predominantly trialled in India.

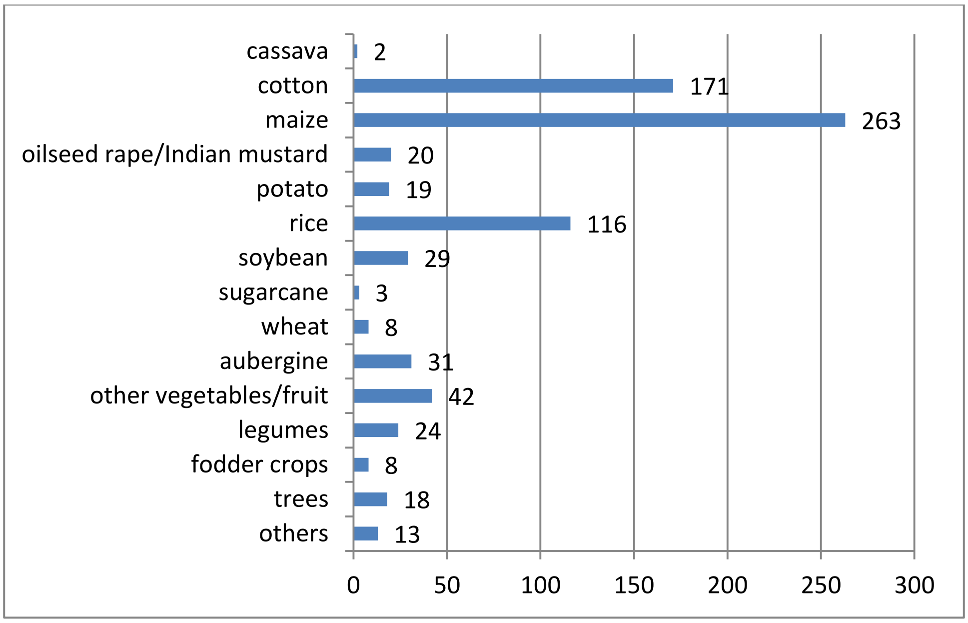


Figure 34 Total number of trials per crop in Asia, 2009-2013

Cassava (*Manihot esculenta*), cotton (*Gossypium hirsutum*), maize (*Zea mays*), oilseed rape (*Brassica napus*), Indian mustard (*Brassica juncea*), potato (*Solanum tuberosum*), rice (*Oryza sativa*), soybean (*Glycine max*), sugarcane (*Saccharum officinarum*), wheat (*Triticum aestivum*), aubergine (*Solanum melongena*)

Other vegetables/fruit: *Brassica oleracea*, okra (*Abelmoschus esculentus*), pepper (*Capsicum annuum*), sweet potato (*Ipomoea batatas*), tomato (*Solanum lycopersicum*), watermelon (*Citrullus lanatus*)

Legumes; bean (*Phaseolus vulgaris*), castor bean (*Ricinus communis*), chickpea (*Cicer arietinum*), pigeonpea (*Cajanus cajan*), groundnut (*Arachis hypogea*)

Fodder crops: alfalfa (*Medicago sativum*), bent grass (*Agrostis* sp.), sorghum (*Sorghum bicolor*)

Trees: apple (*Malus domestica*), banana (*Musa* sp.), *Eucalyptus* spp., papaya (*Carica papaya*), rubber (*Hevea brasiliensis*)

Others: calla (*Zantedeschia* sp.), carnation (*Dianthus caryophyllus*), sweet worm (*Artemisia annua*)

4.6.3 Traits

In India maize events combine herbicide tolerance (glufosinate ammonium, glyphosate) with insect resistance (Lepidoptera) (Figure 35) (Annex 2, Table 6). All events were developed by multinational seed companies. In cotton emphasis is lead on breeding insect resistance into local varieties. Also insect resistance brinjal (aubergine, eggplant) was tested. One event was ready for marketing until the environmental minister vetoed it. Other trait/crop combinations tested in CFTs are insect resistant rice, sugarcane and castor bean, fungal resistant and drought tolerant groundnut, virus resistant tomato, papaya and watermelon and male sterile/fertile mustard. GM potato is tested for late blight and virus resistance. Also dwarf potato plants are investigated.

Insect resistant brinjal is also trialled in Bangladesh, next to *Phytophthora* resistant potatoes.

The Philippines are testing insect resistant and herbicide tolerant maize, insect resistant brinjal and cotton and β-carotene enriched 'Golden rice'. Furthermore, insect resistant cotton and delayed ripening papaya is investigated.

Japan requires local CFTs for food/feed regulatory dossiers. Most of the registered trials are for that purpose. Nevertheless, local research is done as well mostly in rice but also on cold tolerant *Eucalyptus*. Rice is modified for high tryptophan levels, disease resistance, controllable flowering time, UV resistance and increased photosynthesis. Rice is also used to produce cedar pollen tolerogen for oral immunotherapy.

Although Chinese research institutes are very active in biotechnology, no quantitative and only little qualitative information can be retrieved. Researchers developed insect resistant rice as well as phytase maize. For these crops biosafety certificates were granted in 2009, meaning that they can enter variety registration trials. Field trials are also carried out for insect resistant maize, high lysine maize, resistance to pre-harvest germination wheat, and insect resistant soybeans.

In Indonesia CFTs are carried out for cassava (starch modification), potato (late blight resistance), sugarcane (high glucose), tomato (virus resistance) and maize (lepidoptera resistance, glyphosate tolerance).

In Malaysia delayed ripening papaya is under development in field trials. Other crops are not beyond experimental stage.

Many traits are investigated in Pakistan for cotton (exact figures not available): insect resistance, herbicide tolerance, drought tolerance, salt tolerance, virus resistance and modified fibres. Lepidoptera resistant and glyphosate tolerant maize developed by Monsanto is also listed. Furthermore, insect resistant and bacterial blight resistant rice, and drought/salt tolerant and bio-fortified wheat are tested.

South Korea is developing many GM plant species. No official statistics are known. FAS/GAIN biotechnology report on Korea (2013) communicates that a total of 251 cases of research in 14 different crops were approved for field trials in 2012. Only the examples listed in the various reports are counted for this study: resveratrol enriched rice, vitamin A enriched rice, insect resistant rice, environmental stress tolerant rice, virus resistant pepper, vitamin E enriched beans, insect resistant beans, herbicide tolerant bent grass, virus resistant potatoes and Chinese cabbage, watermelon, sweet potato, and apples.

Vietnam has insect resistant maize in a few field trials.

The relative amount of marker genes in Figure 34 is low because data on markers are incomplete. For apple in South Korea and calla in Taiwan and some other crops, traits are not known and therefore not included.

Taiwan is developing delayed senescent broccoli, virus resistant tomato, sweet rice for processing, lactoferrin rice, phytase potato, *Eucalyptus* for pulping, virus resistant papaya and calla lily.

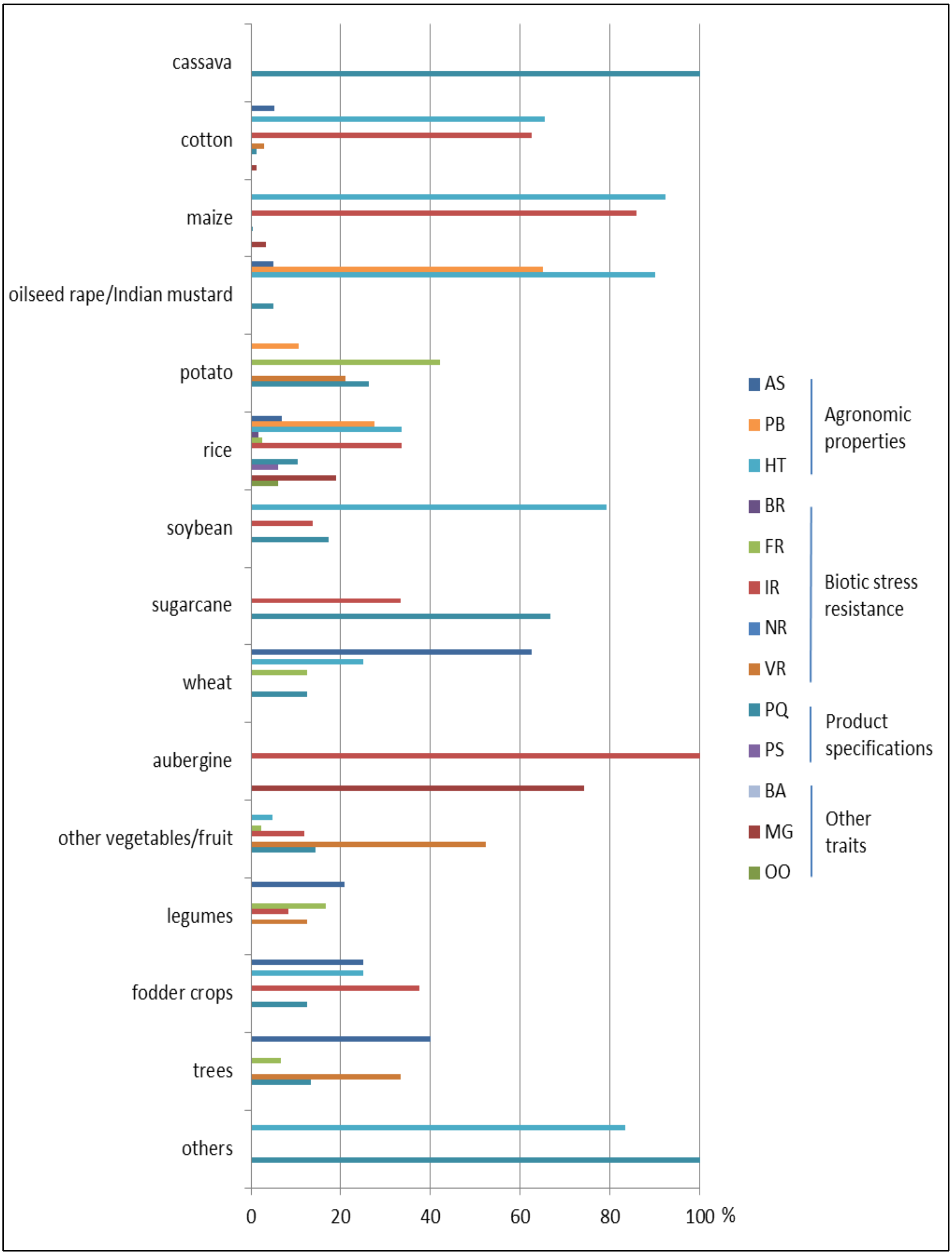


Figure 35 Percentage of all trials in Asia by class and type of trait per crop or group of plant species, 2009-2013 (Annex 2, Table 6)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other

Plant species as in Figure 34.

4.6.4 Applicants

Figure 36 gives an impression of the type of applicants per plant species or group of plant species relative to the total amount of known cases (Annex 3, Table 6).

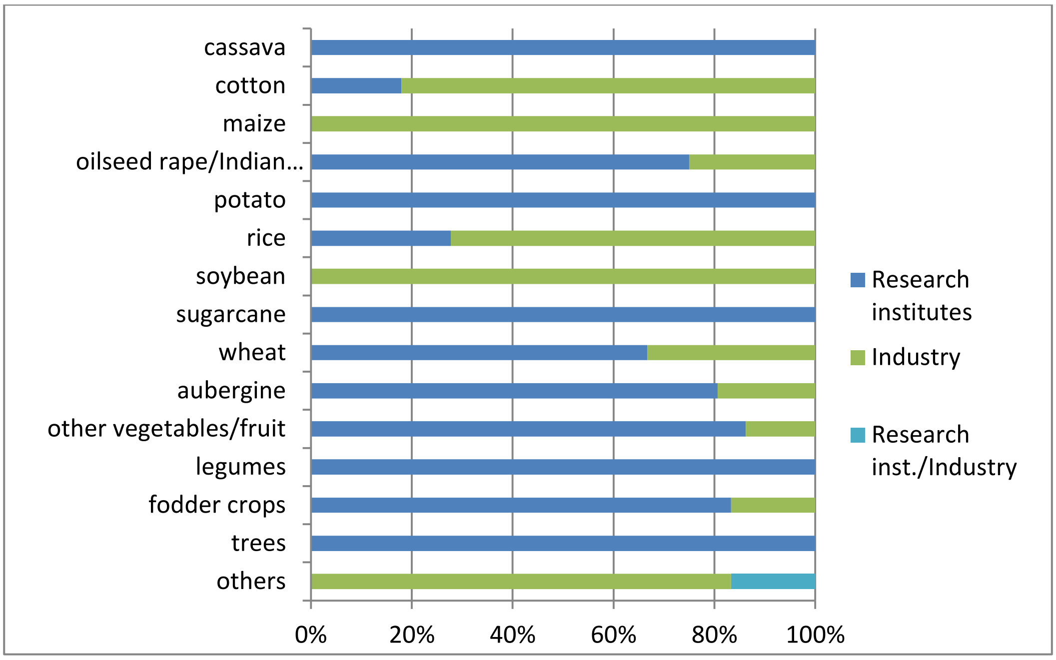


Figure 36 Percentage of all trials in Asia by applicant type per crop or group of plant species, 2009-2013 (Annex 3, Table 6)

Cassava (*Manihot esculenta*), cotton (*Gossypium hirsutum*), maize (*Zea mays*), oilseed rape (*Brassica napus*), Indian mustard (*Brassica juncea*), potato (*Solanum tuberosum*), rice (*Oryza sativa*), soybean (*Glycine max*), sugarcane (*Saccharum officinarum*), wheat (*Triticum aestivum*), aubergine (*Solanum melongena*)

Other vegetables/fruit: *Brassica oleracea*, okra (*Abelmoschus esculentus*), pepper (*Capsicum annuum*), sweet potato (*Ipomoea batatas*), tomato (*Solanum lycopersicum*), watermelon (*Citrullus lanatus*)

Legumes; bean (*Phaseolus vulgaris*), castor bean (*Ricinus communis*), chickpea (*Cicer arietinum*), pigeonpea (*Cajanus cajan*), groundnut (*Arachis hypogea*)

Fodder crops: alfalfa (*Medicago sativum*), bent grass (*Agrostis* sp.), sorghum (*Sorghum bicolor*)

Trees: apple (*Malus domestica*), banana (*Musa* sp.), *Eucalyptus* spp., papaya (*Carica papaya*), rubber (*Hevea brasiliensis*)

Others: calla (*Zantedeschia* sp.), carnation (*Dianthus caryophyllus*), sweet worm (*Artemisia annua*)

Trial surfaces are not mentioned for the vast majority of the trials in Asia. The highest numbers of sites (5 and more) are found for aubergine, cotton, Indian mustard, maize, pepper and rice.

Except in China, India and the Philippines, most CFTs are in the early phases of development. Insect resistant rice and phytase maize are closest to the market in China. India already allows cultivation of cotton. Most cotton trials are based on events developed by multinationals. The Philippines grow GM maize already for a decade. ‘Golden rice’ and insect resistant aubergine are most advanced in the approval process. In South Korea rice enriched with resveratrol and virus resistant pepper are nearing a submission for cultivation.

4.7 Australia – New Zealand

4.7.1 Number of CFTs

In New Zealand a field trial application with a GM *Allium* species was approved for 10 years but never started. The summary application listed decreased susceptibility to insect pests, decreased susceptibility to fungal or bacterial pathogens, decreased susceptibility to viral pathogens, decreased susceptibility to herbicides, altered pungency, colour or carbohydrate metabolism and inducible flowering.

Radiata pine (*Pinus radiata*) with altered plant growth/biomass acquisition, reproductive development, herbicide tolerance, utilisable biomass, wood density and dimensional stability is currently being tested by the New Zealand Forest Research Institute at one location (permit issued December 2010).

In Australia several CFTs were conducted in the reporting period (Figure 37).

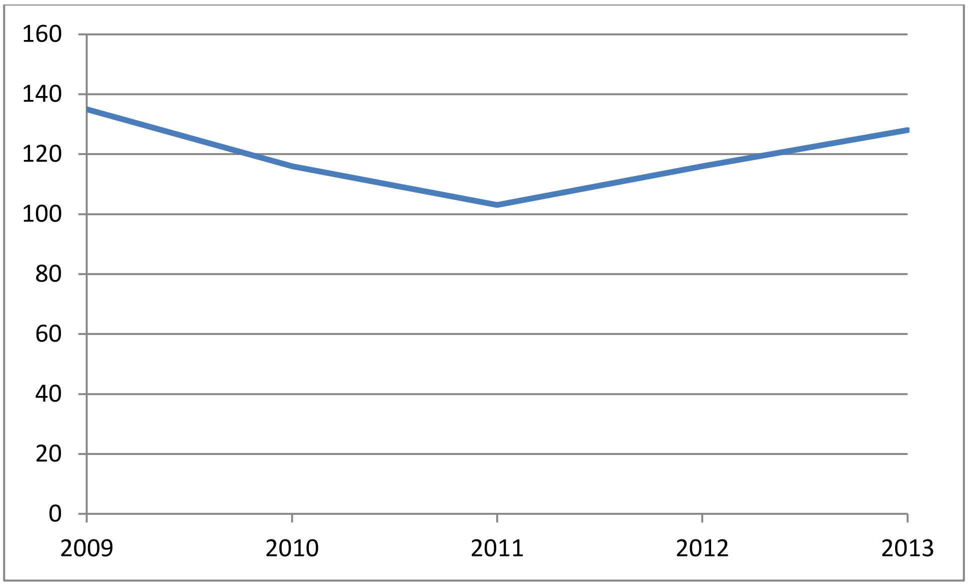


Figure 37 Total number of trials in Australia, 2009-2013

4.7.2 Crops

The main crops are cotton and oilseed rape/Indian mustard (Figure 38). Remarkably only few GM maize CFTs are observed in Australia.

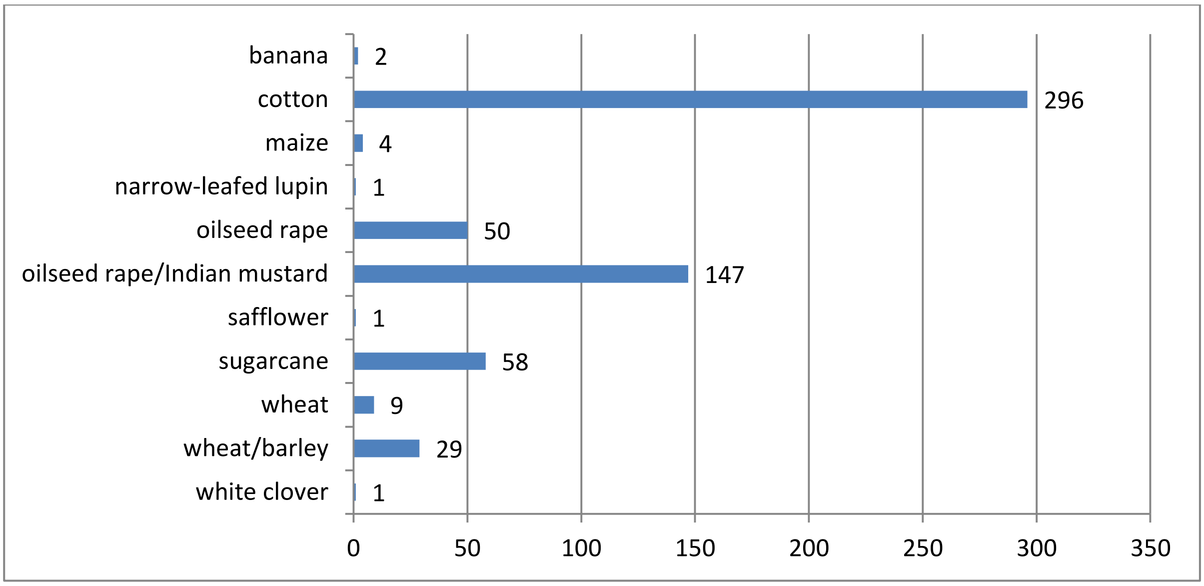


Figure 38 Total number of trials per crop in Australia, 2009-2013
Banana (*Musa* sp.), cotton (*Gossypium hirsutum*), maize (*Zea mays*), narrow-leafed lupin (*Lupinus angustifolius*), oilseed rape (*Brassica napus*), Indian mustard (*Brassica juncea*), safflower (*Carthamus tinctorius*), sugarcane (*Saccharum officinarum*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), white clover (*Trifolium repens*)

4.7.3 Traits

Almost all cotton plants are modified to become herbicide tolerant (glufosinate ammonium, glyphosate) (Figure 39) (Annex 2, Table 7). Other traits are abiotic stress tolerance and yield increase. In the oil crops herbicide tolerance is as important as are plant biology traits (yield, plant development and fertility traits). Sugarcane is tested for abiotic stress tolerance, plant development and yield, and product quality (altered sugar production/accumulation). In half of the cases herbicide tolerance is involved. For the cereals wheat and barley nitrogen use efficiency, drought, salt, and cold tolerance, enhanced Zn uptake and yield improvement are important. Also starch is modified.

4.7.4 Applicants

Cotton, oilseed rape, Indian mustard and sugarcane, the most frequently tested crops, are almost all managed by industry (Figure 40) (Annex 3, Table 7). The permits concern multi-location trials of large scale (up to 36ha). They are sown with herbicide tolerant and insect resistant cotton and herbicide tolerant oilseed rape. CFTs by government and academia are generally smaller and fewer in number.

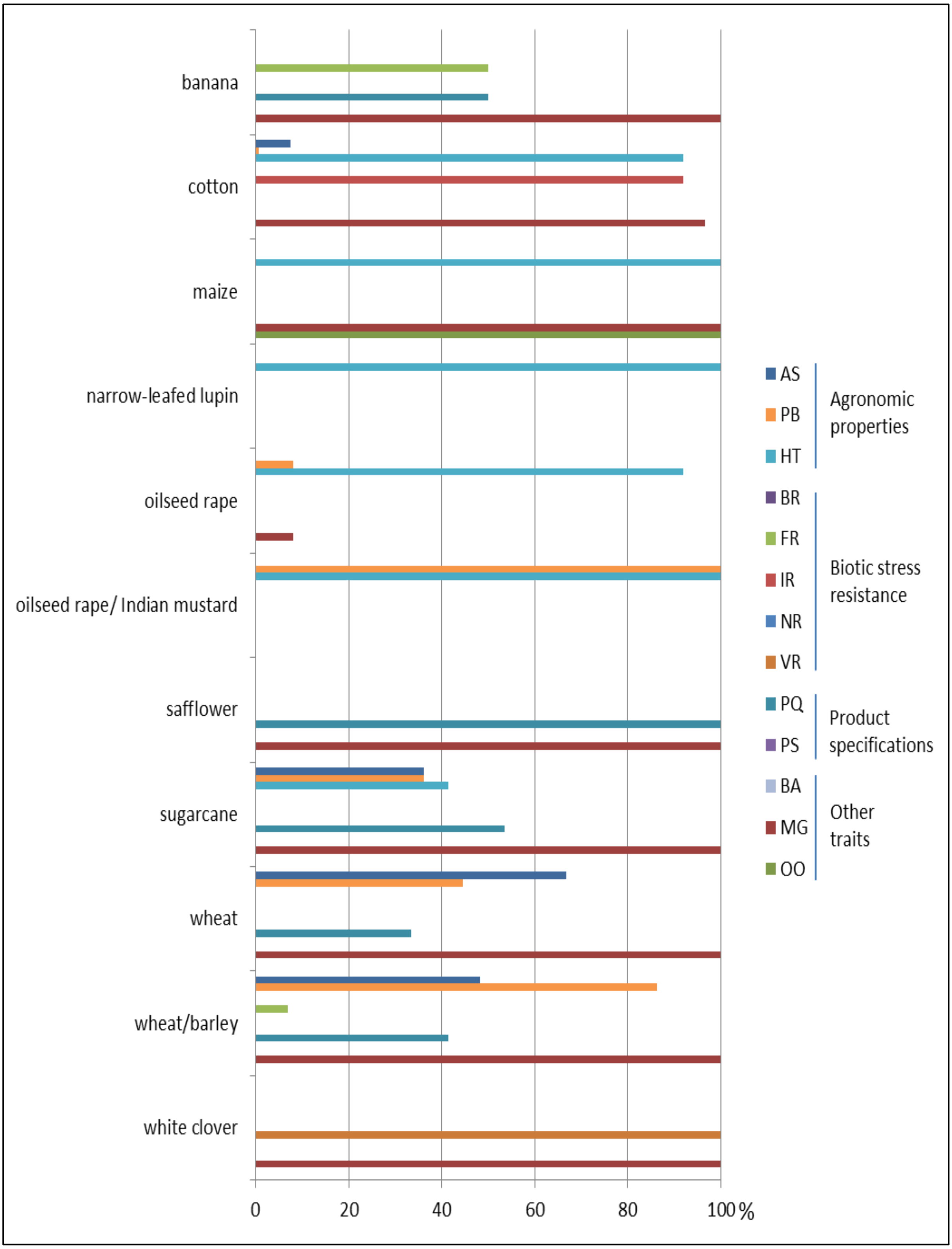


Figure 39 Percentage of all trials in Australia by class and type of trait per crop, 2009-2013 (Annex 2, Table 7)

AS: abiotic stress tolerance; PB: plant biology; HT: herbicide tolerance; BR: bacteria resistance; FR: fungus resistance; IR; insect resistance; NR: nematode resistance; VR: virus resistance; PQ: product quality; PS: product systems; BA: breeding aids; MG: marker genes; OO: other
Plant species as in Figure 38.

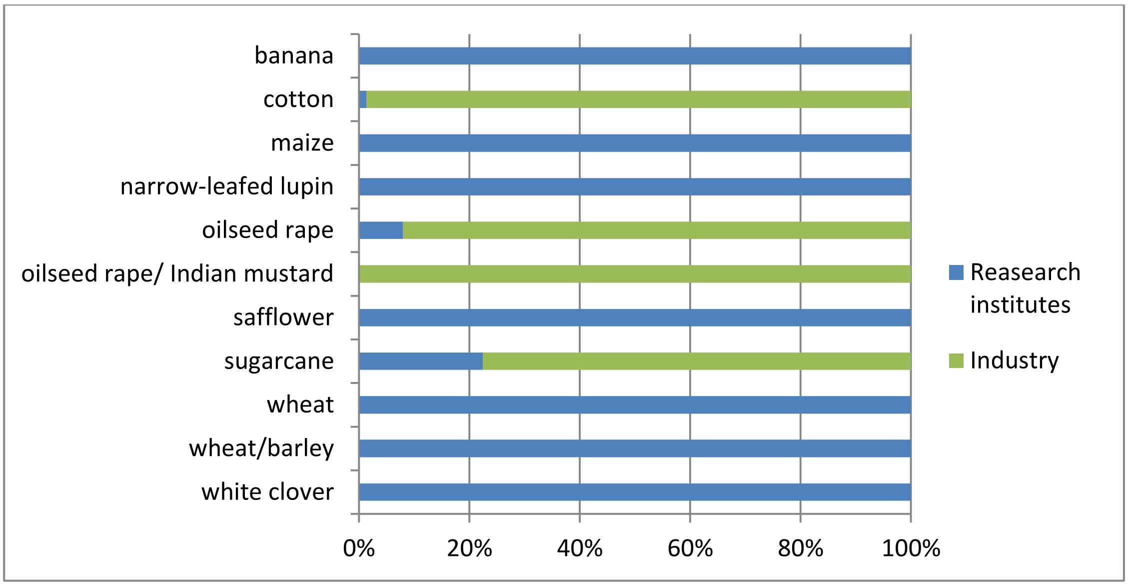


Figure 40 Percentage of all trials in Australia by applicant type per crop, 2009-2013 (Annex 3, Table 7)

Banana (*Musa* sp.), cotton (*Gossypium hirsutum*), maize (*Zea mays*), narrow-leafed lupin (*Lupinus angustifolius*), oilseed rape (*Brassica napus*), Indian mustard (*Brassica juncea*), safflower (*Carthamus tinctorius*), sugarcane (*Saccharum officinarum*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), white clover (*Trifolium repens*)

5 Comparison with previous reports

5.1.1 Number of CFTs/ geographical distribution

The 2009 OECD study covered 3849 CFTs for the years 2006, 2007 and 2008 (van Beuzekom and Arundel, 2009). The present study collects data for 5 years: 2009 till 2013 inclusive. Taking this into account, relatively many more CFTs are recorded. Excluding Chile, data of a total of 23381 trials are collected worldwide. The main cause for this discrepancy must be sought in the definition of a CFT. The authors sought clarification concerning the definition of a CFT that the authors of the OECD report used, but received no additional information. Presumably, notifications and permit applications were used as counting unit, which would result in a lower number. In this report every single location combined with trial year is regarded as 1 trial, corrected for events that are tested at the same location at the same time, even if separate notifications are done. While the approach developed in this report requires more corrections and verifications, it is proposed that it allows a better comparison between countries and over time.

Another factor that may influence the final figure is the fact that for this study issued authorisations predating the study period are taken into account as far as intended trial years overlap with the study period. This is again linked to the definition of a CFT.

Finally, more countries are studied. Previous reports were limited to OECD members and the EU countries. In the present study all parties to the Cartagena Protocol on Biosafety were included for which data are available as well as Argentina. Table 6 provides a comparison between the different reports of countries for which CFTs were reported.

Table 6 Comparison of countries with CFTs between the different reports

2006 OECD study	2009 OECD Study	This study
Canada, USA	Canada, USA	Canada, USA
	Mexico	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Honduras, Mexico, Panama, Paraguay, Uruguay
Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Sweden	Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Lithuania, Netherlands, Poland, Romania, Slovakia, Spain, Sweden, United Kingdom	Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Ireland, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden, United Kingdom
	Japan	Bangladesh, India, Indonesia, Japan, Malaysia, Pakistan, Philippines, South Korea, Vietnam (Taiwan)
Australia	Australia, New Zealand	Australia, New Zealand
		Burkina Faso, Cameroon, Egypt, Ghana, Kenya, Malawi, Nigeria, South Africa, Uganda

Comparing the numbers over the continents (excluding Chile) most field trials are conducted in North America, followed by Latin America and the EU. Table 7 lists the figures presented in the 2009 OECD study compared to this study. The sum of the relative numbers is lower in this study since more countries are included (Chile is excluded). The ratio between the countries differs most probably because of the difference in CFT definitions.

Table 7 Comparison between numbers of CFTs relative to the total number (excluding Chile)

Country	2009 OECD study	This study
Total CFTs	**3849**	**23381**
United States	62.9%	42.3%
Canada	26.5%	15.6%
European Union	7.6%	14.0%
Mexico	1.4%	12.3%
Japan	0.8%	0.4%
Others	0.8%	15.3%

5.1.2 Crops

The 2006 and 2009 OECD study do not indicate crops, so a comparison is not possible.
The results for this study illustrate both a high number of CFTs (96%) for a handful of major field crops and the remaining minor part distributed over a large diversity of crops, grasses, cereals, vegetable, fruits, legumes, ornamentals, trees, shrubs and model species. Table 8 provides an overview of this diversity.

Table 8 Relative percentage of CFTs with different GM plants in the period 2009 - 2013

Plant type	Species	% of CFTs
Major commodities	Maize (*Zea mays*),	**57%**
	Soybean (*Glycine max*), Oilseed rape (*Brassica napus*), Cotton (*Gossypium hirsutum*)	**36%**
	Potato (*Solanum tuberosum*), Sugarbeet (*Beta vulgaris*), Rice (*Oryza sativa*)	**3%**
Other species	Alfalfa (*Medicago sativa*), *Anthurium* sp., *Arabidopsis thaliana*, Aubergine (*Solanum melongena*), Baby's breath (*Gypsophila paniculata*), Barley (*Hordeum vulgare*), Bean (*Phaseolus vulgaris*), Bent grass (*Agrostis* sp.), Black nightshade (*Solanum nigrum*), *Brassica oleracea,* Brown mustard/ Indian mustard (*Brassica juncea*), Calla (*Zantedeschia* sp.), Camelina (*Camelina sativa*), Carnation (*Dianthus caryophyllus*), Cassava (*Manihot esculenta*), Castor bean (*Ricinus communis*), Chickpea (*Cicer arietinum*), Chincherinchee (*Ornithogalum x thyrsoides*), Chrysanthemum (*Chrysanthemum × morifolium*), Cowpea (*Vigna unguiculata*), Crambe (*Crambe abyssinica*), Creeping bentgrass (*Agrostis stolonifera*), Cucumber (*Cucumis sativus*), Cypress vine (*Ipomoea × sloteri*), Easter lily (*Lilium longiflorum*), Ethiopian mustard (*Brassica carinata*), Flax, linseed (*Linum usitatissimum*), Fodder beet (*Beta vulgaris*), Groundnut (*Arachis hypogea*), Iris (*Iris* sp.), Lettuce (*Lactuca sativa*), *Miscanthus* sp., Muskmelon/melon (*Cucumis melo*), Okra (*Abelmoschus esculentus*), Onion (*Allium cepa*), Pea (*Pisum sativum*), Peanut (*Arachis hypogea*), Pepper (*Capsicum annuum*), Peppermint (*Mentha × piperita*), Perennial ryegrass (*Lolium perenne*), *Petunia* sp., Pigeonpea (*Cajanus cajan*), Rose (*Rosa* sp.), Safflower (*Carthamus tinctorius*), Sorghum (*Sorghum bicolor*), Squash (*Cucurbita* sp.), Sugarcane (*Saccharum officinarum*), Sweet potato (*Ipomoea batatas*), Sweet worm (*Artemisia annua*), Switchgrass (*Panicum virgatum*), Tall fescue (*Festuca arundinacea*), Tobacco (*Nicotiana* sp.), Tomato (*Solanum lycopersicum*), triticale (x*Triticosecale Wittmack*), Watermelon (*Citrullus lanatus*), Wheat (*Triticum aestivum*), Narrow-leafed lupin (*Lupinus angustifolius*), White clover (*Trifolium repens*)	**3%**

Plant type	Species	% of CFTs
Trees/ shrubs	Apple (*Malus domestica*), American chestnut (*Castanea dentata*), American elm (*Ulmus americana*), Banana (*Musa sp.*), Birch (*Betula pendula*), *Eucalyptus* sp., Grapefruit (*Citrus × paradisi*), Grapevine (*Vitis* sp.), Loblolly pine (*Pinus taeda*), Orange (*Citrus sinensis*), Papaya (*Carica papaya*), Pear (*Pyrus communis*), Persimmon (*Diospyros s*p.), Plum (*Prunus domestica*), *Populus* spp., Rubber (*Hevea brasiliensis*), Sweetgum (*Liquidambar* sp.), Walnut (*Juglans* sp.), Radiata pine (*Pinus radiata*)	**1%**

5.1.3 Traits

Results on trait types are hard to compare. One or more trait types may be mentioned for one trial application, but whether these are stacked in one event or present in separate plants within the trial is generally not disclosed. Moreover, one gene may lead to more than one trait: *e.g.* a transcription factor gene may induce branching (plant architecture) and therefore more seeds (yield); salt and drought tolerance may be encoded by the same gene.

In this study traits are aggregated according to trait type per CFT unit, whereas the 2009 OECD study looks at the traits types separately (cfr. trait field trials). Figure 41 illustrates the differences in counting method and the possible consequence on the result presentation.

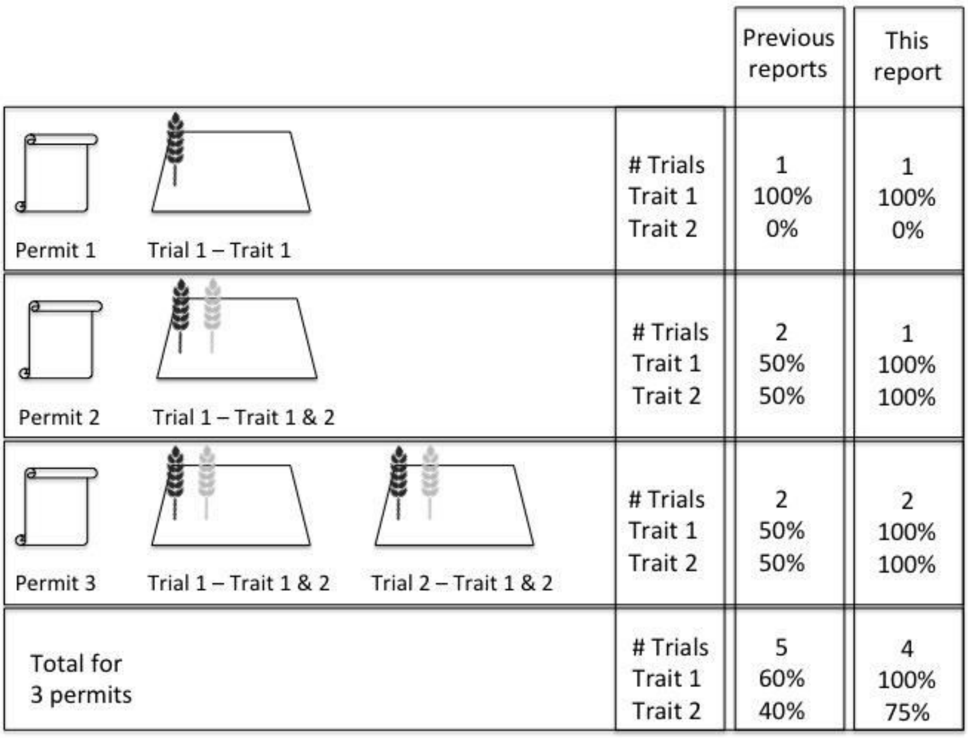


Figure 41 Schematic representation of the different CFT/trait counting methods and how they affect the results

The example presents the outcome for 3 CFT permits resp. covering a single trial site with a single trait GMO, a single trial site with a 2 GMOs with a different trait and two trial sites with a 2 GMOs with a different trait. Based on descriptions in previous reports it seems that the authors summed the traits per permit. The percentage was then calculated on a trait basis and the total was expected to be

100%. This could be misleading. In the example Trait 1 is present on all field sites, yet is only reported for 60% of the trait/trials. In this report an attempt was made to identify the actual (or estimated) field trial locations as unit. Traits were counted per CFT unit. In consequence, the total % can exceed 100% whenever multiple traits are tested together. The information would unfortunately not allow to distinguish between different traits in different GMOs or different traits stacked in one GMO.

Furthermore, in the OECD study traits are summed up for all crops, while here a more detailed analysis is presented per plant species.

The most prevalent trait is herbicide tolerance (73,1% of all trials), followed by insect resistance (35,5%). Taken together biotic stress accounts for 42,8%. Figures are lower in the 2009 OECD study (herbicide: 27.0%; pest resistance: 17.3%). However, taking into account that in the 2009 OECD study traits were analysed individually, the ratio between the two groups seems not to have changed: for each record of a biotic stress trait, the 2009 OECD study reports 1,6 herbicide tolerance, whereas this ratio is 1.7 in this report.

Abiotic stress resistance (17.7%) and plant biology traits (20.6%) are investigated in about a fifth of all trials. This is almost equal to the previous study where 24,0% of all traits, counted individually (equal to 41,4% on trial basis) were classified as agronomic traits.

Product quality traits are in the proportion of 13.7% (this study) to 12.9% (2009 OECD study), which is –taking into account the difference in calculation- a relative decrease during this period compared to the 2006-2008 period.

In the period 2006-2008, 6637 separate traits were tested in 3849 field trials, which yields an average factor of 1,72 traits/CFT. The same calculation for the 2009-2013 period yields an average factor of 1,95 traits/CFT.

5.1.4 Applicants

Industry accounts for 92.6% of all CFTs, research institutes for 7.4%. This has to be compared with an average of 19.3% of trait trials for the non-profit research sector (universities, government research institutes and private non-profit organisations) in the period 2006-2008. The apparent decrease may be the result the differences in CFT definitions: research institutes tend to trial on 1 or very few locations, whereas industry often performs multi-location CFTs.

Between 2006 and 2008, 74.5% of field trials by European Union firms were located outside of Europe, compared to less than 40% between 1992 and 1996. Between 2006 and 2008, American firms conducted 32.0% of their field trials outside the United States. For this study it was felt that the identification of “European” and “American” firms is not very realistic when discussing large corporations that act at global level. Their choice seems predominantly determined by commercial perspective of markets, availability of research and development infrastructure and a conducive regulatory climate. Several developers (previously identified as “European” or “American”) have commented on the European regulatory situation and announced relocation of development activities, which is further reflected in the decline of field trials in Europe.

6 Discussion

This study surveyed CFTs with GM plants as a basis to investigate developments in plant biotechnology, more specifically the development of GM crops. CFTs are seen as an indication of a scientific interest and of developments towards commercial/ large-scale introduction.

In contrast to previous studies, this study elaborated a more comprehensive survey methodology:

- The geographical scope included a far broader range of countries (all EU member states, all OECD members, all parties to the Cartagena Protocol on Biosafety, Argentina and the Russian Federation), for which data can be retrieved.
- The basic unit of the CFT was defined and publically available information was adjusted to allow comparison between countries. Still some inherent differences in reporting result in an underestimation of numbers for some countries and an overrepresentation for others.

When discussing methodology, diverging views on which “GMOs” (or similar concept) are regulated became an issue during the study period. This can be illustrated by two components:

- In contrast to the EU, many authorities do not subject breeding stacks of previously approved GMOs to regulatory scrutiny. In consequence, CFTs with such stacks may or may not be recorded as CFT depending on the regulatory situation in the country.
- New breeding techniques are evaluated to see if their products will be regulated. If authorities reach different conclusions, then it is likely that a trial with the same product may be recorded in one country as a GMO CFT and not recorded at all in another country.

The 2009 COGEM Trend Analysis warned that this situation would become more complex. Both aspects have been observed in the survey period. Many of these techniques are now in use and technical progress is advancing, without an internationally accepted delineation of the GMO coverage.

In general, the number of CFTs per year worldwide remained constant over the survey period. It can be assumed that if the same methodology had been used for previous reports, the 2009 OECD data would have been much higher.
On the other hand, regional differences are observed. In Europe, the amount of trials continues to decline. Also a slight decrease is seen for North America in 2013. In Africa and Asia, there is a rising interest, but numbers are still very low.

Maize is the most widely trialled crop. Also soybean, oilseed rape and cotton continue to be important. Again, regional differences are noticed. In Canada oil crop trials are the most prevalent, in Australia cotton CFTs followed by oil crops. In Latin America cotton trials are as frequent as maize trials.

Accounting for 96% of all CFTs, the major commodity crops obviously continue to dominate. While it is difficult to speculate on the underlying mechanisms, there are probably different influencing factors:

- Big markets justify the important investments that are required for development and regulatory approvals. Smaller, niche crops may not present the same financial opportunities.
- Global commodities actually require a global programme with many repetitive local CFTs. In this respect, it is likely that products that have been approved in a first market enter regulated CFTs in other potential markets and thereby remain included in the survey.
- For most of the big arable crops GM products have been approved and thereby a regulatory track has been established. Follow-on products can rely on this experience and it is therefore more attractive to develop a next product in a crop, where a GM pipeline has been established.
- As indicated in this survey, big crops are usually developed by industry. In particular companies with a global network and experience in bringing products to market, may be better placed to tap into a CFT infrastructure.

The variety of smaller crops is decreasing especially in the USA and Europe. In spite of the technical potential, regulatory hurdles might partly be at the origin. However, it is also possible that for smaller crops and/or developments in local markets, less CFTs are required. In this case it would be more important to look at repetition of the same CFT over years, rather than increasing number of CFTs in order to evaluate the likelihood for market realisation. Also it must be taken into account that for crops with a longer generation time (such as trees), changes (*e.g.* new CFTs) will possibly occur at lower frequency.

The 2009 COGEM Trend Analysis indicated that a broader diversity of GM crops was expected to reach the market. It is still correct that a broad diversity is being deployed in CFTs and that without CFTs, subsequent market introduction is impossible. Yet the data seem to indicate that –with some minor exceptions- the main products will remain limited to the major commodities.

Herbicide tolerance remains the most studied agronomic trait on all continents. Insects are the most challenged pest in GM crops. This does not mean however that only first-generation traits are successful:

- First-generation traits are further deployed beyond the primary markets. In those countries, they may still be regulated and require CFT approvals and would therefore remain included in this survey. An example could be insect resistant cotton that after market approval in the USA is further deployed in all essential cotton markets.
- In addition, seed productions for export (*e.g.* counter-season production in Argentina, Chile, Uruguay) contribute to this as the products may not have been approved for those market and therefore still require a field trial permit.
- As data are reported here on trait types, improvements in the trait type may be missed. *E.g.* stacking and combinations of different modes of actions further expand the insect resistance trait. The stacked maize MON-89Ø34-3xDAS-Ø15Ø7-1xMON-88Ø17-3xDAS-59122-7, which was approved (Commission Decision 2013/650/EU of 6 November 2013) for import, food and feed use in the EU, contains 6 *cry* genes conferring insect resistance and 2 genes conferring tolerance to a specific herbicide. These developments will not show separately as they all relate to the same trait.
- Given the success of these first-generation traits, it seems likely that new traits/products are offered in combination with them. They have become a basic feature. Therefore, if a new GM line is tested, the CFT is likely to include in addition the herbicide tolerance and/or insect resistance.
- Also new traits are registered under the same trait type. *E.g.* herbicide resistance not only includes resistance to glyphosate, glufosinate ammonium or sulfonylureas, but also to 2,4-D, dicamba and HPPD inhibitors (4-Hydroxyphenylpyruvate dioxygenase) etc.

Other pest and disease resistances are investigated to a much lower extent, vastly dependent on plant species. The growing numbers of field trials for agronomic traits as identified in the 2009 OECD report are sustained. The abiotic stress tolerances concern mainly drought tolerance and nitrogen use efficiency. Both traits are predominantly present in the USA, Canada and to a much lesser extent in Australia. Alterations in plant biology ultimately intend to lead to higher yields, either by modifying plant development, architecture, or fertility traits to produce hybrids. Once more, the centre of research and development is North America, but products are mainly intended for global commercialisation.

Product quality like altered oil, protein and starch composition slightly loose position relative to the whole array of traits. However, it may be misleading to only look at the overall figures: specific applications of modified crop composition in soybean and corn have been submitted for market approval and developments in other crops are advancing.

Very few trials are dedicated to the production of pharmaceuticals or other industrial compounds. The low number may be misleading, as these applications may not require the same level of multi-location trials as suitable for an agronomic trait.

Analysis of marker genes for selection -although often not mentioned in databases- reveals that antibiotic resistance markers and herbicide tolerance genes are still widely used. This is in line with the findings by Breyer *et al.* (2014) that despite of the controversy on antibiotic resistance markers they are still used in CFTs. Other markers involve visual reporter genes (*e.g.* β-glucuronidase and fluorescent protein genes), phosphomannose isomerase gene, isopentenyl transferase gene, etc. Also marker removal mechanisms (*e.g.* Cre-*lox* system) are reported.

The 2009 COGEM Trend Analysis predicted a wide range of traits to become available. While these continue to be developed and some reach the pre-commercial level (drought tolerant and nitrogen use efficient crops, cold tolerant *Eucalyptus*), the dominant traits remain and are likely to remain for some time herbicide tolerance and insect resistance.

The CFTs for the main field crops are handled by industry. Smaller crops are mainly studied by universities or governmental research institutes. Involvement of public research and public-private partnerships are evolving in Asia and in Africa. These provide interesting step-wise introductions of GM handling capacity:

- The first step typically involves the local adaptation of a GM crop that has been developed for a primary market. Insect resistant cotton, developed and marketed in the USA and then adapted in Burkina Faso for the local market serves as an example.
- In a second step, the early transformation, testing and selection –usually involving some CFTs- is done abroad, whereas the development CFTs and preparation for commercial release is performed at local level. Examples include banana and cassava projects linking North American and Australian researchers with African agronomic centres.
- In a final step, local labs are running their own molecular and plant transformation activities, which are the start for development projects.

In the 2009 Trend Analysis, COGEM expressed concern over the possible fall-back of developing countries in relation to the use of plant biotechnology. During the survey period, many of these countries have established legal frameworks. In different cases, these were inspired by an interest to conduct CFTs. In fact, some countries in Africa and Asia already have conducted more CFTs than some European countries. While there are still important hurdles, in particular in relation to intra-regional and international trade, these examples illustrate that a country can tap into biotechnology opportunities provided that a basic interest is present.

The key centre for second-generation GM plants in terms of number of CFTs remains North America. Drought tolerant and nitrogen use efficient crops are closest to the market. The first GM drought tolerant maize was commercialised in the USA in 2012 (permit issued December 2011 (USDA-APHIS, petitions)). Africa and Asia are already developing crops and traits for the local market. Insect resistant brinjal has recently been approved for commercialisation in Bangladesh. Other Asian countries are expected to follow. 'Golden rice' has been announced to be close to market introduction in the Philippines. In Africa, supported by international programs, applications in essential food crops such as sorghum, cassava, banana, maize and rice are advancing, but technical as well as regulatory challenges make it hard to predict timing for market availability. Latin America has relatively less local research dedicated to the countries' needs. Notable exception is the commercial approval in Brazil of a GM common bean (*Phaseolus vulgaris*) genetically modified and selected for resistance to the viral disease, caused by the *Bean Golden Mosaic* Virus (BGMV). With these exceptions all crop/trait combinations are still in early phase development.

Whereas big commodity crops reach a global market and therefore will also be presented for authorisations in the EU (albeit for import), it is less clear how this situation will be handled for smaller crops and/or products not developed by industry.

The declining number of CFTs in Europe furthermore illustrates that it is no longer considered as an important direct market for GM seeds and plants. European based research and development contributes to CFTs in other parts of the world in crops and varieties that are of relevance in these markets. The indication in the 2009 COGEM Trend Analysis of the ”declining influence of the EU on global developments” seems to be confirmed.

Studies by JRC (Stein & Rodríguez-Cerezo, 2009) and FAO (Ruane, 2012) predict an increasing amount of events to come to the market. While this study in general could identify the same traits being intensely studied in CFTs, it seems that introduction into the market is delayed compared to earlier expectations and a shift in time is noticed.

Acknowledgements

The authors like to thank the following persons for their contribution for the African data.

- Mr. Innocent Akampurira, Biosafety Desk Officer, Uganda National Council for Science and Technology, Uganda.
- Mr. Eric Amaning Okoree, National Coordinator for Biosafety, Ghana.
- Mr. Moussa Savadogo, African Biosafety Network of Expertise (ABNE), Burkina Faso
- Dr. Chiedozie Egesi, National Root Crops Research Institute (NRCRI), Umudike, Nigeria.
- Dr Mark Halsey, Director of Product Development, Institute for International Crop Improvement, Danforth Center, St. Louis, USA.
- Dr Narender Nehra, Director of Regulatory Affairs and Biotech Stewardship, Institute for International Crop Improvement, Danforth Center, St. Louis, USA.

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Annex 1: Country listing (including indication of membership to OECD, EU, EFTA, EEA and status for the Cartagena Protocol on Biosafety) for information on CFTs with GMOs, with reference to consulted public databases where applicable.

Country	OECD	EU	EFTA	EEA	CPB	CFTs with GM plants
Afghanistan					Accession	No records of CFTs were discovered
Albania					Accession	No records of CFTs were discovered
Algeria					Ratification	No records of CFTs were discovered
Angola					Accession	No records of CFTs were discovered
Antigua and Barbuda					Ratification	No CFTs in study period
Argentina						http://www.minagri.gob.ar/SAGPyA/areas/biotecnologia/index.php (*till 2012*)
Armenia					Accession	No records of CFTs were discovered
Australia	M					http://www.ogtr.gov.au/
Austria	M	MS		M	Ratification	No CFTs in study period
Azerbaijan					Accession	No records of CFTs were discovered
Bahamas					Ratification	No CFTs in study period
Bahrain					Accession	No records of CFTs were discovered
Bangladesh					Ratification	http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp http://gain.fas.usda.gov/Pages/Default.aspx
Barbados					Accession	No CFTs in study period
Belarus					Accession	No records of CFTs were discovered
Belgium	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Belize					Accession	No CFTs in study period
Benin					Ratification	No CFTs in study period
Bhutan					Accession	No records of CFTs were discovered
Bolivia (Plurinational State of)					Ratification	http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp
Bosnia and Herzegovina					Accession	No CFTs in study period
Botswana					Ratification	No records of CFTs were discovered
Brazil					Accession	http://www.ctnbio.gov.br/index.php/content/view/3508.html
Bulgaria		MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Burkina Faso					Ratification	Dr Moussa Savadogo http://gain.fas.usda.gov/Pages/Default.aspx
Burundi					Accession	No records of CFTs were discovered
Cambodia					Accession	No records of CFTs were discovered
Cameroon					Ratification	http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp
Canada	M					http://www.inspection.gc.ca/english/plaveg/bio/confine.shtml#sum
Cape Verde					Accession	No records of CFTs were discovered
Central African Republic					Ratification	No records of CFTs were discovered
Chad					Ratification	No CFTs in study period
Chile	M					http://historico.sag.gob.cl/opendocs/asp/pagDefault.asp?boton=Doc51&argInstanciaId=51&argCarpetaId=341&argTreeNodosAbiertos=(341)(-

Country	OECD	EU	EFTA	EEA	CPB	CFTs with GM plants
						51)&argTreeNodoSel=324&argTreeNodoActual=341
Colombia					Ratification	http://www.ica.gov.co/Normatividad/Normas-Ica.aspx?page=1 Arcadia Biosciences
Comoros					Accession	No records of CFTs were discovered
Congo					Ratification	No records of CFTs were discovered
Costa Rica					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Croatia		MS			Ratification	No CFTs in study period
Cuba					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Cyprus		MS		M	Accession	No CFTs in study period
Czech Republic	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Democratic P.R. of Korea					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Democratic Republic of the Congo					Accession	No records of CFTs were discovered
Denmark	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Djibouti					Accession	No records of CFTs were discovered
Dominica					Accession	No CFTs in study period
Dominican Republic					Accession	No CFTs in study period
Ecuador					Ratification	No CFTs in study period
Egypt					Ratification	http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp http://gain.fas.usda.gov/Pages/Default.aspx
El Salvador					Ratification	No CFTs in study period
Eritrea					Accession	No records of CFTs were discovered
Estonia	M	MS		M	Ratification	No CFTs in study period
Ethiopia					Ratification	No records of CFTs were discovered
Fiji					Ratification	No records of CFTs were discovered
Finland	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
France	M	MS		M	Approval	http://gmoinfo.jrc.ec.europa.eu/
Gabon					Accession	No records of CFTs were discovered
Gambia					Ratification	No CFTs in study period
Georgia					Accession	No records of CFTs were discovered
Germany	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Ghana					Accession	Mr. Eric Amaning Okoree http://gain.fas.usda.gov/Pages/Default.aspx
Greece	M	MS		M	Ratification	No CFTs in study period
Grenada					Ratification	No CFTs in study period
Guatemala					Accession	No CFTs in study period
Guinea					Ratification	No CFTs in study period
Guinea-Bissau					Accession	No CFTs in study period
Guyana					Accession	No CFTs in study period
Honduras					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Hungary	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Iceland	M		M	M		http://gmoinfo.jrc.ec.europa.eu/
India					Ratification	http://igmoris.nic.in/major_developments.asp http://igmoris.nic.in/field_trials.asp http://igmoris.nic.in/commercial_approved.asp http://www.envfor.nic.in/divisions/csurv/geac/geac_home.html
Indonesia					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Iran (Islamic					Ratification	No CFTs in study period

Country	OECD	EU	EFTA	EEA	CPB	CFTs with GM plants
Republic of)						
Ireland	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Israel	M					No CFTs in study period
Italy	M	MS		M	Ratification	No CFTs in study period
Jamaica					Ratification	No CFTs in study period
Japan	M				Accession	http://www.bch.biodic.go.jp/english/lmo.html
Jordan					Ratification	No CFTs in study period
Kazakhstan					Accession	No CFTs in study period
Kenya					Ratification	http://ke.biosafetyclearinghouse.net/approvedgmo.shtml Dr Narender Nehra and Dr Mark Halsey
Kiribati					Ratification	No records of CFTs were discovered
Kyrgyzstan					Accession	No records of CFTs were discovered
Lao People's Democratic Republic					Accession	No records of CFTs were discovered
Latvia		MS		M	Accession	No CFTs in study period
Lebanon					Accession	No records of CFTs were discovered
Lesotho					Accession	No records of CFTs were discovered
Liberia					Accession	No CFTs in study period
Libya					Accession	No records of CFTs were discovered
Liechtenstein			M	M		No records of CFTs were discovered
Lithuania		MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Luxembourg	M	MS		M	Ratification	No CFTs in study period
Madagascar					Ratification	No records of CFTs were discovered
Malawi					Ratification	http://allafrica.com/stories/201403311302.html
Malaysia					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Maldives					Accession	No records of CFTs were discovered
Mali					Ratification	No CFTs in study period
Malta		MS		M	Accession	No CFTs in study period
Marshall Islands					Accession	No records of CFTs were discovered
Mauritania					Accession	No records of CFTs were discovered
Mauritius					Accession	No records of CFTs were discovered
Mexico	M				Ratification	http://www.cibiogem.gob.mx/OGMs/Paginas/Solicitudes_Reg_OGMs.aspx
Mongolia					Accession	No records of CFTs were discovered
Montenegro					Succession	No records of CFTs were discovered
Morocco					Ratification	No CFTs in study period
Mozambique					Ratification	No CFTs in study period
Myanmar					Ratification	No records of CFTs were discovered
Namibia					Ratification	No records of CFTs were discovered
Nauru					Accession	No records of CFTs were discovered
Netherlands	M	MS		M	Acceptance	http://gmoinfo.jrc.ec.europa.eu/
New Zealand	M				Ratification	http://www.epa.govt.nz/new-organisms/popular-no-topics/Pages/GM-field-tests-in-NZ.aspx
Nicaragua					Ratification	No CFTs in study period
Niger					Ratification	No CFTs in study period
Nigeria					Ratification	Chiedozie Egesi http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp
Niue					Accession	No records of CFTs were discovered
Norway	M		M	M	Ratification	No CFTs in study period

Country	OECD	EU	EFTA	EEA	CPB	CFTs with GM plants
Oman					Accession	No records of CFTs were discovered
P.R. of China					Approval	http://gain.fas.usda.gov/Pages/Default.aspx http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp Xia *et al.*, 2012
Pakistan					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx Khan *et al.*, 2011
Palau					Ratification	No records of CFTs were discovered
Panama					Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Papua New Guinea					Accession	No records of CFTs were discovered
Paraguay					Ratification	http://www.senave.gov.py/resoluciones-del-senave.html
Peru					Ratification	No CFTs in study period
Philippines					Ratification	http://www.ncbp.dost.gov.ph/ http://biotech.da.gov.ph/Decision_docs_field.php
Poland	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Portugal	M	MS		M	Acceptance	http://gmoinfo.jrc.ec.europa.eu/
Qatar					Accession	No records of CFTs were discovered
Republic of Korea	M				Ratification	http://gain.fas.usda.gov/Pages/Default.aspx
Republic of Moldova					Ratification	No CFTs in study period
Romania		MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Russian Federation						No CFTs in study period
Rwanda					Ratification	No records of CFTs were discovered
Saint Kitts and Nevis					Accession	No CFTs in study period
Saint Lucia					Accession	No CFTs in study period
Saint Vincent and the Grenadines					Accession	No CFTs in study period
Samoa					Ratification	No records of CFTs were discovered
Saudi Arabia					Accession	No CFTs in study period
Senegal					Ratification	No CFTs in study period
Serbia					Accession	No CFTs in study period
Seychelles					Ratification	No records of CFTs were discovered
Slovak Republic	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Slovenia	M	MS		M	Ratification	No CFTs in study period
Solomon Islands					Accession	No records of CFTs were discovered
Somalia					Accession	No records of CFTs were discovered
South Africa					Accession	http://www.daff.gov.za/daffweb3/Branches/Agricultural-Production-Health-Food-Safety/Genetic-Resources/Biosafety/Information/Permits-Issued Information/Permits-Issued
Spain	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Sri Lanka					Ratification	No CFTs in study period
Sudan					Accession	No records of CFTs were discovered
Suriname					Accession	No CFTs in study period
Swaziland					Accession	No records of CFTs were discovered
Sweden	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
Switzerland	M		M		Ratification	No CFTs in study period
Syrian Arab Republic					Accession	No CFTs in study period

Country	OECD	EU	EFTA	EEA	CPB	CFTs with GM plants
Tajikistan					Accession	No records of CFTs were discovered
Thailand					Accession	No CFTs in study period
The former Yugoslav Republic of Macedonia					Ratification	No records of CFTs were discovered
Togo					Ratification	No CFTs in study period
Tonga					Accession	No records of CFTs were discovered
Trinidad and Tobago					Accession	No CFTs in study period
Tunisia					Ratification	No CFTs in study period
Turkey	M				Ratification	No CFTs in study period
Turkmenistan					Accession	No records of CFTs were discovered
Uganda					Ratification	Mr. Innocent Akampurira, Dr Narender Nehra and Dr Mark Halsey http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp
Ukraine					Accession	No CFTs in study period
United Kingdom	M	MS		M	Ratification	http://gmoinfo.jrc.ec.europa.eu/
United Republic of Tanzania					Accession	No CFTs in study period
United States	M					http://www.aphis.usda.gov/biotechnology/status.shtml
Uruguay					Ratification	http://www.mgap.gub.uy/portal/hgxpp001.aspx?7,1,144,O,S,0,MNU;E;2;2;12;5;MNU
Venezuela (Bolivarian Republic of)					Ratification	No CFTs in study period
Viet Nam					Accession	http://www.isaaa.org/Kc/Cropbiotechupdate/Default.Asp http://gain.fas.usda.gov/Pages/Default.aspx http://www.seedquest.com/
Yemen					Accession	No CFTs in study period
Zambia					Accession	No records of CFTs were discovered
Zimbabwe					Ratification	No records of CFTs were discovered

In addition, information was collected from the Biosafety Clearing House (http://bch.cbd.int/)

Annex 2: Percentage of all trials by class and type of trait per crop

Table 1 Percentage of all trials in the EU by class and type of trait per crop, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
cotton	84	0	0	82	0	0	52	0	0	0	0	0	1	0
maize	2019	0	2	92	0	0	62	0	0	0	0	0	10	0
oilseed rape	96	0	0	0	0	0	0	0	0	100	0	0	100	0
potato	610	1	0	2	0	32	0	1	0	68	1	0	50	1
soybean	77	0	0	100	0	0	0	0	0	0	0	0	0	0
sugarbeet	260	0	0	82	0	0	0	0	26	0	0	0	26	0
apple	2	0	50	0	0	50	0	0	0	0	0	0	50	0
birch	1	0	100	0	0	0	0	0	0	0	0	0	100	0
grapevine	1	0	0	0	0	0	0	0	100	0	0	0	100	0
pear	1	0	100	0	0	0	0	0	0	0	0	0	100	0
plum	1	0	0	0	0	0	0	0	100	0	0	0	100	0
poplar/aspen	11	0	73	0	0	0	0	0	0	18	0	0	45	18
barley	20	10	0	0	0	20	0	0	0	20	50	0	95	0
crambe	2	0	0	0	0	0	0	0	0	100	0	0	0	0
cucumber	4	0	0	0	0	0	0	0	0	100	0	0	100	0
fodder beet	5	0	0	100	0	0	0	0	0	0	0	0	0	0
linseed/flax	21	0	0	24	0	29	24	0	0	76	0	0	57	24
pea	4	0	0	0	0	100	100	0	100	100	0	0	100	0

	Agronomic properties				Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
rice	1	0	0	0	0	0	0	0	0	0	100	0	100	0
triticale	6	0	0	0	0	0	0	0	0	0	0	0	100	0
wheat	16	0	0	0	0	81	13	0	0	6	0	0	100	0
arabidopsis	11	0	0	0	0	0	0	0	0	0	0	0	100	100
black nightshade	10	0	0	0	0	0	100	0	0	0	0	0	100	0
petunia	4	0	0	0	0	0	0	0	0	0	0	0	100	100
tobacco	11	0	0	0	0	0	0	0	0	0	0	0	100	100
tree tobacco	1	0	0	0	0	0	0	0	0	0	0	0	100	100
wild tobacco	1	0	0	0	0	0	0	0	0	0	100	0	100	0

Table 2 Percentage of all trials in Canada by class and type of trait per crop, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
alfalfa	7	0	0	57	0	0	0	0	0	29	0	0	29	14
barley	1	0	0	0	0	0	0	0	0	0	100	0	100	0
brown mustard	38	24	11	76	0	0	0	0	0	0	0	0	24	0
camelina	37	0	54	32	0	0	0	0	0	30	0	0	35	0
Ethiopian mustard	16	6	6	0	0	0	0	0	0	94	0	0	88	6
linseed/flax	4	0	0	0	0	0	0	0	0	50	0	0	100	50
maize	161	13	50	66	0	6	17	0	0	5	0	0	47	4
oilseed rape	2960	40	50	18	0	0	0	0	0	2	0	0	6	1
pea	20	0	0	100	0	100	0	0	0	0	0	0	0	0
poplar	39	0	0	5	0	3	0	0	0	15	0	0	95	85
potato	1	0	0	0	0	0	0	0	0	100	0	0	100	0
safflower	3	0	0	100	0	0	0	0	0	0	100	0	0	0
soybean	326	0	41	61	0	0	2	0	0	10	0	0	40	0
tobacco	5	0	0	0	0	0	0	0	0	0	100	0	80	0
wheat	28	0	11	86	0	14	0	0	0	21	0	0	100	0

Table 3 Percentage of all trials in USA by class and type of trait per crop or group of plant species, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
cotton	172	21	2	78	0	1	23	0	3	0	8	0	3	12
maize	1862	41	36	54	0	7	41	0	0	2	24	2	13	20
oilseed rape	30	21	31	77	0	2	0	0	0	0	19	0	0	6
potato	9	7	3	2	1	36	4	1	0	11	74	0	0	40
rice	8	13	60	23	3	0	0	3	0	0	0	22	0	40
soybean	327	10	22	85	1	10	27	1	8	0	21	2	10	16
sugarbeet	22	14	0	56	0	0	0	0	0	30	3	0	0	15
sugarcane	4	9	2	28	0	0	19	0	0	7	47	0	0	77
tomato	0	0	3	4	14	7	15	14	0	26	47	0	0	66
other cereals	62	56	15	21	0	33	2	0	0	0	34	2	2	57
other oil crops	1	4	11	22	0	0	0	0	0	0	70	19	0	70
other legumes	2	12	18	0	0	29	6	0	0	0	35	0	0	82
fodder crops	61	38	41	36	0	2	1	0	0	0	76	0	4	29
other vegetables/fruits	2	11	26	47	0	0	16	0	0	0	0	0	0	53
fruit trees	4	8	12	12	18	41	4	18	4	20	25	0	0	100
other trees	85	64	73	2	1	2	1	1	0	0	19	0	0	66
ornamentals	0	0	0	29	29	0	0	29	29	0	43	0	0	100
model species	16	12	11	6	4	3	6	4	1	1	30	6	0	75
others	4	44	0	0	0	0	0	0	0	11	44	0	0	100

Table 4 Percentage of all trials in Latin America except Chile by class and type of trait per crop, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
alfalfa	12	25	8	75	0	0	0	0	0	8	0	0	67	0
banana	1	0	0	0	0	100	0	0	0	0	0	0	100	0
bean	1	0	0	0	0	0	0	0	100	0	0	0	0	0
carnation	3	0	0	0	0	0	0	0	0	100	0	0	100	0
chrysanthemum	4	0	0	0	0	0	0	0	0	100	0	0	100	0
cotton	2073	0	0	99	0	0	62	0	0	0	0	0	0	0
eucalyptus	2	0	100	0	0	0	0	0	0	0	0	0	0	0
maize	1948	1	0	92	0	0	81	0	0	3	0	0	17	0
potato	2	0	0	0	0	0	50	0	50	0	0	0	0	0
rice	50	10	74	32	0	0	0	0	0	0	0	0	0	0
rose	3	0	0	0	0	0	0	0	0	100	0	0	100	0
safflower	3	0	0	33	0	0	0	0	0	0	100	0	0	0
sorghum	1	100	0	0	0	0	0	0	0	0	0	0	0	0
soybean	799	2	5	94	0	0	27	0	0	4	0	0	0	0
sugarbeet	2	0	0	100	0	0	0	0	0	0	0	0	0	0
sugarcane	22	9	0	45	0	0	5	0	9	27	0	0	0	0
tobacco	1	0	0	100	0	0	0	0	0	0	0	0	100	0
wheat	29	97	0	3	0	3	0	0	0	0	0	0	0	0

Table 5 Percentage of all trials in Africa by class and type of trait per crop, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
baby's breath	1	0	0	0	0	0	0	0	0	100	0	0	0	0
banana	4	0	0	0	50	0	0	25	0	25	0	0	0	0
cassava	16	0	0	0	0	0	0	0	50	50	0	0	13	0
chincherinchee	1	0	0	0	0	0	0	0	100	0	0	0	100	0
cotton	34	0	0	47	0	0	91	0	0	0	0	0	26	0
cowpea	4	0	0	0	0	0	100	0	0	0	0	0	25	0
maize	106	19	5	64	0	0	75	0	0	0	0	0	27	0
potato	1	0	0	0	0	0	100	0	0	0	0	0	0	0
rice	2	100	0	0	0	0	0	0	0	0	0	0	0	0
sorghum	1	0	0	0	0	0	0	0	0	100	0	0	0	0
soybean	3	0	0	100	0	0	0	0	0	67	0	0	0	0
squash	1	0	0	0	0	0	0	0	100	0	0	0	0	0
sugarcane	9	0	67	0	0	0	0	0	0	100	0	0	0	0
sweet potato	3	0	0	0	0	0	33	0	33	33	0	0	0	0

Table 6 Percentage of all trials in Asia by class and type of trait per crop, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
cassava	2	0	0	0	0	0	0	0	0	100	0	0	0	0
cotton	171	5	0	65	0	0	63	0	3	1	0	0	1	0
maize	263	0	0	92	0	0	86	0	0	0	0	0	3	0
oilseed rape/ Indian mustard	20	5	65	90	0	0	0	0	0	5	0	0	0	0
potato	19	0	11	0	0	42	0	0	21	26	0	0	0	0
rice	116	7	28	34	2	3	34	0	0	10	6	0	19	6
soybean	29	0	0	79	0	0	14	0	0	17	0	0	0	0
sugarcane	3	0	0	0	0	0	33	0	0	67	0	0	0	0
wheat	8	63	0	25	0	13	0	0	0	13	0	0	0	0
aubergine	31	0	0	0	0	0	100	0	0	0	0	0	74	0
other vegetables/ fruit	42	0	0	5	0	2	12	0	52	14	0	0	0	0
legumes	24	21	0	0	0	17	8	0	13	0	0	0	0	0
fodder crops	8	25	0	25	0	0	38	0	0	13	0	0	0	0
trees	15	40	0	0	0	7	0	0	33	13	0	0	0	0
others	12	0	0	83	0	0	0	0	0	100	0	0	0	0

Table 7 Percentage of all trials in Australia by class and type of trait per crop, 2009-2013

		Agronomic properties			Biotic stress resistance					Product specifications		Other traits		
	Total number of CFTs	% Abiotic Stress	% Plant biology	% Herbicide tolerance	% Bacteria resistance	% Fungus resistance	% Insect resistance	% Nematode resistance	% Virus resistance	% Product quality	% Product systems	% Breeding aids	% Marker genes	% Other
banana	2	0	0	0	0	50	0	0	0	50	0	0	100	0
cotton	296	7	1	92	0	0	92	0	0	0	0	0	97	0
maize	4	0	0	100	0	0	0	0	0	0	0	0	100	100
narrow-leafed lupin	1	0	0	100	0	0	0	0	0	0	0	0	0	0
oilseed rape	50	0	8	92	0	0	0	0	0	0	0	0	8	0
oilseed rape/ Indian mustard	147	0	100	100	0	0	0	0	0	0	0	0	0	0
safflower	1	0	0	0	0	0	0	0	0	100	0	0	100	0
sugarcane	58	36	36	41	0	0	0	0	0	53	0	0	100	0
wheat	9	67	44	0	0	0	0	0	0	33	0	0	100	0
wheat/barley	29	48	86	0	0	7	0	0	0	41	0	0	100	0
white clover	1	0	0	0	0	0	0	0	100	0	0	0	100	0

Annex 3: Percentage of all trials by applicant type per crop, 2009-2013

Table 1 Percentage of all trials in the EU by applicant per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry
cotton	84	1	99
maize	2019	11	89
oilseed rape	96	0	100
potato	610	22	78
soybean	77	0	100
sugarbeet	260	1	99
apple	2	100	0
birch	1	100	0
grapevine	1	100	0
pear	1	100	0
plum	1	100	0
poplar/aspen	11	82	18
barley	20	50	50
crambe	2	100	0
cucumber	4	100	0
fodder beet	5	0	100
linseed/flax	21	43	57
pea	4	0	100
rice	1	0	100
triticale	6	100	0
wheat	16	100	0
arabidopsis	11	100	0
black nightshade	10	100	0
petunia	4	100	0
tobacco	11	100	0
tree tobacco	1	0	100
wild tobacco	1	0	100

Table 2 Percentage of all trials in Canada by applicant type per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry
alfalfa	7	71	29
barley	1	0	100
brown mustard	38	0	100
camelina	37	22	78
Ethiopian mustard	16	13	88
linseed/flax	4	100	0
maize	161	36	64
oilseed rape	2960	2	98
pea	20	100	0
poplar	39	100	0
potato	1	0	100
safflower	3	0	100
soybean	326	0	100
tobacco	5	100	0
wheat	28	14	86

Table 3 Percentage of all trials in the USA by applicant type per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry
cotton	172	3	97
maize	1862	4	96
oilseed rape	30	0	100
potato	9	22	78
rice	8	0	100
soybean	327	2	98
sugarbeet	22	26	74
sugarcane	4	7	93
tomato	0	55	45
other cereals	62	37	63
other oil crops	1	19	81
other legumes	2	76	24
fodder crops	61	12	88
other vegetables/ fruits	2	53	47
fruit trees	4	80	20
other trees	85	17	83
ornamentals	0	100	0
model species	16	65	35
others	4	56	44

Table 4 Percentage of all trials in Latin America except Chile by applicant type per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry
alfalfa	12	0	100
banana	1	100	0
bean	1	100	0
carnation	3	0	100
chrysanthemum	4	0	100
cotton	2073	1	99
eucalyptus	2	0	100
maize	1948	0	100
potato	2	50	50
rice	50	2	98
rose	3	0	100
safflower	3	0	100
sorghum	1	0	100
soybean	799	4	96
sugarbeet	2	0	100
sugarcane	22	23	77
tobacco	1	100	0
wheat	29	76	24

Table 5 Percentage of all trials in Africa by applicant type per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry
baby's breath	1	100	0
banana	4	100	0
cassava	16	94	0
chincherinchee	1	100	0
cotton	34	50	50
cowpea	4	100	0
maize	106	0	100
potato	1	7	93
rice	2	100	0
sorghum	1	100	0
soybean	3	100	0
squash	1	0	100
sugarcane	9	100	0
sweet potato	3	100	0

Table 6 Percentage of all trials in Asia by applicant type per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry	% Research inst./ Industry
cassava	2	100	0	0
cotton	171	18	82	0
maize	263	0	100	0
oilseed rape/ Indian mustard	20	75	25	0
potato	19	100	0	0
rice	116	28	72	0
soybean	29	0	100	0
sugarcane	3	100	0	0
wheat	8	67	33	0
aubergine	31	81	19	0
other vegetables/ fruit	42	86	14	0
legumes	24	100	0	0
fodder crops	8	83	17	0
trees	15	130	0	0
others	12	0	83	17

Table 7 Percentage of all trials in Australia by applicant type per crop, 2009-2013

	Total number of CFTs	% Research institutes	% Industry
banana	2	100	0
cotton	296	1	99
maize	4	100	0
narrow-leafed lupin	1	100	0
oilseed rape	50	8	92
oilseed rape/ Indian mustard	147	0	100
safflower	1	100	0
sugarcane	58	22	78
wheat	9	100	0
wheat/barley	29	100	0
white clover	1	100	0