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# **PUBLIC VS PRIVATE AGBIOTECH RESEARCH: ROLE AND PATHWAYS THROUGH AN ANALYSIS OF EPO AND USPTO PATENTS 2002-2009**

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## **Abstract**

Patents are a functional information tool in the study of agbiotech investments in research. The analysis aims to improve the knowledge of the international patent system, through the definition of an updated picture of agbiotech patent filed in EU and US, the two most significant innovation area worldwide, though presenting huge differences in managing IP rights.

The paper provide a complex analysis of biotech patents patterns starting from a comprehensive data set including more than 7000 patents filed in the period 2002-2009. The main findings show that the private sector is still dominant and market oriented, but reveals a partial shift from the first wave of innovations to a new one characterized by nutritional components. The role of public sector in basic research is also confirmed, both in Europe and in US, and represents also a source of IP for innovative products. Public research is focused on plant developmental processes (i.e. abiotic resistance) useful in specific agricultural landscapes.

**Keywords:** agbiotech, patent, intellectual properties, public research.

## **Section 1**

### **1.1 Introduction**

Research and development (R&D) in agricultural sector was traditionally provided by public research institutions (Alston et al 2001). In the past two decades the historical pattern of agriculture R&D changed dramatically as an effect of the introduction of innovative research tools and technologies like molecular approach to plant breeding.

Biotechnology literally means the use of living organisms to perform a task or function. In modern parlance, however, the term biotechnology is used to refer to the newer methods of genetic engineering of organisms through the use of recombinant DNA.

Biotechnology has many application in agriculture, including diagnostics, vaccines and therapeutics for animal health, DNA fingerprinting and the use of marker assisted selection, intragenics and genetic engineering to develop improved plant varieties (GMO) (Beuzekom et al, 2009)

Today people use the term GMO to refer to a genetically modified organism, one that has been engineered using rDNA. Others refer to foods created in this manner as genetically engineered or GE foods. (Lemaux, 2008).

The first GM plant was tobacco, in 1983 (Bevan et al, 1983), but no plants were commercially grown until the FlavrSavr™ tomato was commercialized in 1994. Then other commercial crops entered the market, principally large acreage crops, as corn, cotton, soybean.

In 2009, 14 million farmers planted 134 million hectares (330 million acres) of biotech crops in 25 countries, up from 13.3 million farmers and 125 million hectares (7 percent) in 2008. Notably, in 2009, 13 of the 14 million farmers, or 90 percent, were small and resource-poor farmers from developing countries (ISAAA2009).

Despite sizeable GM crop acreage, the diversity of crop types and traits in commercial production is limited. Few minor acreage GM crops are at present commercially successful, papaya (*Carica papaya*), certain types of squash (*Cucurbita sp.*), and sweet corn. Almost all major-acreage, commercial GM crops are based on pest protection via genes from Bt or HT.

More recently, stacked versions of these traits were released, maize engineered for rootworm and European corn borer resistance (both Bt-based) and tolerance to RoundUp®. Except GM papaya, all commercial varieties in 2007 are from the private, not the public, sector.

Six European countries planted 94,750 hectares of biotech crops in 2009, down from seven countries and 107,719 hectares in 2008, as Germany discontinued its planting. Spain planted 80 percent of all the Bt maize in the EU in 2009 and maintained its record adoption rate of 22 percent from the previous year.

The field area for genetically modified plants in the European Union decreased in 2009. In France and Germany, national cultivation bans for genetically modified Bt maize (MON810) were enacted in 2009. Both countries have suspended the approval issued according to EU law.

Even in Spain, which still maintains the largest crop area by far of Bt maize in Europe, four per cent less Bt maize was cultivated than in the previous year. However, the cultivation of maize experienced a general decrease in Spain. The proportion of Bt maize in Spanish maize production remained almost unchanged with approximately 22 per cent

This issue of GM cultivation is highly sensitive in Italy, where traditional “high quality” food are considered as needing protection from any “contamination” from biotech products. The

opposition to biotech remains very strong, including some leading farmer organizations and political parties. In 2008 Italy has approved protocols for biotech field trials for nine crops but leaving implementing regulations up to the regions, many of which have declared themselves to be GMO free. Nevertheless, most Italian scientists remain skeptical about their actual significance, because too many constraints exist to make field tests practical. During years in Italy many research centers have abandoned agricultural biotechnology research because there is little likelihood that any farm in Italy will be able to benefit from such research soon (USDA, 2008).

Biotechnology offers prospects in addressing problems concerned with agricultural productivity and environmental safety, and as a new frontier in agricultural sciences, has opened new possibilities for the solution of agricultural problems.

The development of improved varieties, yielding crops of higher nutritional value or displaying improved resistance to disease imply a reasonable return for the efforts and expenses dedicated to research (Diez, 2002).

Intellectual property rights in agriculture are frequently used to protect technological advances. These rights allow their owners to exclude competitors from "making, using, offering for sale, or selling" an invention for a limited period of time. As scientific discoveries in agricultural biotechnology have accelerated over the past few decades, the use of patents and other intellectual property rights to protect these discoveries has increased tremendously.

In this new scenario the scientific basic research is owned by public sector, in particular universities, but this new approach needs more economic investment as well as the production of other agricultural inputs (agrochemicals), that private sector is commonly more able to bear, introducing itself as a new actor of this complex setting (Graff, 2003).

Pathways and role of public and private research in agbiotech innovation can be analysed by the evaluation of two principal tools, agbiotech patents and field tests data providing information on

both the amount of development work to produce new GM plant varieties and the type of GM traits under development In this first phase of the work we focused on the analysis of agbiotech patents in two different scenarios, USA and European Union.

## **Section 2**

### **2.1 Problem statement**

Over the past two or more decades, the structure of agricultural input industries has changed very rapidly. Private-sector investment in agricultural and food research and development (R&D) has grown dramatically, while public-sector investment has remained relatively constant. Private-sector plant breeding has been the fastest growing segment of the private research portfolio. Mergers, acquisitions, strategic alliances, and some divestiture in recent years have characterized the sector (Shoemaker et al., 2001) Patents are a functional information tool in the study of agbiotech sector.

A patent is a document, issued by an authorized governmental agency, granting the right to exclude anyone else from the production or use of a specific new device, apparatus, or process for a stated number of years. The grant is issued to the inventor of this device or process after an examination that focuses on both the novelty of the claimed item and its potential utility.

The strong proliferation of patents in the last two decades could be view as a reaction of both the intervention of the private sector, and its needs of intellectual property rights protection as parts of his investments, as well as the Bayh-Dole Act of 1980, which enable universities to patent results of research financed with federal funds (Yancey and Stewart, 2007).

Several studies examined the role of patents in the development and use of platform technologies for plant biotechnology - plant transformation techniques and structural genomics - showing that patents are important in inducing private firms to develop these platform technologies. This development led to the commercialization of many GM varieties, more rapidly than would have been the case otherwise. Moreover, the evidence suggests that the benefits from patents on tools outweigh the costs (Pray and Naseem 2005).

Literature about intellectual property (IP) protection by public research institutes suggest that the ability to protect intellectual property gives universities an opportunity to increase the source of funds, as well as provide incentives to researchers to produce innovations. Although the extension of IPRs may seem to be in conflict with the traditional role of universities to create, sustain and disseminate knowledge as a public good, it also provides a way to meet the objective of increasing social welfare, which might not be possible without IP protection. Nevertheless, literature argues that such protection can be compatible with the mission of public organizations, especially in cases where private firms will underinvest due to thin markets, high development costs or technological complexity (Maredia 1999)

In both cases, literature suggests the analysis of patents as economic indicators (PAKES Schmookler and Brownlee 1962; Griliches and Schmookler 1963; Schmookler 1966). Among the major findings was the discovery of a strong relationship between patent numbers and R & D expenditures, implying that patents are a good indicator of differences in inventive activity across different firms (Griliches 1990).

The patent variable had the advantage of being a more direct consequence of inventive activity than the other indicators of performance available and the advantage that patent applications were, at least in principle, available for an unusually long time period in an extremely detailed breakdown.

Use of patent data is not without difficulties: for example the “economic value” of a patent may differ greatly depending on type of institution to whom the patent is assigned and public sector institutions may do so for reasons differing from those motivating private firms.

Patent statistics are interesting in spite of all the difficulties that arise in their use and interpretation remaining a unique resource for the analysis of the process of technical change.

Therefore, considering the complexity of pathways of IP protection (Pray and Naseem, 2005) and the related increasing costs, our analysis wants to contribute in improving the knowledge of the international patent system, through the definition of an updated picture of agbiotech patent filed in UE and US, the two most significant innovation areas worldwide, though presenting huge differences in managing IP rights. A specific focus of the analysis is also to study the degree of collaboration between public and private sector and the concentration of the ownership of patents in agbiotech innovations between firms and public institutions.

## **2.2 Methodology**

In this work we examine IP in agricultural biotechnology to assess the impacts of IP rights and the Bayh-Dole Act, the concentration of IP in both the private and public sectors and the technological dimension of public sector contribution.

The study focus on agbiotech application filed and patents granted at the European Patent Office (EPO) and United States Patent and Trademark Office (USPTO) from 2002 to 2009. For data collection and interpretation we follow the approach proposed by Graff et al. (2003) who analyses patents for the period 1982-2001, making a classification of the patents for technological areas and a comparison of portfolio for the private and public research.

The analysis of available data sources led us to the selection of the “worldwide” database on the website [ep.espacenet.com](http://ep.espacenet.com), created by the European Patent Office.

In a second step we selected the “queries” able to make the extraction of data effective, and we built up the agbiotech patents database. More specifically, starting from International Patent Classification, we considered groups A01 (Agriculture; Forestry; Animal Husbandry; Hunting; Trapping; Fishing) and C12 (Biochemistry; [...]; Microbiology; Enzymology; Mutation or Genetic Engineering) and related subgroups. The final query is “(A01H1/08 or A01H4 or A01H5) and C12N15”, that permitted us to extract only patents related to agbiotech products.

Next we organized data as follow: the main aggregation keys are applicants of technologies, organization typology (multinationals firms, other privates, academic or government organization or patent management company), kind of collaboration, origin (EPO o USPTO), publication date and technological categories (table 1). This high level of detail and elaboration has been possible

only by manual selection of elementary data, in contrast to the use of software lacking in flexibility and accuracy in identification of clusters.<sup>1</sup>

This type of classification enabled the analysis of agbiotech IP innovation characteristics and comparison with data of the previous period 1982-2001 (Graff 2003).

**Table 1 - Classification of technological categories and sub categories related to agbiotech<sup>2</sup>**

<i>PLANT TECHNOLOGIES</i>
nutrition component
yield
stress/disease resistance
herbicide resistance
insect resistance
physical structure/plant function
male sterility
<i>BIO PROCESSES/METABOLIC PATHWAYS</i>
promoters
genes & enzymes
biological process/metabolic pathways
<i>BIOLOGICAL PROCESSES DNA SCALE</i>
bio process DNA scale
genomics
<i>GENETIC TRASFORMATION</i>
<i>CULTIVARS</i>
<i>PHARMACEUTICALS</i>

Source: elaboration on USDA classification

To analyze the rate of concentration among firms and sub categories, we used the Concentration Ratio (CR4)<sup>3</sup> and the Herfindahl index, also known as Herfindahl-Hirschman Index<sup>4</sup>.

<sup>1</sup> For example, about 500 patents were without a clear applicant, it has been possible to assigned them using direct interrogation of other sources like WIPO and CAMBIA.

<sup>2</sup> Our classification follows the USDA classification scheme except for cultivars that were previously eliminated (cultivars are present only in USPTO) and genomics that we considered into biological processes DNA scale macro category in order to gather information about to basic research.

<sup>3</sup> The CR4 is calculated as the sum of the percent patent share of the top 4 firms and sub categories.

<sup>4</sup> The Herfindahl Index (H) is calculated as

To examine the degree of specialization related to patents macro categories and sub categories the Standardize Revealed Technological Advantage Index (SRTA) was computed by analogy with other studies on patents (EU, 2001; Soete et al., 1983).<sup>5</sup>

### Section 3

#### 3.1 Results and discussion

##### 3.1.1 Trends in EPO and USPTO 2002-2009

Our analysis is based on the differentiation between patents filed at the European Patent Office (EPO) and at the United States Patent and Trademark Office (USPTO). We observed the dynamic

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$$H = \sum_{i=1}^N s_i^2$$

The H index ranges from 1 / N to one, where N is the number of firms or categories. A small index indicates competitiveness in patent granted with no dominant inventors or categories.

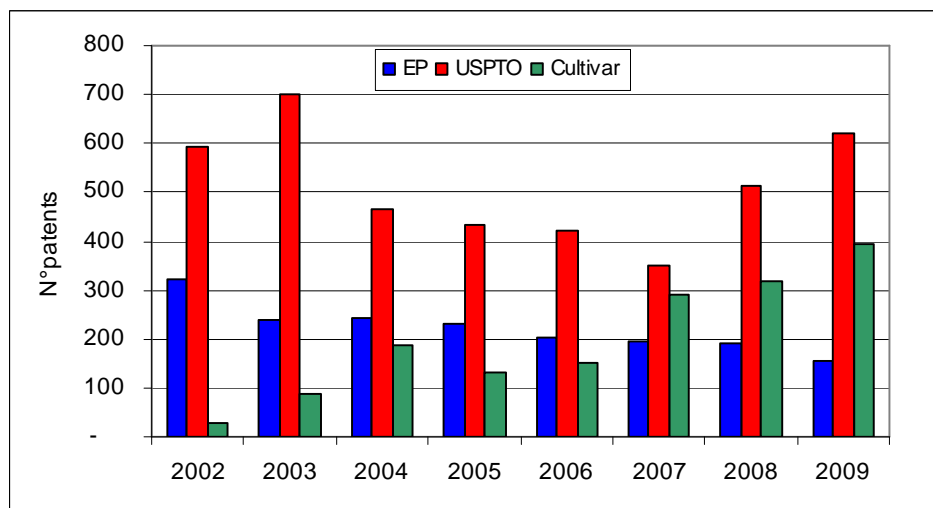
<sup>5</sup>The standardize index varies between -1 (non specialization) and +1 (specialization).

$$SRTA = (RTA - 1) / (RTA + 1)$$

$$RTA = \frac{(P_{ij}) / \sum_i P_{ij}}{\sum_i P_{ij} / \sum_i \sum_j P_{ij}}$$

of numbers of patent granted in the period from 2002 to 2009, taking into account the eventual time shift between the two systems in filing the same patent.

**Figure 1 - Annual trends in plant biotechnology IP 2002-2009**



Source: elaboration on ep.espacenet.com data

We decided to analyse patents related to cultivars separately because this specific category is patentable only at USPTO; biotech cultivars in Europe can be filed only at the International Union for the Protection of New Varieties of Plants (UPOV). Nevertheless, we include patents of cultivar in the analysis of private sector, because they represent an important field of R&D.

The total number of patents analyzed is 7465 (5878 without cultivars), 1779 filed in EPO and 5686 (4099 without cultivars) filed in USPTO; the trend of the two patent systems is completely different: in the European one there is a constant trend with a progressive soft decreasing and the number of patents in 2009 significantly lower than in 2002; on the contrary American system is characterized for high volatility in the number of patents granted. In contrast with the EPO situation, USPTO registered in 2009 the highest number of patents (Figure 1). Observing only

cultivars patent, the trend 2002-2009 is slightly fluctuating, but in the last four years is still increasing.

The analysis of the number of patents filed at EPO and USPTO and classified for applicants shows the fundamental role of the private sector both in European patent system and in the American one (Table 2a). Both in EPO and USPTO the private sector is dominant (62.5% in EPO and 62,9% in USPTO). In particular, around 40% of total patents granted in the two system comes from major commercial firms<sup>6</sup>. Cultivars patents are granted by private sector (84%) and, in particularly, by commercial firms which account for 68,7% of total cultivars granted (Table 2b).

**Table 2a - Number of patents granted at EPO and USPTO by sector and collaboration (2002-2009)**

	EPO		USPTO	
	Number	Percentage	Number	Percentage
<b>Private sector</b>				
Multinational firms	676	38,0%	1.663	40,5%
Other private	435	24,5%	922	22,5%
<b>Subtotal</b>	<b>1.111</b>	<b>62,5%</b>	<b>2.581</b>	<b>62,9%</b>
<b>Public sector</b>	<b>424</b>	<b>23,8%</b>	<b>1.244</b>	<b>30,3%</b>
<b>Collaboration</b>				
Private-private	40	2,2%	47	1,1%
Private-public	102	5,7%	101	2,5%
Public-public	76	4,3%	85	2,1%
<b>Subtotal</b>	<b>218</b>	<b>12,3%</b>	<b>233</b>	<b>5,7%</b>
Uncertain	0	0,0%	0	0,0%
<b>Indipend.</b>	<b>26</b>	<b>1,5%</b>	<b>41</b>	<b>1,0%</b>
<b>Total</b>	<b>1.779</b>	<b>100,0%</b>	<b>4.103</b>	<b>100,0%</b>

Source: ours calculation on ep.espacenet.com data

<sup>6</sup> Major commercial firms are the six big multinational firms: Bayer, Basf, DOW Agrosiences, Du Pont, Syngenta, additionally assigning patents from acquired companies (i.e. Crop design = Basf). Other private applicants includes both independent inventors and other firms.

Public sector has a restrained, but significant, role in both patent systems, its activity is almost absent (1,8%), only in cultivars patentability while in the other categories it accounts for 23,8% in EPO and 30,3% in USPTO.

Patents number jointly assigned to collaborating organization are less than other typologies of applicants; nevertheless collaboration show a higher importance in the European patent system.

**Table 2b - Number of cultivar granted at USPTO by sector and collaboration (2002-2009)**

	USPTO (cultivars)	
	Number	Percentage
<b>Private sector</b>		
Multinational firms	1.090	68,7%
Other private	243	15,3%
<b>Subtotal</b>	<b>1.333</b>	<b>84,0%</b>
<b>Public sector</b>	<b>28</b>	<b>1,8%</b>
<b>Collaboration</b>		
Private-private	224	14,1%
Private-public		0,0%
Public-public		0,0%
<b>Subtotal</b>	<b>224</b>	<b>14,1%</b>
Uncertain		0,0%
<b>Indipend.</b>	<b>2</b>	
<b>Total</b>	<b>1.587</b>	<b>100,0%</b>

Source: ours calculation on ep.espacenet.com data

### **3.1.2 Concentration analysis**

A more detailed analysis prevails interesting differences between patents categories and sub categories considered and typology of applicants. For this purpose we calculate the Herfindahl index (HI) considering each major firms, the whole public sector and other residual private like an aggregate (table 3).

The HI suggests a low degree of concentration. It means that every actors contribute to grant patents in every categories; pharmaceutical macro category represent an exception with an HI of 0,4 due to the activity of the public sector and other privates. However, is important to emphasize the contribution of public research both in basic research than in the study of plant developmental processes (abiotic resistance) useful in specific agricultural landscapes.

The role of multinationals appears rather homogeneous among the different categories. This in contrast whit the scenario of cultivars category (previously eliminated because absent in EPO), where almost 80% of patents is attributed to three corporations (Monsanto, Du Pont and Syngenta).

**Table 3 - Patent assigned by type of inventing organization and cluster of genetic trait technology (%)**

Category	Public	BASF	BAYER	DAS	DU PONT	MONSANTO	SYNGENTA	Other private	Total	HI
<b>bio processes DNA scale</b>	<b>36,8</b>	<b>6,8</b>	<b>6,0</b>	<b>0,9</b>	<b>15,4</b>	<b>7,7</b>	<b>2,6</b>	<b>23,9</b>	<b>100,0</b>	<b>0,231</b>
bio proc DNA scale	39,2	8,2	3,1	1,0	14,4	7,7	3,1	23,2	100,0	0,243
genomics	25,0	0,0	20,0	0,0	20,0	7,5	0,0	27,5	100,0	0,224
<b>bioprocesses</b>	<b>31,4</b>	<b>7,4</b>	<b>4,6</b>	<b>1,4</b>	<b>16,7</b>	<b>10,4</b>	<b>3,1</b>	<b>25,0</b>	<b>100,0</b>	<b>0,209</b>
bio proc metab path	32,9	7,3	5,4	2,3	10,9	10,6	3,7	26,8	100,0	0,213
genes & enzymes	30,0	8,4	4,8	0,8	19,8	9,5	2,1	24,6	100,0	0,208
promoters	33,8	3,9	2,6	1,3	17,0	13,4	5,0	23,0	100,0	0,219
<b>genetic transformation</b>	<b>31,4</b>	<b>4,5</b>	<b>7,2</b>	<b>2,0</b>	<b>7,5</b>	<b>12,2</b>	<b>3,9</b>	<b>31,2</b>	<b>100,0</b>	<b>0,226</b>
<b>pharmaceuticals</b>	<b>40,5</b>	<b>0,0</b>	<b>1,8</b>	<b>8,1</b>	<b>0,0</b>	<b>1,8</b>	<b>0,0</b>	<b>47,7</b>	<b>100,0</b>	<b>0,400</b>
<b>plant technology</b>	<b>29,5</b>	<b>9,6</b>	<b>6,9</b>	<b>1,9</b>	<b>10,8</b>	<b>12,0</b>	<b>6,4</b>	<b>23,0</b>	<b>100,0</b>	<b>0,184</b>
herbicide res	16,0	9,0	17,9	2,6	11,5	9,6	16,7	16,7	100,0	0,145
insect res	10,2	5,4	9,1	8,1	18,8	23,7	15,1	9,7	100,0	0,152
male sterility	35,7	1,4	15,7	0,0	10,0	5,7	7,1	24,3	100,0	0,230
nutrit components	27,7	5,5	8,8	1,9	10,9	14,1	3,6	27,6	100,0	0,197
phys struct plant funct	46,4	1,3	6,7	0,9	10,7	5,4	7,6	21,0	100,0	0,284
stress disease res	37,3	13,4	1,6	0,9	9,3	7,9	5,2	24,4	100,0	0,234
uncertain	22,2	0,0	0,0	0,0	11,1	22,2	0,0	44,4	100,0	0,309
yield	18,3	38,0	0,0	0,0	4,9	18,3	0,0	20,4	100,0	0,256
<b>total</b>	<b>31,1</b>	<b>7,7</b>	<b>5,8</b>	<b>1,8</b>	<b>13,1</b>	<b>10,9</b>	<b>4,3</b>	<b>25,3</b>	<b>100,0</b>	<b>0,201</b>

Source: elaboration on ep.espacenet.com data

In order to evaluate actors strategies we investigate the composition of portfolios for each major firms, public sector and residual other private (table 4). Combining this information with CR4 index we observed, for BASF, Du Pont, Bayer and Monsanto, that in spite of a good diversification of portfolios, the first-four sub categories represent the core business. This result is

influenced by the absence of cultivars, as already mentioned, that represent a strategic category for three of the six multinational firms considered. The composition of plant technology category displays a partial shift from the first wave of innovations (mainly herbicide and insect resistance) to a new one characterized by nutritional components.

Finally, the public sector and the aggregation of the other private applicants show an high level of diversification.

**Table 4 - IP portfolio of single inventors by cluster of genetic trait technology**

Category	Public	BASF	BAYER	DAS	DU PONT	MONSANTO	SYNGENTA	Other private	Total
<b>bio processes DNA scale</b>	<b>5,2</b>	<b>3,9</b>	<b>4,5</b>	<b>2,1</b>	<b>5,1</b>	<b>3,1</b>	<b>2,6</b>	<b>4,1</b>	<b>4,4</b>
bio proc DNA scale	4,6	3,9	1,9	2,1	4,0	2,6	2,6	3,3	3,6
genomics	0,6	0,0	2,6	0,0	1,1	0,5	0,0	0,8	0,7
<b>bioprocesses</b>	<b>45,6</b>	<b>43,0</b>	<b>36,2</b>	<b>35,1</b>	<b>57,5</b>	<b>43,1</b>	<b>31,9</b>	<b>44,6</b>	<b>45,1</b>
bio proc metab path	14,3	12,8	12,6	18,1	11,3	13,2	11,6	14,3	13,5
genes & enzymes	23,6	26,6	20,4	11,7	36,9	21,2	12,1	23,8	24,5
promoters	7,7	3,6	3,2	5,3	9,3	8,7	8,2	6,5	7,1
<b>genetic transformation</b>	<b>10,5</b>	<b>6,0</b>	<b>12,9</b>	<b>11,7</b>	<b>6,0</b>	<b>11,6</b>	<b>9,5</b>	<b>12,8</b>	<b>10,4</b>
<b>pharmaceuticals</b>	<b>2,7</b>	<b>0,0</b>	<b>0,6</b>	<b>9,6</b>	<b>0,0</b>	<b>0,3</b>	<b>0,0</b>	<b>3,9</b>	<b>2,1</b>
<b>plant technology</b>	<b>36,1</b>	<b>47,1</b>	<b>45,6</b>	<b>41,5</b>	<b>31,4</b>	<b>41,9</b>	<b>56,0</b>	<b>34,6</b>	<b>38,1</b>
herbicide res	1,5	3,4	9,1	4,3	2,6	2,6	11,2	1,9	2,9
insect res	1,1	2,4	5,5	16,0	5,0	7,5	12,1	1,3	3,5
male sterility	1,5	0,2	3,6	0,0	1,0	0,7	2,2	1,3	1,3
nutrit components	11,6	9,2	19,7	13,8	10,8	16,8	10,8	14,1	13,0
phys struct plant funct	6,2	0,7	4,9	2,1	3,4	2,1	7,3	3,5	4,2
stress disease res	12,5	18,1	2,9	5,3	7,4	7,5	12,5	10,0	10,4
uncertain	0,1	0,0	0,0	0,0	0,1	0,3	0,0	0,3	0,2
yield	1,6	13,0	0,0	0,0	1,0	4,4	0,0	2,1	2,6
<b>Total</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>	<b>100,0</b>
<b>CR4 sub category</b>	61,9	70,5	65,7	55,3	68,3	62,7	48,3	65,1	61,3
<b>HI sub category</b>	0,129	0,153	0,131	0,122	0,185	0,127	0,105	0,133	0,128

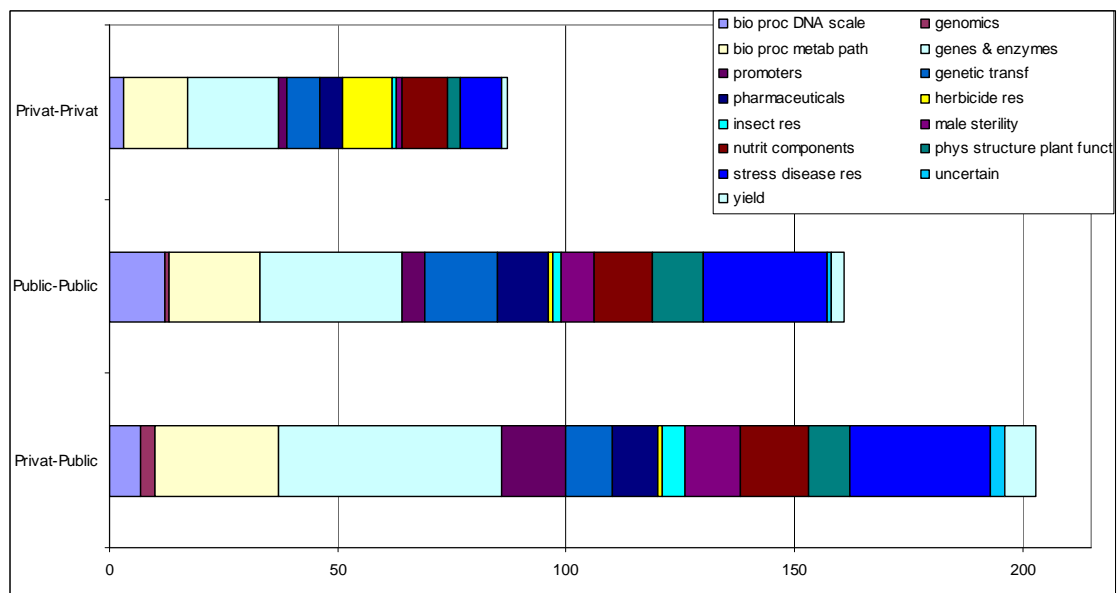
Source: elaboration on ep.espacenet.com data

### 3.1.3 Collaborations

In terms of collaboration, results show that almost the 7,7% of patents comes from synergies:

3,5% private/public, 2,7% public/public and only 1,5% private/private .

**Figure 2 – Patents distribution by collaboration typology (2002-2009)**



Source: elaboration on ep.espacenet.com data

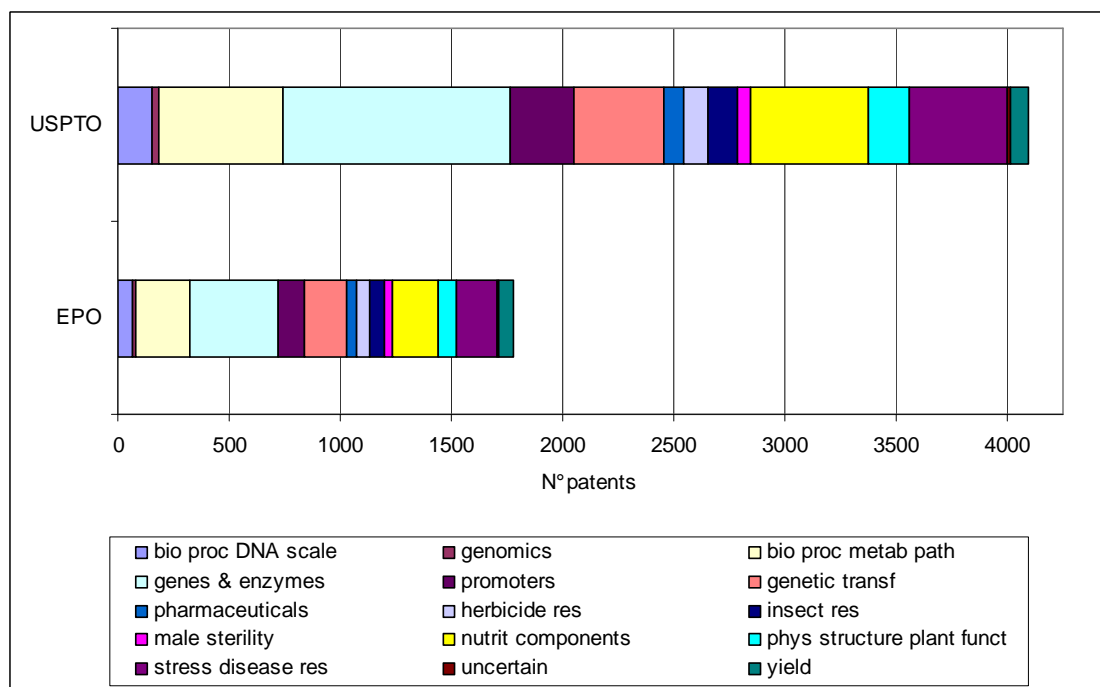
We observed that the main field developed by collaborations is ‘genes & enzymes’ (figure 2). In general collaborations focuses on basic research, and the target of collaboration between public institutions are ‘stress disease resistance’ and ‘nutrient components’ suggesting an interest in improving agricultural development and increase food security in poor countries with drought and soil salinity problems.

In contrast private sector collaborations are clearly market oriented, as suggested by patents filed in herbicide resistance category.

### 3.2 EPO vs. USPTO

This chapter reviews the empirical data in order to analyze the two different patent systems in terms of characteristics of public research, main countries involved and international patents flow. The analysis of sub categories distribution (figure 3), excluding cultivars, gives information about trend in R&D expenditure. Results show no significant differences between the two patent systems. In particular, data underline the important role of ‘genes & enzymes’ category followed by patent in ‘bio processes/metabolic pathways’, ‘nutrition components’, ‘genetic transformation’ and ‘stress disease resistance’; altogether these five categories account for more than 70% in both the systems.

**Figure 3 - Patents distribution by patent office and sub categories (2002-2009)**



Source: elaboration on ep.espacenet.com data

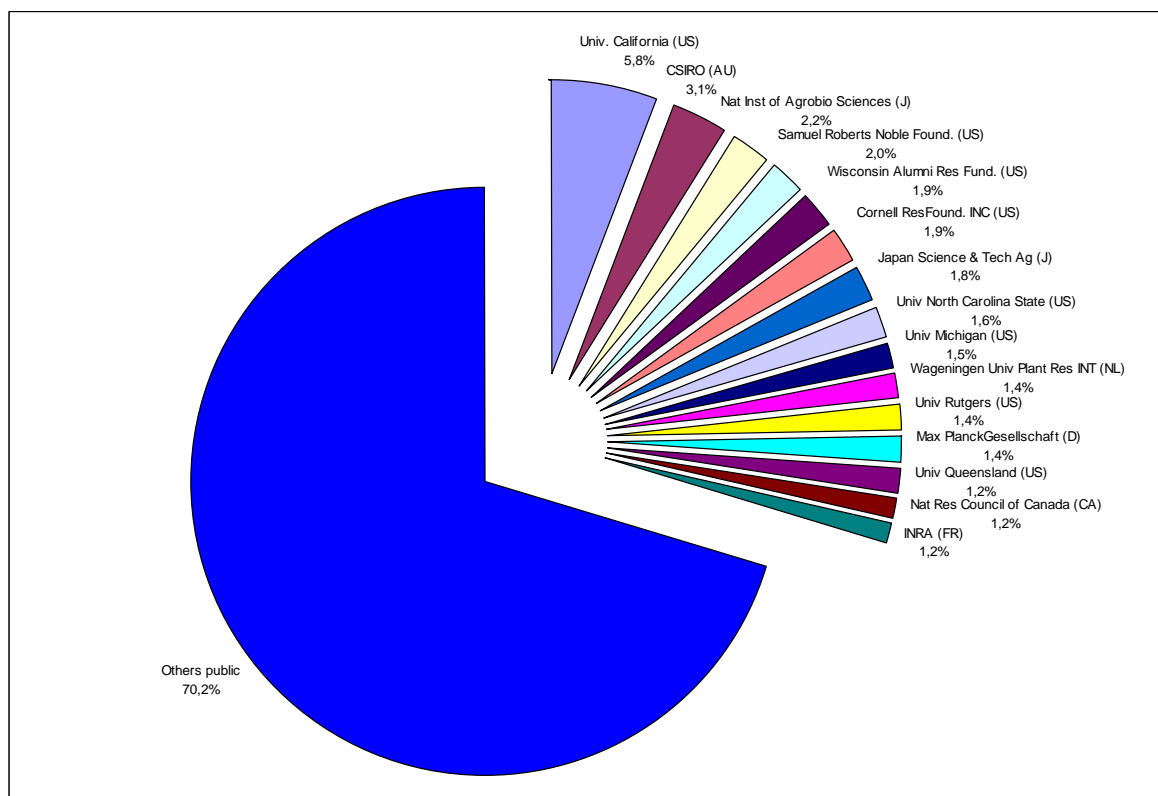
Focusing on public sector and his strong fragmentation, we note that despite the total number of applicants (369), public institutions that account for more than 1% in patent granting are 22, 10 from US, 4 from Japan and 4 from European Union and 1 from Australia, Canada and Taiwan. We also note a major role of American universities, in particular, according with Graff et al. (2003) the University of California account for the 5,8%, a very high contribute within the public sector.

Public sector, with 31% of total patent, is significantly present in most of all technology areas, but it still confirms a scarce activity in the most strategic areas from the commercial point of view (herbicide and insects resistance, beyond cultivars). The comparison of the concentration of patents owners shows that there is an high degree of diversification in the public sector (the first four public research institutions in terms of number of patents owned represent 13% of total).

Furthermore, the number of public patent filed at EPO is only the 38% of the ones filed at USPTO, but this ratio remains quite constant in each technological categories analyzed.

A deeper analysis of public sector takes into consideration the role of different actors involved in agbiotech research in terms of typology (table 5). In the European patent system is important to underline the main role of both universities and research institutes, while in the other the research institutions are almost absent. Comparing the two systems at macro category level we observe a similar trend, suggesting that interest of public actors both in EU and Us is oriented to the same subjects.

**Figure 4 - Distribution of assignment of public patents (2002-2009)**



Source: elaboration on ep.espacenet.com data

**Table 5 – Public domestic actors: EPO vs. USPTO (2002-2009)**

EU in EP	bio processes DNA scale	bioprocesses	genetic transformation	pharmaceuticals	plant technology	Total	%
Collaboration	4	7	3	1	7	22	13,8
Research instit.	2	24	4	1	27	58	36,5
Gov	0	3	0	0	2	5	3,1
No-profit	1	3	0	0	3	7	4,4
University	6	39	5	3	14	67	42,1
<b>Total</b>	<b>13</b>	<b>76</b>	<b>12</b>	<b>5</b>	<b>53</b>	<b>159</b>	<b>100,0</b>
%	8,2	47,8	7,5	3,1	33,3	100,0	
US in USPTO	bio processes DNA scale	bioprocesses	genetic transformation	pharmaceuticals	plant technology	Total	%
Collaboration	0	11	2	3	15	31	4,6
Research instit.	0	0	0	0	2	2	0,3
Gov	0	3	1	0	10	14	2,1
No-profit	2	27	9	9	24	71	10,5
University	28	235	62	12	218	555	82,5
<b>Total</b>	<b>30</b>	<b>276</b>	<b>74</b>	<b>24</b>	<b>269</b>	<b>673</b>	<b>100,0</b>
%	4,5	41,0	11,0	3,6	40,0	100,0	

Source: elaboration on ep.espacenet.com data

The analysis at country level shows a significant difference between the two patent systems (figure 6). In particular, foreign applicants in the EPO accounts for more than 68% while in USPTO the rate is less than 50% suggesting that EPO is a patent system less attractive for foreign applicants, probably related to greater regulatory constraints. Nevertheless, these results depends on the high difference in terms of patents number granted in USPTO and EPO. In fact, in the United States almost 1.800 patents to 4.103 come from abroad while in Europe the overall figure is slightly above 1200 with a gap, in the references period, of 600 patents approximately. This suggests a lower attractiveness of the European patent system which also underlain a lower capacity to agbiotech research, conditioned by a political climate less supportive of biotechnology (especially for final products). However, all stakeholders from different countries, including Europeans, have patented more in the U.S. than in Europe (4.103 vs. 1.779). This data, in part due to disregard patents previously registered at the other system, are related to european multinational firms activity. In fact, patents granted by european public sector in two different systems are approximately equal, while US public stakeholders have filed on USPTO 673 patents and on EPO only 123.

Furthermore, in the period 2002-2009, US public actors share in USPTO was 16,4%, while for the european one at EPO was only 8,9%. This probably mean that a greater possibility of development of public research system in US can attract additional resources for the the overall research.

**Table 6 – Foreign actors and public research: EPO vs. USPTO (2002-2009)**

European Patent Office				
	Total		Public	
	N°	%	N°	%
Us	628	35,3	133	7,5
Japan	144	8,1	71	4,0
Switzerland	90	5,1	2	0,1
Australia	65	3,7	41	2,3
Canada	46	2,6	29	1,6
<b>Total</b>	<b>1779</b>	<b>100,0</b>	<b>500</b>	<b>28,1</b>
Ue in EPO	561	31,5	159	8,9
United States Patent and Trademark Office				
	Total		Public	
	N°	%	N°	%
Eu	746	18,2	163	4,0
Japan	270	6,6	163	4,0
Switzerland	129	3,1	0	0,0
Canada	117	2,9	85	2,1
Australia	116	2,8	85	2,1
<b>Total</b>	<b>4103</b>	<b>100,0</b>	<b>1329</b>	<b>32,4</b>
Us in USPTO	2329	56,8	673	16,4

Source: elaboration on ep.espacenet.com data

In the european union total public patents show a high rate of specialization in the category: bioprocesses DNA scale, pharmaceutical, male sterility and yield (table 7). The public research in USPTO shows no specialization. More interesting is the framework for public actors of the main countries: US public research is more specialized in genomics, pharmaceuticals and herbicide resistant; public research in Europe is specialized on basic research (bioprocesses DNA scale) while shows no specialization in genomics and in the category characterized by a greater possibility of practical applications (applied research), with exceptions concerning the categories male sterility and yield.

The available data for Japan, Canada and Australia shows different degree of specialization, but needs to be checked by extending the analysis to its patent systems.

**Table 7 – Specialization (SRTA index) of public research by actors (2002-2009)**

	bio proc DNA scale		bioprocesses			genetic transformation	pharmaceuticals
	bio proc DNA scale	genomics	bio proc metab path	genes & enzymes	promoters	genetic transf	pharmaceuticals
Public_EP	0,14	-0,03	0,07	-0,03	-0,05	0,04	0,14
Public_USPTO	-0,06	0,00	-0,03	0,01	0,02	-0,01	-0,06
Public_US	-0,13	0,20	0,06	-0,06	-0,03	0,04	0,12
Public_EU	0,24	-0,30	0,07	0,09	-0,08	-0,17	-0,05
Public_Japan	0,11	-1,00	-0,21	0,16	0,15	-0,15	-0,09
Public_Australia	0,14	-1,00	0,07	-0,04	-0,39	-0,09	-0,59
Public_Canada	0,05	0,50	0,07	-0,04	-0,25	-0,09	-1,00

	plant technology						
	herbicide res	insect res	male sterility	nutrition component	structure plant	stress disease res	yield
Public_EP	0,10	-0,40	0,22	-0,05	-0,10	-0,10	0,21
Public_USPTO	-0,01	0,10	-0,10	0,01	0,02	0,02	-0,06
Public_US	0,19	-0,07	-0,17	-0,02	0,05	0,03	-0,31
Public_EU	-0,63	-0,16	0,18	0,08	-0,22	-0,22	0,33
Public_Japan	-1,00	-1,00	-0,20	-0,03	0,01	-0,04	0,29
Public_Australia	0,08	0,58	-0,42	0,25	-0,10	-0,06	-0,28
Public_Canada	0,59	-0,19	0,15	0,21	-0,13	-0,09	-0,24

Source: elaboration on ep.espacenet.com data

## Conclusion

Our study is in accordance with the main findings of Graff et al. (2003) on public and private sector role in the US patent system; we provided a deeper analysis including the European one and focusing on patents concentration among sectors and categories.

The results give a basis for considering broader questions of science policy in agriculture, public-sector IP policies and the design of more effective IP management strategies to maximize the exploitation of patented technologies in this rapidly innovating industry.

The role of public sector in agbiotech basic research is confirmed both in Europe and in US and represents also a source of IP for innovative products.

The private sector, and in particular the 6 biggest firms that operate in the agbiotech sector, owns the majority of the IP; this suggests a great economic interest in the agricultural innovation, but it

also displays a partial shift from the first wave of innovations (mainly herbicide and insect resistance) to a new one characterized by nutritional components.

We also remark a diversification in the innovation typology development: the one involving the private sector is much more market oriented, in contrast with the activity of the public research that is focused on plant developmental processes (for example developing plants with abiotic resistance) useful in specific agricultural landscapes.

It's important to highlight that the number of patents filed to the EPO is never grown at the same rate of the patents registered in USA, this probably means a lower patent capability of the research in Europe in comparison with the American's one. To verify this hypothesis, we planned a further investigation using World Intellectual Property Organization (WIPO) data and the main national systems; and we also planned to extend the period of analysis. WIPO data permit to know the most important patents in biotechnology field, granted for countries. Finally, we are going to use these informations together with macroeconomic basic indicators such as GDP, High Tech Exports and expenditure in Research & Development both from industry and governments to understand international patterns involving economic dimension and growth.

An interesting perspective is linked to the data relating to trials of genetically modified plants in different countries (US, EU, CA, AU).

Further field of analysis is the identification of the path of individual agbiotech companies, spin offs and systems of technology transfer from public research.

#### 4. References

- Alston, J.M., Pardey, P.G. and Taylor, M.J. (eds) (2001). *Agricultural Science Policy: Changing Global Agendas*. John Hopkins University Press, Baltimore.
- Bergman, K. and Graff, G.D. (2007). The global stem cell patent landscape: implications for efficient technology transfer and commercial development. *Nature Biotechnology*, 25, 4: 419-424.
- Beuzekom, B., and Arundel, A. (2009). *OECD Biotechnology Statistics*. Organisation for Economic Co-operation and development.
- Bevan, M.W., Flavell, R.B., Chilton, M.D. (1983). A chimeric antibiotic resistance gene as a selectable marker for plant cell transformation. *Nature* 304:184–87.
- Bottiger, S., Graff, G.D., Pardey, P.G., Van Dusen, E. and Wright, B.D. (2004). Intellectual property rights for plant biotechnology: international aspects. *Handbook of Plant Biotechnology*. Paul Chritou and Harry Klee eds. John Wiley & Sons, Ltd, Chichester, 2004.
- Chan, H.P. (2006). International Patent Behavior of Nine Major Agricultural Biotechnology Firms. *AgBioForum*, 9(1): 59-68.
- Diez , M.C.F. (2002). The impact of plant varieties rights on research: the case of Spain. *Food Policy* 27,171–183
- European Commission (2001). *European Competitiveness Report 2001*.
- GMO-Compass, European Commission. <http://www.gmo-compass.org>
- Graff, G.D. and Zilberman, D. (2001). An intellectual property clearinghouse for agricultural biotechnology. *Nature Biotechnology*, 19, 1179-1180.

- Graff, G.D., Cullen, S.E., Bradford, K.J., Zilberman, D. and Bennet, B.A. (2003). The public-private structure of intellectual property ownership in agricultural biotechnology. *Nature Biotechnology*, 21, 9: 989-995.
- Graff, G.D., Cullen, S.E., Bradford, K.J., Zilberman, D. and Bennet, B.A. (2003). The public-private structure of intellectual property ownership in agricultural biotechnology. *Nature Biotechnology*, 21, 9: 989-995.
- Graff, G.D., Wright, B.D., Bennet, B.A. and Zilberman, D. (2004). Access to intellectual property is a major obstacle to developing transgenic horticultural crops. *California Agriculture*, 58, 2: 120-127.
- Griliches, Z. (1990). Patent Statistics as Economic Indicators: A Survey. *Journal of economic literature*, 28,4:1661-1707.
- Heisley, P.W., King, J.L. and Rubenstein, K.D., (2005). Patterns of Public-Sector and Private-Sector Patenting in Agricultural Biotechnology. *Agbioforum*, 8:73-82.
- International Service for the Acquisition of Agri-biotech Applications (2009). Global Status of Commercialized Biotech/GM Crops: 2009
- Lemaux, P.G. (2008). Genetically Engineered Plants and Foods: A Scientist's Analysis of the Issues (Part I.) *Annu. Rev. Plant Biol*, 59:771–812.
- Maredia, M., Erbis, F., Naseem, A., Hightower, A., Oehmke, J., Weatherspoon, D., and Wolf, C. (1999). Public Agricultural Research and the Protection of Intellectual Property: Issues and Options. *AgBioForum*, 2:247-252.
- Pakes, A., (1985). On Patents, R&D, and the Stock Market Rate return. *Journal of Political Economy*, 3,92.

- Pray, C.E. and Naseem, A. (2005) Intellectual Property Rights on Research Tools: Incentives or Barriers to Innovation? Case Studies of Rice Genomics and Plant Transformation Technologies. *AgBioForum*, 8(2&3): 108-117.
- Schmookler, J. (1966). Invention and Economic Growth. *Cambridge, Mass.: Harvard Univ. Press*.
- Schmookler, J. and Brownlee, O.H. (1962). Determinants of Inventive Activity. *A.E.R. Papers and Proc.* 52: 165-76.
- Shoemaker, R., Harwood, J., Day Rubenstein, K, Dunahay, T., Heisey, P., Hoffman, L., et al. (2001). Economic issues in agricultural biotechnology (agriculture information bulletin no. 762). Washington, DC: USDA ERS Resource Economics Division.
- Soete, L.G., Wyatt, S.M.E. (1983). The use of foreign patenting as an internationally comparable science and technology output indicator. *Scientometrics* 5,1
- USDA Foreign Agricultural Service (2008). GAIN Report Number: IT803.
- Yancey, A. and Stewart, C.N. (2007). Are university researchers at risk for patent infringement? *Nature Biotechnology*, 25, 11: 1225-122.