**The London School of Economics and Political Science**

# *From Public Understanding of GMOs to Scientists' Understanding of Public Opinion. A case study of the listening capacity of scientists in the UK and Italy.*

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## Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).



I warrant that this authorization does not, to the best of my belief, infringe the rights of any third party.

Dedications and Acknowledgments:

I dedicate this dissertation to my partner Enrico Bortolazzo, who made it possible, and our baby, who is about to be born.

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Abstract:

Genetically modified organisms have been accompanied by hopes and concerns regarding the potential of this technology to reshape agricultural practices, our environment and the food we eat. The controversy surrounding GMOs raised questions regarding the present and future relationship between science and society. This thesis contributes to this debate by exploring GM scientists' thoughts about public opinion and its influence on their work. I contend that how scientists listen to public opinion is mediated by national context, which I explore through a comparison of the United Kingdom and Italy.

Within the public understanding of science, and social studies of science more generally, the listening capacity of scientists has largely been ignored. Asking if, how and under what conditions GM scientists listen to public opinion on GMOs, I address this gap in the literature. A mixed method approach is used to answer these questions. This combines descriptive statistics with a range of qualitative methods, including narrative analysis, case study and situational analysis. This methodological approach is meant to bridge qualitative and quantitative methodologies, historically polarised within PUS scholarship.

This thesis is structured by my own changing understanding of the listening process. Initially, I assumed a stimulus-response model of scientists' listening, in which the public talks and scientists respond. Following my data collection and analysis, I developed a new model for listening that includes three moments: hearing public opinion, interpreting it, and responding to it. Using this model, I identify two typical patterns in GM scientists' listening process. Both of these patterns are associated with the 'deficit model', which scientists used differently according to their national contexts. Drawing on Jasanoff's (2005) concept of civic epistemology, I contend that these patterns are indicative of scientists' civic epistemologies, which are informed by a number of different factors.

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## Chapter One

## Introduction

> I could not have imagined, nearly eight years ago, when this newspaper was launched and I began this column with one in praise of the tomato, that I would one day write in the same space about a genetically engineered tomato. But such a tomato, Flavr Savr, has just been approved (it was voluntarily submitted by its maker, Calgene) by the US Food and Drug Administration.
>
> The qualities of the Flavr Savr, which is expected to reap a bonanza for its creators (Calgene has a joint development agreement with Unilever, the world's largest maker of margarine), are that it stays firmer and ripens longer on the vine. This has been achieved by isolating the gene that produces polygalacturonase (PG) and reversing its action. PG is responsible for ripening a tomato. Ripening is a form of decay; PG breaks down the pectin in the tomato's cell walls and allows it to decay (ripen) and spread its seeds. By reversing the action of the gene, the process is delayed. (Botsford, *The Independent*, 1994)

The above quote describes the first genetically modified product that left the laboratory to become commercially available to the public. Ironically, when read from today's perspective, feature writer in *The Independent* Keith Botsford forecasts a financial bonanza for the developers of this biotechnologically produced tomato. However, as we now know, such wealth never materialised; indeed Flavr Savr was pulled from the shelves. The fate of this tomato is bound up in the somewhat surprising extent of public opposition to genetically modified organisms (GMOs), which caused GMOs to become less associated with hype regarding progress and profits and more with the politics of science in national and international controversies. These debates have, in turn, raised new questions about the relationships between science, the public and the governance of biotechnology. This thesis explores these relationships with a focus on GMOs. But while much of the scholarship on GMOs has focused on the relationships between the public and the government, this thesis instead asks how science itself is influenced by these controversies initiated by lay people's concerns. To do so, I compare the development of GMOs in the UK and Italy to see if and how public opinion shapes the science of genetic modification in two different national contexts.

It is well established that the European public reacted strongly against genetically modified products. The *Eurobarometer* series of surveys on biotechnology 2005, for example asserts that '[o]verall Europeans think that GM food should not be encouraged. GM food is widely seen as not being useful, as morally unacceptable and as a risk for society' (Gaskell et al, 2006: 4). Several public perception studies[1] have shown significant concerns about GMOs in both Italy and the UK. As members of the European Union (EU), the two countries have also shared similar views on the regulation of GMOs. However, there are important differences in these countries and their relationship to GM science. While Italy entered the biotechnology debate in the early 1990s, the British government had been developing a national framework to regulate biotechnology since the late 1970s (Torgersen et al, 2002). This framework is premised upon a clear differentiation between scientific and ethical matters, which contrasts with the ways Italian regulators see the moral and scientific parameters of GMOs as interconnected. In addition, the Italian government's lack of support for GMOs is marked even in comparison to other EU countries. Meanwhile, the UK is known as one of the most supportive countries within the EU in terms of agricultural biotechnology (Cantley, 1995). Finally, while Italy has only recently turned its attention towards the relation between science and the public, the UK has initiated much of the modern debate on the public understanding of science. In other words,

[1] For example, the Eurobarometer series of surveys on biotechnology (1991; 1993; 1996; 1999; 2002; 2005) and Marris et al. (2001).

while Italy and the UK share similar negative public opinion about GMOs, they structured the relations between lay people, the government, science in general, and GM science in particular, in very different ways. This makes these two countries interesting sites to study *whether* GM science listen to negative public opinion, *how* it gets translated into scientists' actions and narratives, and finally which factors influence the listening capacity of science.

This dissertation is situated in the Public Understanding of Science (PUS), which is centrally focused on the relationship between science and society. According to early *classical* PUS scholars, improving public understanding of science is crucial in order to increase people's support towards science and therefore guarantee society's wellbeing (Bauer, 2007). *Critical PUS* scholars argue that, rather than focus on the extent to which publics misunderstand science, scholars should instead attend to the ways in which publics come to understand science in their daily lives (Wynne, 1991; 1992; Irwin and Wynne, 2003; Epstein, 1996; 2000).

> In the real world people have to reconcile or adapt to living with contradictions which are not necessarily in their control to dissolve. Whereas the implicit moral imperative driving science is to reorganize and control the world so as to iron out contradiction and ambiguity, this is a moral prescription that may be legitimately rejected, or at least limited by people. They opt instead for a less dominatory, more flexible and adaptive relationship with their physical and social worlds. (Wynne and Irwin, 2003: 41)

In addition to these critiques, new biotechnological inventions like GMOs have emerged to challenge the institutionalized relationship between science and the public. In this context, PUS scholars have been actively developing new models that better describe, and normatively [re]frame, the relation between science and lay people. Along these lines, in the late 1990s, *classical* PUS scholars proposed the public engagement or dialogue model. This specifically flourished in order to respond to, and contemporaneously overcome, some of the many criticisms raised by *critical* PUS scholars.

Increasing public engagement with science and shaping the relation between these two actors in the form of dialogue are considered crucial steps in order to realise this new PUS model. However, numerous PUS scholars (Irwin, 2006; Wynne, 2006) argue that engagement and dialogue remain theoretical concepts from the unsatisfying practices.

> Control over the framework for engagement – whether a consensus conference, an attitudinal survey, a web discussion or a wider debate – constitutes an important source of power (Irwin, 2001). It can be imagined that governments will be very reluctant to relinquish this or to broaden the form of public talk beyond current democratic and epistemological assumptions. However, and as appears to be the case in the wake of GM Nation?, institutions that embark on such exercises may find themselves under considerable pressure to support them more fully and to take their outcomes seriously. The alternative – as may be experienced in certain European nations – is what can, very crudely, be labeled 'dialogue fatigue' as engagement exercises come to be viewed as ritualistic and diversionary. (Irwin, 2006: 316)

Better ways to engage publics and scientists with one another are thus needed. In this context, I contend that PUS scholars should pay more attention to how scientists learn about publics' opinions regarding their work. To address this topic, this thesis asks if, how and under what conditions scientists listen to public opinion regarding GMOs in Italy and the UK.

Asking this question requires a mixed methods approach, where quantitative and qualitative methods are used in tandem to explore different and overlapping facets of this topic. I begin the thesis by mapping out public opinion on GMOs through secondary analysis of the *Eurobarometer* series of surveys on biotechnology and primary analysis of newspaper articles on GMOs. This analysis aims to identify key events and changing trends in public opinion. I assume that 'if' scientists listen to the public, notable changes in agricultural biotechnology output (publications, patents and field trials) would happen *after* key events in public opinion. For this reason, in Chapter 3, I use descriptive statistics in order to explore the association between public opinion and scientific output. In order to further probe 'if' and 'how' public opinion shapes scientific activity, Chapter 4 examines GMO scientists' own narratives on this topic. Drawing on 21 interviews, I compare Italian and UK scientists to see if they narrate the role of public opinion in their work differently. Finally, Chapter 5 draws on the arguments of STS scholars that science is extremely local (Latour, 1987). Here, I compare two national projects on GMOs, namely the *Farm Scale Evaluation* in the UK and the *OGM in Agricoltura* study in Italy. Using a multiple-case study approach and situational analysis to interpret different data that relate to these two nationally-specific projects, I analyse how scientists 'listen' to publics in these specific projects, while identifying key political, social and economic factors that affect scientists' responses to negative opinion on GMOs in these specific cases. I complete this analysis by devising a model of the listening process, which I propose right before my concluding chapter. By exploring science on the receiving end of a communication process with society, I aim to contribute to PUS scholars' understanding of the relation between science and society.

In the rest of this chapter, I provide an overview of the development of agricultural biotechnology and its regulations, paying particular attention to Italy and the UK. In addition, I review the literature most relevant to this thesis, which includes both the Public Understanding of Science and the numerous sociological studies on the topic of GMOs. Furthermore, I discuss my analytical approach and the reasons that convinced me to compare Italy and the UK. I conclude with an overview of the whole thesis, including a synopsis of the six chapters that will follow.

**1. Agricultural Biotechnology: science and policy**

> Modern biotechnology did not spring full-blown from an instant of brilliant scientific inspiration. Nor did it instantly reveal its political potential. (Jasanoff, 2005: 32)

In this section, I begin by describing agricultural biotechnology, its historical evolution and the three generations of products around which it has been developed. I then address national and international policies on and regulations of biotechnologies, along with disputes that have arisen from the mid-1970s to the present. This historical overview has been developed by reviewing the work of several key analysts of European and US science policy, mainly Sheila Jasanoff (2005) and Helge Torgersen (Torgersen et al, 2002), as well as Les Levidow and Joseph Murphy (2006; 2007). In other words, and in relation to the epigraph, this review allows us to see how biotechnology, along with the politics of biotechnology, has developed over time.

*Agricultural biotechnology*

The word biotechnology combines the Greek words *bios* for life, *techno* for techniques, and *logos* for thought or principle (Pellegrini, 2006). According to the British historian of biotechnology Robert Bud, Karl Ereky, a Hungarian pig farmer, used this word for the first time in 1919 in order to describe that area of technology dealing with living beings (Bud, 1991). Today, biotechnology is normally understood as 'the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services' (OECD, 1982: 18).

As a scientific discipline, modern biotechnology finds its roots in Gregor Mendel's principles of inheritance (1860) and the development of molecular biology (Jasanoff, 2005). Paramount for the development of modern biotechnology was James Watson and Francis Crick's discovery of DNA's structure, which, with its 'double helix' mechanism, has become one of the most iconic images of the last century. Exactly twenty years after the decoding of DNA (1953), Stanley Cohen and Herbert Boyer, two molecular biologists from Stanford University, developed and patented a technique to systematically transform DNA (1973). Their strategy consisted of taking a DNA fragment, by means of enzymatic restriction, and inserting it into a plasmid, which is a non-chromosomal DNA molecule present in bacteria. Cohen and Boyer then reinserted the plasmid into the original bacterium. The new DNA segment, as well as the rest of the plasmid, was then expressed.

Rapid improvements followed, which allowed researchers to significantly broaden the spectrum of host organisms available for transformation to include a vast array of plants and animals. These changes were followed by an increase in technological control. Today there are several methods by which a bacterium or plant can be genetically modified. These include mechanical and biological methods, such as particle bombardment, direct cell injection, as well as viral and bacterial transformation.

With further technological development, there was an increasing demarcation between 'green' and 'red' biotechnologies. While 'red' biotechnologies were developed for therapeutic or medical purposes, 'green' biotechnologies were used to transform crops, farm animals and microorganisms for environmental purposes or food production. Under EU Directive 2001/18, the results of these transformations officially came to be known as Genetically Modified Organisms (GMOs). Definitions, however, are always somewhat slippery. Experts and non-experts alike have increasingly come to associate 'GMOs' with genetically modified plants, crops (GM crops) and the food products containing them (GM food). For the purpose of this study, I include GM crops and GM food under the GMO umbrella.

Experimental scholars' interest in, and ability to, genetically transform plants and other organisms have continued to expand. In addition to *basic research* in genetics and molecular plant biology, scientists have modified plants for three main purposes. *First generation* crops include plant varieties modified in order to alter their agronomical characteristics for the benefit of the producers (Hout, 2002). Typical examples are Bt maize, Bt cotton and Bt potato[2], all of which were genetically transformed in order to produce the so-called 'cry' protein that is naturally expressed in *Bacillus thuringiensis* (Bt) and is toxic to certain insect pests. Thus, farmers need to use fewer pesticides, which can make production easier, more secure and more profitable. Foodstuffs derived from Bt crops have been used for years for both animal and human consumption[3]. *Second generation* GM plants offer

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[2] Farmers have used *Bacillus thuringiensis* (Bt) as a natural pesticide since 1940. Recently companies have started to genetically modify crops to express the Bt toxin, thus the name Bt maize, Bt cotton and Bt potato. In 1999, the US began to grant patents for the Bt gene. Following various mergers, a few companies now own the technology. For example, Aventis, based in Belgium, was granted a patent on 'all transgenic plants containing Bt', while the US company Mycogen obtained a patented that covers 'the insertion of any insecticidal into any plants' (Khor, 2002: 25).

[3] For example, several Bt crops, excluding the Starlink variety, have been legal in North America for both animal and human consumption for more than a decade (Atherton and Atherton, 2002).

direct benefits to either consumers or the environment (Hout, 2002). A prominent example of a *second generation* GMO is Golden Rice, a variety of *Oryza sativa* rice transformed to produce beta-carotene, a precursor of vitamin A. While touted as a technological fix for malnutrition, Golden Rice has been controversial and, to date, has not reached the market (Jasanoff, 2005a). Finally, *third generation* crops include plant varieties modified in order to produce compounds useful in medicine, industry or science. Being the most recent application in agricultural biotechnology, these kinds of GMOs have not yet reached the market (Hout, 2002).

Following these guidelines and drawing on my undergraduate training as an agricultural biotechnologist, I summarise the differences between *basic research, first generation GMOs, second generation GMOs* and *third generation GMOs* in Table 1. Tables like this offer conceptual clarity, but also carry risks of oversimplification. Therefore, the table is meant to capture some recurrent tendencies in descriptions of GM crops and GM food by both experts and non-experts.

**Table 1 Classification of the four main areas of GMO research**

| | **Characteristics** | **Examples** |
|---|---|---|
| ***Basic research on GMOs*** | Every study and research on genetically modified plants and food aiming to answer basic questions of molecular biology and genetics. | Transgenic modified maize to study the development of the endosperm (Gutierrez-Marcos, J.F. et al, 2004); modified tobacco for the study of metabolic pathways of protein degradation (Cola et al, 2005); *Arabidopsis thaliana* modified to study the pathway of amino-acids (Jonathan D. et al, 2009). |
| ***1st generation GMOs*** | Crops genetically modified for the benefit of the producer, to increase agronomical characteristics of the plant variety and food products containing them. | Potatoes with increased resistance to poplar mosaic virus (Farnham and Baulcombe, 2006); tomatoes with increased resistance to wilt virus (Accotto et al, 2006); metabolic and environmental studies on Bt crops (Zhou et al, 2009). |
| ***2nd generation GMOs*** | Actual crops, and the foodstuffs they contribute to, genetically modified in order to either increase the nutritional values of the plants or improve their resistance to environmental stresses. | Rice with increased levels of vitamin A precursors (Khush, 2002; Hoa et al, 2003; Paine et al, 2005); (cooking) plant oils with improved fatty acid composition (Napier and Sayanova, 2005; Schmidt 2005; Wildung and Croteau, 2005); grains enriched with vitamin E (Cahoon et al, 2003; Dormann, 2003); vegetables with enhanced foliate levels; tobacco modified to increase resistance to low temperatures (Zhao L, 2009). |
| ***3rd generation GMOs*** | Plants genetically modified to produce medical, industrial and pharmaceutical compounds, intended for human or other consumptions. | Genetically modified plants to produce immunogenic compounds against Rabbit virus (Mikschofsky et al, 2009) and transgenic chloroplast for vaccine production against small-pox and related viruses (Rigano et al, 2009). |

*Biotechnology Policy*

Since the technique for cloning genes into foreign cells was patented in 1973, the economic and political potentials of biotechnology, as well as the ethical and safety issues associated with it, have captured much attention. In 1974, *Science* magazine published a letter by Paul Berg and colleagues, entitled 'Potential Biohazards of Recombinant DNA Molecules', calling for a cautious approach to biotechnology applications. The article begins with a description of the first and most important of the four recommendations proposed by scientists, suggesting a voluntary moratorium on DNA transformations until more scientific evidences in favour of this technology could be generated.

> First, and most important, that until the potential hazards of such recombinant DNA molecules have been better evaluated or until adequate methods are developed for preventing their spread, scientists throughout the world join with the members of this committee in voluntarily deferring the following types of experiments.
> TYPE I: Construction of new, autonomously replicating bacterial plasmids that might result in the introduction of genetic determinants for antibiotic resistance or bacterial toxin formation into bacterial strains that do not at present carry such determinants, or construction of new bacterial plasmids containing combinations of resistance to clinically useful antibiotics unless plasmids containing such combinations of antibiotic resistance determinants already exist in nature.
> TYPE II: Linkage of all or segments of the DNAs from oncogenic or other animal viruses to autonomously replicating DNA elements such as bacterial plasmids or other viral DNAs. Such recombinant DNA molecules might be more easily disseminated to bacterial populations in humans and other species, and thus possibly increase the incidence of cancer or other diseases. (Berg et al, 1974: 2593)

In February 1975, molecular biologists from all over the world gathered at Asilomar to discuss scientific regulations of genetic transformations. As the historian of science Susan Wright notes (1986; 2001), scientists at this conference appreciated the potential of biotechnology; however they felt that these would be better realised if carefully controlled. The following year, the US National Institute of Health (NIH) issued guidelines for DNA transformation. These were in line with scientists' proposals and created norms for conducting risk assessments and determining adequate laboratory standards (Torgersen et al, 2002).

The first European government to take a stance on biotechnology was the British one, with the launch of the Genetic Manipulation Advisory Group (1976), which gathered scientists, members of trade unions, companies and public interest groups (Torgersen et al, 2002). Two years later, the British government issued its first regulation on biotechnology, which required British scientists using recombinant DNA to inform the Health and Safety Executive. Over time, more European countries began to develop national regulations on biotechnology, including Sweden, Germany and France. Others, such as Italy and Greece, put the topic on hold. In doing so, these nations allocated the responsibility to the European Union, which itself postponed instituting regulations until 1986 with the 'Community Framework for the Regulation of Biotechnology' (Torgersen et al, 2002).

During the 1980s, the line between basic and applied research became increasingly blurred as industry became more involved in GMO research and development. Many biotechnology companies were formed during this time, including Celltech in Britain, Kabi in Sweden and Novo in Denmark. This shift from public institutions to private companies was met with renewed enthusiasm from national governments, which began to fund expensive projects to promote biotechnology research as part of their economic development (Torgersen et al, 2002). However, commercial applications also reinvigorated issues originally raised at Asilomar, but with some important differences. In 1975, it was scientists who argued for a precautionary approach in their own research. During the 1980s, however, a more diverse array of social actors became involved in the debates that were becoming increasingly polarised. Industry, government and science tended to emphasize possible advantages and profits of GMOs. In opposition, environmental

NGOs (like Greenpeace), consumer organisations and other, loosely organised, lay groups pointed to possible risks. Worried about the long-term effects, opponents of GMOs described the risks posed by these organisms, which had never been encountered in nature, as entirely 'new', and the consequences of their release as irreversible and unforeseeable, given that total absence of risk could not be proven.

Alongside the development of these debates, in 1982 Lindow and Panopoulos, scholars at UC Berkeley, sent a request to the NIH for the first field test of a genetically modified organism, known as the ice minus bacterium[4]. Only six years earlier NIH regulations would have defined experiments of this kind as too risky and banned their execution. However, after an initial rejection, in 1983 the NIH reviewed its decision in favour of the scholars (Krimsky, 1991: 115-120). As Jasanoff notes in the extract below, for some, this episode highlighted how far the scientific community had distanced itself from the precautionary atmosphere that had characterised Asilomar, and the inadequacy of NIH regulations in controlling commercial releases of biotechnology.

> Several events in the early 1980s highlighted the insufficiency of the NIH-RAC review process for controlling commercial biotechnology. The first challenge came when two University of California scientists, Steven Lindow and Nikolaos Panopoulos, sought permission to carry out a field test using 'Ice-Minus'. […] The RAC members who reviewed the application initially asked for some modifications but decided unanimously after a second round of review that the experiment was safe.
> The scientific community has travelled far indeed from its precautionary posture at the Asilomar conference. (Jasanoff, 2005: 50)

As the number of applications for release of biotechnology products increased, new technical and regulatory gaps were being identified in the NIH regulations.

[4] The ice minus bacterium is a member of the pseudomonias family and has been genetically modified to increase plant resistance to frost. It was suggested that it would have a significant impact on California's strawberry production (Jasanoff, 2005).

Thus, in 1986 the Office of Science and Technology Policy (OSTP) issued the 'Coordinated Framework for the Regulation of Biotechnology', which delegated the responsibility for overseeing and regulating developments in biotechnology to three agencies: the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA) and the US Department of Agriculture (USAD). In addition, it established the 'Biotechnology Science Coordination Committee', which provided a common regulatory approach across the three institutions. Overall, the framework, enforced by the OSPT, contributed to clarifying the US's opinion, which held that biotechnology products are similar to existing ones and therefore do not need special treatment (Jasanoff, 2005). This position was solidified at the international level in the same year, when the OECD issued the 'Recombinant DNA Safety Considerations' (1986) on the risk assessment of GMOs, which argued against special regulations for GMOs. However, somewhat inadvertently, this document ironically paved the way for the construction of recombinant organisms as a separate category (Torgersen et al, 2002).

In the late 1980s, the debate over whether genetically modified organisms should be classified as a new category of substance became central to the European Union, which had been observing member states' policies on biotechnology. The European Commission had previously opted for a horizontal approach to controlling biotechnology and proposed the 'Community Framework for the Regulation of Biotechnology' (1986). However, scientists and industry protested that the framework 'stigmatized' GMOs and argued for regulations that would follow the US example (Torgersen et al, 2002). Responding to these critiques, the European Commission issued Directive 219/90 on the Contained Use of Genetically Modified

Micro-organisms, and Directive 220/90 on the Deliberative Release of Genetically Modified Organisms into the Environment (1990) that, in attempting to achieve a compromise, failed to meet anyone's expectations. Concerns about the long-term and unknown effects of GMOs coming from the EU publics were addressed by a) focusing on the whole process of genetic modification, rather than just the product, b) including the possibility of public participation, and finally, c) acknowledging the nature of biotechnology as a 'problem'. However, legislation never met the many national issues raised by biotechnology and, as emphasised by Torgersen et al (2002) below, also failed to explicitly identify which risks, beyond the scientific ones, were being raised by the 'biotechnology problem'.

> By emphasising uncertainty, this regulatory solution tried to force together two apparently incongruent approaches to risk assessment, namely one that built on scientific evidences ex-post, and one that built on scenarios of hypothetical risks ex-ante. It also acknowledged the dual nature of the 'biotechnology problem' – technical as well as matter of public perception – without openly addressing issues beyond risk that could not be dealt with by scientific experts. This artistic and delicate balancing act attempted to bridge the gap between the different regulatory styles and public attitudes in various European countries. (Torgersen et al, 2002: 49)

The regulations' focus on scientific risks, rather than ethical and moral issues, intended to respond to scientists and industries' concerns and their demand for a purely scientific approach to regulation. Nevertheless, supporters of biotechnology perceived the Directives as somewhat ambiguous and open to interpretation. In particular, they argued that rather than an ex-post risk assessment approach typical of the US policies, the new legislation included hypothetical risk scenarios that, even though were supposed to be scientific, were clearly not scientifically proven. This attitude ultimately opened the way to the 'transatlantic conflict over agricultural biotechnology' that characterised much of the following decades and continues, even today (Murphy et al, 2006).

Significantly, Directives 219/90 and 220/90 elicited somewhat different interpretations across various EU member states. In Germany, for example, the Directives were seen as an opportunity to relax the quite strict local regulation of biotechnology, which was enforced by the former gene law (1990). The focus of discussion shifted from environmental concerns to the economic potential of the biotechnology industry, and Germany began to promote the deregulation of GMOs in Europe. The UK's reaction was rather more cautious. With the goal of taking a balanced approach to the opposing views on biotechnology, two separate committees were created, namely the Advisory Committee on Release into the Environment (ACRE) and the Nuffield Council. The former, made up of leading scientists, has been responsible for advising the government on the risks associated with the release of GMOs, on a purely scientific base. The latter focuses on ethical questions raised by biotechnology. Italy, on the other hand, decided to merge scientific and ethical issues and implemented the EU Directives by appointing an 'Interministerial Commission for the Investigation of Biotechnology', made up of a combination of scientific experts and policymakers. In Italy, the Directives and corresponding national policies did not resonate within the public arena, as opposed to the vociferous protests by farmers in France (Torgersen et al, 2002).

The years that followed the EU Directives were characterised by an increase in confidence towards both 'red' and 'green' biotechnology. For a short period of time, tensions over GMOs relaxed. Industrial compounds expanded significantly during this time (Torgersen et al, 2002), with the public discourse focused on 'progress' in medical technologies and research, as exemplified by the Human Genome Project.

> Progress in medical applications, which had become generally accepted, was one of the reasons the public opposition cooled in many countries where biotechnology have been vigorously contested. It was clear that such medical progress was intimately linked to various areas of biotechnological research. A range of highly welcome new drugs and vaccines had emerged over time. Forensic identification of suspects had made huge progress and had been accepted by courts of law; […] The Human Genome Project made great progress in the 1990s in developing methods of establishing the base sequence of various organisms and – ultimately – the human genome. (Torgersen et al, 2002: 58)

However, this discourse changed as the first genetically modified food entered the market. Introduced by two popular supermarkets branches, Safeway and Sainsbury, a tomato puree obtained from Flavr Savr, a GM tomato variety with reduced pectinase activity, entered the British market in 1996. Even though its sales initially exceeded those of its non-GM equivalents, in 1999, following consumer pressure, both supermarkets decided to withdraw the product from the market[5].

Beginning in 1996, three events created and/or highlighted differences in the politics of biotechnology in the EU when compared to the US. First, the spread of Bovine Spongiform Encephalopathy (BSE) alerted European consumers to matters of food safety, creating a very different social milieu around issues of food. Secondly, the first import of GM crops from the US triggered protests from the public and NGOs. Finally, the cloning of Dolly the sheep brought to the fore, at a global level, ethical questions about biotechnological innovations.

In a clear effort to control the situation, the European Commission issued Regulation 258/97 concerning novel food and food ingredients, which imposed

[5] http://www.ncbe.reading.ac.uk/NCBE/GMFOOD/tomato.html (last visit 24/07/2010).

labelling for any new products that contain GMOs, are substantially different from existing equivalents or raise ethical questions. Delays in implementation, due to industries' reluctance to label their products, resulted in an increase in public scepticism towards GM products. In this context, EU member states reacted against EU regulations and almost unanimously began to oppose GMOs.

The first public protest against the release of GMOs into the environment came from Austria in 1996 and was followed, a year later, by its government's decision to ban imports of GM crops and thus to deliberately violate EU regulations. A similar event happened in Greece, where the first GM field trial (1997) was met by NGO protests and the government's decision to ban GM oilseed canola. Furthermore, increasing concerns about GMOs pushed the French government to impose a two-year moratorium on the marketing of certain plants and drove the UK to an unexpected reversal of support towards biotechnology (Torgersen et al, 2002). Ultimately, after Denmark, Greece, France, Luxemburg and Italy had formally communicated to other member states their intention to suspend any further authorization to cultivate or commercialize GMOs, the EU Council decided to temporarily suspend approving GM products (Bauer and Gaskell, 2001).

By the turn of the century, the debate over GMO regulations had surpassed EU-US boundaries and entered the global arena. Canada and Argentina initially supported GMOs, mainly due to the large economic potential of these products for large-scale agricultural systems (Torgersen et al, 2002). However, integrating these products into other countries was somewhat more problematic. Brazil opted for a strict anti-GM policy in order to avoid labelling and to continue commercial trading with Europe. Only the recent agricultural crisis with soybeans pushed the Brazilian government to change its policy, and legalize GMOs (2003). In Japan, Australia and New Zealand, new food policies were established in 2001. These made labelling mandatory for foods containing over 5% GMOs in Japan and 1% for Australia and New Zealand (Withman, 2000). One year later, in October 2002, Zambia refused a shipment of GM corn from the United States to help reduce famine in southern Africa.  The Zambian Minister of Agriculture stated that these foods risked contaminating local crops, and could negatively impact the country's commercial trade with Europe (Boyd, 2003). This event raised broader social questions about the ability of GMOs to solve social problems such as famine, malnutrition, or economic underdevelopment. With the turn of the century, India and China, potentially the biggest markets for GMOs, restricted their support for agricultural biotechnology and decided against the commercial cultivation of GM crops (Rousu and Huffman, 2001).

In this extremely delicate context, between 2001 and 2003, the European Union issued Directive 2001/18 on the deliberative release into the environment of GMOs, and Regulations 1829/2003 and 1830/2003 concerning the traceability and labeling of GMOs and the traceability of food and feed products produced from GMOs. These regulations repealed Directive 220/90 and completed the early Regulation 258/97. Directive 2001/18, which directly appeals to the 'precautionary principle', reflects the EU's anti-GM position by setting a limit to the time period for trials (10 years with possible renewal) and also increasing the monitoring of GMO releases. Regulations 1829/2003 and 1830/2003, on the other hand, fill a regulatory gap in regards to labelling GM products that, through the years, had driven several European companies to opt for the voluntary exclusion of GM ingredients from their products and the spread of GM free labelling (Collavin, 2007). More specifically, the Regulations provided consumers with a system for tracking food products through the different steps of the food chain, set the 0.9% GMO threshold for food intended for both human and animal consumption and extended labelling of products containing GMOs to include food produced from GMOs[6].

Meanwhile the US, alongside Argentina, Mexico, Australia, New Zealand, Brazil and India, filed a formal complaint with the WTO against the de facto moratorium in Europe that was put in place in 1999. The final response from the WTO arrived in 2007, three years after the EU had voluntarily dismissed the de facto moratorium. This was held for four years at the community level, during which time no new products were allowed to grow or enter the European market. In addition, between 1999 and 2003, Europeans only planted one out of the 14 GM varieties already approved before the beginning of the moratorium[7]. In the following years, the moratorium has continued on a national level in three out of the five countries that originally requested it, namely France, Luxemburg and Greece. In Italy, which was among the proponents of the moratorium in 1999, the ban against GMOs did not continue, however a convoluted implementation of the EU Coexistence Recommendations for GM and non-GM products achieved similar results[8] (Collavin, 2007). In this context, it is interesting to note that a few years earlier, before Regulations 1829/2003 and 1830/2003 were issued, Italy was the first country to appeal to Article 12 of Regulation 258/97 to suspend the commercialization of BT-11

[6] http://ec.europa.eu/food/food/biotechnology/index_en.htm (last visit 24/07/2009)
[7] ISAAA Global Review of Commercialized Transgenic Crops 1998, 1999, 2000, 2001 and 2002.
[8] According to the current situation, 13 GM varieties that are judged to be safe in the EU are still illegal in Italy.

(Novartis), MON-809, MON-810 (Monsanto) and T25 (Aventis). Although the European Scientific Commission rejected the request, this episode resulted in the suspension of the national commercialization of the four varieties between 2000 and 2004.

The science and policy surrounding GMOs has increased in importance at the global level, involving environmental and social problems, along with economic and trade-related concerns. Two main positions prevail, which became entrenched over the years and have even extended beyond the original EU-US debates. The first of these two positions focuses on the products generated through biotechnology, leaves scientists responsible for defining and overseeing risks, and is primarily concerned with promoting the economic benefits of GMOs. The US has been the primary supporter of this position. The second position has flourished in Europe, but has recently received support beyond European boundaries. This position aims to protect citizens from both foreseeable and unforeseeable risks, attempts to address the environmental and safety consequences of large releases of GMOs more democratically, and is ultimately focused on the process through which new biotechnology products are developed and introduced into commerce (Torgersen et al, 2002).

For the purpose of this thesis, it is important to note that both Italy and the UK fall within this second position. Nonetheless, as shown in this section, Italy and the UK developed very distinct local ways to address the politics of biotechnologies. Although the UK began to address biotechnology and its regulations from the mid-1970s onwards, Italy left the issue to the European Union until comparatively late. In Italy, the government and policymakers have articulated one of the strongest concerns about GMOs[9] within the EU. Meanwhile scepticism in the UK spread mostly from NGOs and lay people. Finally, it is interesting to note that, whereas the boundaries between scientific and moral matters in regards to GMOs were never straightforward in Italy (Collavin, 2007), the British government has consistently opted for a clear separation between science and ethics (Torgersen et al, 2002). These differences suggest that blanket statements about the EU may distort state-level variations.

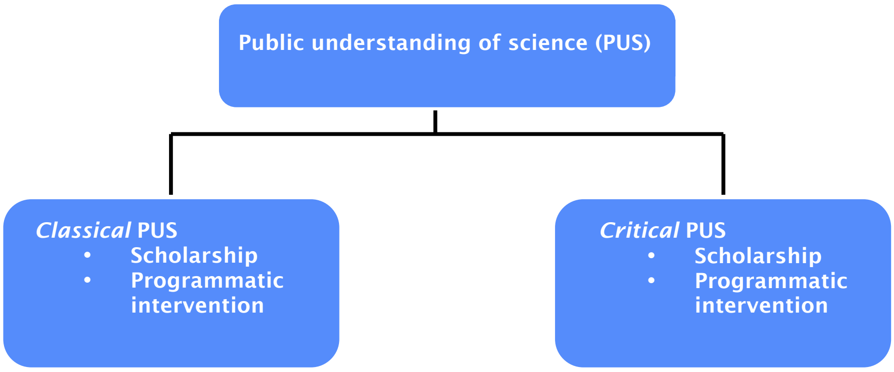
Comparing two nations that have historically been lumped together, but that approached the GMO issue in very different ways, can reveal the importance of local level political, social and economic factors that contribute to shaping scientific responses to negative public opinion. If the public's understanding of science is locally mediated (Wynne, 1991; 1992; 1996), it can be assumed that scientists' understanding of the public are also mediated by social, political, economic and cultural factors. On this basis, I compare the listening capacity of scientists in two different national contexts where negative public opinion is prominent.

## 2. Public Understanding of GMOs

My approach to the listening capacity of scientists is embedded within the Public Understanding of Science (PUS) scholarship and the recent sociological body of work on genetically modified organisms. I here provide a review of these two areas of study, with the intention of both describing them and positioning this study and myself. Given that many sociologists have written on these matters, I limit this review to those works that are crucial to the thesis.

[9] For further detail, see the Italian position on the EU moratorium and the government's appeal to article 12 of regulation 258/97.

## 2.1 Public Understanding of Science (PUS)




The contemporary period of Public Understanding of Science (PUS) research begins in 1985, with the Royal Society Report entitled 'Public Understanding of Science' (Royal Society Report, 1985). This document was followed by increased attention, largely from academics, towards the study of the relation between science and society, which has been renewed up until now. In order to review this broad body of work, I begin the section by exploring two opposite fields of scholarship that characterise the PUS, namely *classical* and *critical* PUS, and conclude with an overview of the PUS scholarship within the Italian and British contexts.

As an introduction to the *classical* and *critical* PUS, I present two vignettes that sociology scholars Alan Irwin and Mike Michael (2003) use to describe the two different approaches typical to the *classical* and *critical* PUS research.

> First vignette – 'A researcher calls at your home. You make her a cup of tea. After taking down some demographic details, she asks a series of questions about science and scientific method […] After the questionnaire (and the cup of tea) has been finished you are left wondering just how your 'scientific literacy' compares with the rest of the population.' (Irwin and Michael, 2003: 19)

> Second vignette – 'Your town is situated close to a chemical works and many of your friends and relatives work there. Occasionally you hear about things that have gone wrong at the plant: mishaps such as chemical spillages and gas release […] The chemical company holds a

> number of open meetings which you attend. Managers and scientists from the plant reassure you there is nothing to worry about. At the back of the room are two university lecturers –sociologists– taking notes.' (Irwin and Michael, 2003: 19)

I chose these two passages as they powerfully highlight the fundamental tension between *classical* and *critical* PUS scholarship. Not only will such research be experienced very differently by 'the public' that is being studied, as is illustrated by the vignettes; *classical* and *critical* PUS also reveal a clear methodological opposition between quantitative and qualitative studies. However, it would be simplistic to reduce the tensions to a mere methodological issue; rather, as Irwin and Michael (2003) argue, these two approaches embody two different models of the public, science, policy and understanding.

The history of the *classical* PUS field of scholarship begins right after the publication of the 'Public Understanding of Science' report (1985). At that time, the scientific community, as well as numerous western governments, expressed serious concerns about the *deficit* of knowledge and the lack of support for science coming from lay people. As we read in the quote below, taken from Martin Bauer's reconstruction of twenty-five years of PUS debate, early PUS scholars focused on lay people's knowledge, or lack thereof (Bauer, 2007).

> The literacy idea attributes a knowledge deficit to an insufficiently literate public. This *deficit model* serves the education agenda, demanding increased efforts in science education at all stages of the life cycle. (Bauer, 2007: 80-81)

Along these lines, PUS scholars hypothesized that lay people's support for science would grow in parallel with their levels of scientific understanding. Following these suggestions, throughout the 1980s and early 1990s, several governments decided to re-shape their scientific curricula.  In the UK, science became a compulsory subject for pupils up to the age of 16. The United States launched governmental programmes such as ‘Project 2061’, aimed to both explore and meliorate American students’ scientific skills (Gregory and Miller, 1998). However, the results of subsequent survey studies on public knowledge and perception showed no substantial increase in both public understanding of science and levels of support (Miller, 2001).

In the mid 1990s, the earliest doubts about a positive correlation between ‘knowledge of’ and ‘support for’ science began to emerge (Evans and Durant, 1995; Aldhous et al, 1999). Accordingly, c*lassical* PUS researchers turned their attention to science’s image, materializing their efforts within science museums, which were re-designed and opened up to a more interactive relation with the public (Gregory and Miller, 1998). However, surveys on public attitudes towards and understanding of science, usually commissioned by the national governments, indicated little change (Reif and Melich, 1991; 1993; Melich et al, 1996; 1999). And in 2000, with the House of Lords Science and Technology report (House of Lords, 2000), *classical* PUS scholarship experienced a further shift. In this document, both the strategic value of science and the need for more public support are reiterated. In addition, the report suggests that the relation between science and society need to be reshaped as a two-way communication process, one that engages the public directly. As Irwin notes from that moment on, ‘[t]alk of public dialogue and engagement has become fashionable internationally, and particularly within Europe’ (Irwin, 2006: 299).

Since the formulation of the knowledge *deficit* model, however, another body of scholarship has been challenging the classical PUS research approach. C*ritical* PUS places more emphasis on local context than cognition, and does not share with *classical* PUS research the same views on publics, science and society. Instead of following how *critical* PUS scholarship unfolded through the years, as I did with the classic PUS, I review the work of this group of scholars by focusing on Brian Wynne (1991; 1992; 1996) and Steven Epstein's (1996; 2000) studies. I chose these scholars and their works, not only because they played a crucial role in the development of *critical* PUS research, but also because, taken together, they provide a comprehensive picture of the key differences between the two PUS approaches.

The portion of Wynne's work I comment on focuses on how a sheep-farming community in Cumbria embraces its 'local knowledge' in order to fight experts' pronouncements of nuclear contaminations. In the study, the physicist-turned-sociologist Brian Wynne argues that local communities do not necessarily misunderstand science.  Rather, their experiential knowledge[s] lead them to conclude that science is inevitably prone to a degree of error, something that the government usually and unhelpfully refuses to acknowledge. This scepticism, in other words, is not so much towards science per se, as towards the government's science policy. American sociologist Steven Epstein, on the other hand, explores how the American gay community interacts with scientific researchers in the development and trials of AIDS treatments. Like Wynne, albeit in a very different scientific context and with a different kind of community (i.e. collective vs local), the American study shows how experiential knowledge can be incorporated into scientific knowledge production in order to produce 'better' forms of knowledge for those most implicated by the study's findings.

Importantly, the results of these and other studies by social scientists contradict the *classical* PUS assumption of a *deficit* of knowledge in the public, given that both ‘publics’ being researched show an experiential form of knowledge that is different from, but not inferior to, that of scientists. Furthermore, *critical* PUS scholars emphasise that the format of research, such as questionnaire surveys, can lead academics to frame people as simple repositories of knowledge. In addition, *critical* PUS research question the very idea of knowledge and suggest looking at scientific facts as the result of a negotiation process that occurs within society, and not simply within the ivory towers of science. In summary, *critical* PUS research tries to capture the complexity of concepts such as public, science and understanding through a much more local and contextual approach that is coupled with a more reflexive and complex idea of personhood.

With the development of a dialogue and engagement approach, the early critiques posed by *critical* PUS scholars have since been characterised by a normative tone. The engagement model aligns with *critical* PUS arguments that the relationship between science and lay people should be based on mutual, instead of unidirectional, respect. As Irwin (2001: 3) notes, this new model raises numerous questions among PUS scholars. Some of these questions are included in the excerpt below.

> [i]n this changing context, it becomes especially important to analyze the particular constructions that are being placed upon what we can term *scientific citizenship*. Does dialogue imply that public knowledges are given the same status as scientific understandings—or instead that familiar deficit notions of an uninformed public are recycled? Who, for example, gets to decide what counts as a legitimate problem for discussion? How are the *informative* (or information giving) and *consultative* (or information gathering) dimensions of participation to be balanced? What happens when public opinion is opposed to government policy—or, more likely, when certain shades of opinion are opposed but others are in favour? (Irwin, 2001)

A few years later, searching for possible answers to such questions, Irwin (2006) explored the ‘GM Nation?’ public debate, a government funded engagement exercise that took place in the UK over the summer of 2003. He argues that, regardless of recent attempts to incorporate *critical* PUS insights into the dialogue model, the *deficit* model persists. Echoes of the deficit model emerge, for example, in a new, and subtler version of the deficit model, that scholars call ‘deficit of trust’.

> Thus, one can detect that the old language of cognitive deficit increasingly is in competition with talk of a new form of deficit: this time a deficit not of scientific understanding but of *public* trust. Just as top-down communication was seen as the cure for the old deficit, greater openness and consultation can remedy the new one. (Irwin, 2006: 303)

Irwin thereby detects a frailty in the British attempt to democratize science, which other scholars have similarly noted in other EU countries (Horst et al, 2007). In this context, *critical* PUS research suggests governments and institutions reflect further on the impact that politics of dialogue might have on their traditional understandings of science, democracy and citizenship (Irwin, 2001; 2006; Leach et al, 2005; Pellegrini, 2005).

Building on more than a decade of work in the critical PUS, Sheila Jasanoff (2005) proposes the idea of public epistemologies (Jasanoff, 2005: 254). Jasanoff defines civic epistemology ‘the institutionalized practices by which members of a given society test and deploy knowledge claims used as a basis for making collective choices’ (Jasanoff, 2005: 255). Civic epistemology is empirically based, and therefore rejects some of the assumptions about the public that plague the deficit model, such as the ‘technically illiterate public’ (Jasanoff, 2005: 254). In addition, it forces scholars to look at citizens as active participants in the process of knowledge production (Burri, 2008). Finally, it proposes a more fundamental shift of focus from what the public knows about science to how knowledge is culturally constructed

(Jasanoff, 2005). In order to show the empirical validity of this concept, Jasanoff outlines six specific dimensions of civic epistemology[10], and contends that the analytical power of civic epistemology goes beyond the boundaries of academic discourses to become a conceptual tool for the development of future policies of science (Jasanoff, 2005). In the process, Jasanoff shows that the public understanding of science can be understood as a citizenship project that is enacted in different ways, in different social contexts. Following the focus on lay people, as valuable actors in the process of knowledge construction, Jasanoff emphasises that '[t]aken out of the context, the 'lay' subject can become in its way as much an ideal-type as the 'technically-illiterate' individual who sits at the heart of the deficit model.' (Jasanoff, 2005: 254)

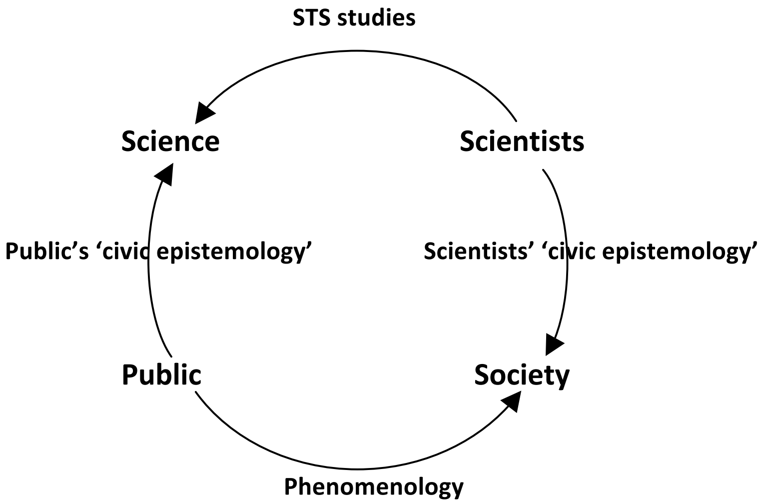
Scholars have both praised and criticised the concept of civic epistemology. For example, the Israeli political scientist Yaron Ezrahi (2008) suggests this concept allows Jasanoff to beautifully demonstrate that, although scientific knowledge might appear similar across countries, the ways it is integrated in society and legitimized differ profoundly. Somewhat less convinced, the British environmental activist and academic Robin Grove-White (2008) suggests that, besides its merits, civic epistemology on the one hand fails to underline the discontinuity within national patterns, and on the other hand does not acknowledge the relevance of international tensions and anxieties typical of the global scientific biotechnological nexus. Historian and philosopher of science from Melbourne University Rosemary

[10] The six dimensions identified by Jasanoff are: styles of public knowledge making, public accountability, demonstrations, objectivity, expertise and visibility of experts. The scholar uses this to compare Britain, Germany and the United States and show how national comparisons across these lines are likely to successfully capture cultural variations in knowledge production.

Robins (2008) suggests that, by focusing on policy, Jasanoff has left the local and contextual nature of science unquestioned, which therefore 'black-boxes' science as universally valid.

In answering the final critique, Jasanoff explains that the notion of civic epistemology grows out the idiom of co-production (Jasanoff, 2004), which implies a blurring of boundaries between nature and culture (or science and policy). In addition, Jasanoff argues that civic epistemology has the further benefit of allowing STS scholars to take a step forward and shift the attention 'from a primary focus on the production side of science, such as micro-practices within the laboratory, to a broader engagement with the reception side' (Jasanoff, 2008). I agree with Jasanoff that STS needs to explore how scientific knowledge is produced outside of its traditional institutional sites, such as the laboratory. And I think that the work of scholars such as Jasanoff and Wynne represents an important extension of PUS scholarship to address political issues. However, if we want to understand the publics' contributions to knowledge production processes beyond being mere receivers of information, we need to take an additional step.

While Jasanoff expands the concept of epistemology from scientific knowledge to also include public, lay knowledge, opening up relevant venues of analysis, this expansion is one-sided. There are many ways in which society 'knows itself', and sociologists of knowledge, as well as phenomenologists (for example see Alfred Schütz's work), have written on this extensively. In addition, STS scholars have sometimes studied how scientists learn about science (see Latour, 1987). Now, thanks to scholars such as Wynne and Jasanoff, we can also look at how the public knows science. However, what is still missing is a focus on what scientists know about society. In other words, it is crucial that we expand the concept of civic epistemology from being solely concerned with the public to also include the civic epistemologies of scientists. Within the broader engagement between science and society that Jasanoff suggests, it makes sense to ask not only how the public legitimizes scientific knowledge, but also if and what scientists know about society.




Having said this, I turn to a closer analysis of the British and Italian contexts, as they represent the primary foci of this thesis.

Interestingly, the UK, as a country, has probably initiated the greatest number of examples of PUS activities. The earliest date back to 1986, which is when the Committee of Public Understanding of Science (COPUS) was first appointed. The committee was intended to facilitate the communication process *from* science *to* the public. Shortly after its foundation, COPUS awarded several research grants to innovative research in the field of science communication, founded programmes aimed to increase practitioners' communication skills, launched the Rhône-Phoulenc book prize to encourage popular science writing (White and Stein, 2002), and finally ran the first survey on the British public's understanding of and attitudes towards science (1988). Two years later, the British Science Museum and the Institute of Physics founded the *Public Understanding of Science* journal. This rapidly became a place to publish scholarly research addressing the relation between science and society. Almost contemporaneously, Wynne's (1991) study on Cumbria nuclear pollution was published, inaugurating the British version of the *classical* and *critical* PUS debate. This debate, which was somewhat more intense than those in most other European countries, brought the UK to the forefront of PUS research. Inspired by both these bodies of scholarship, over the last two decades, UK PUS initiatives typically shifted from the PUS *deficit* model towards public engagement and dialogue approach. Examples range from public surveys in science literacy and perception (Gregory and Miller, 1998), to the 'Public Consultation of Development in the Biosciences' (1997), the 'GM Nation?' (2001) and, more recently, 'Sciencehorizons' (2007).

In contrast, Italian scholars began to contribute to PUS scholarship around the beginning of the twenty-first century. As a result, the *classical* PUS deficit research model and the more recent engagement dialogue approach tend to coexist in Italy and do not follow the temporal development seen in the UK. Therefore, different understandings of science and society are downplayed in the literature and emerge contemporaneously in Italian interventions. For example, I found that in a very short amount of time, Italy saw its first scientific literacy assessment ('Annuario di scienza e società', 2003), the launch of the Observa Foundation on the matter of science and society (2003), the opening of new science centres (Turin, 1998, Naples, 2001) and the first exercise in public dialogue with science (Casalino, 2003).

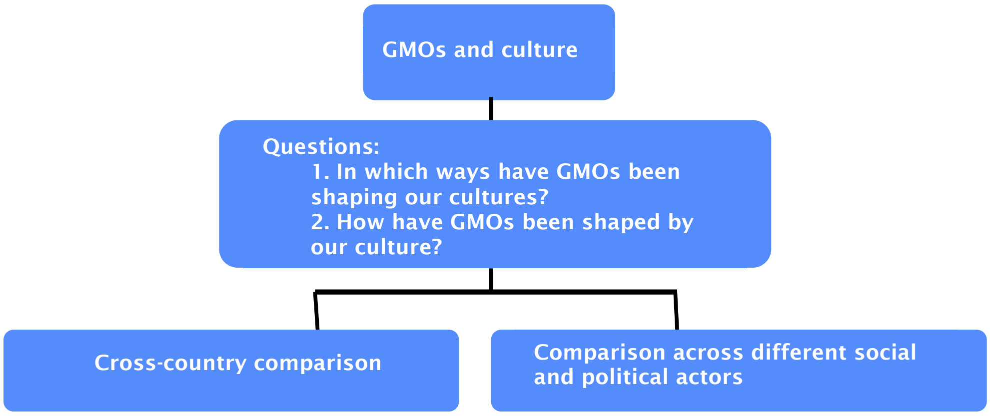
Importantly, almost none of these projects employed either a purely *classical* or *critical* PUS research framework, but rather tended to blend them together.

Reviewing PUS scholarship has been useful in order to both position this thesis within the existing body of literature and to structure the following discussion, which concerns social studies of GMOs. Asking if, how and under what conditions scientists listen to public opinion, I situate this work at the intersection between *critical* and *classical* PUS.

**2.2 Social Studies of GMOs**

The case of GMOs has been very prominent within PUS scholarship. In order to review the sociological body of knowledge on GMOs, a number of sub-categories are helpful to organise this vast literature. One set of studies focuses on how culture both influences the development of GMOs and is shaped by GMOs. A second group of literature could perhaps be classified as 'governance' studies, revolving around issues of regulation. A third stream of research focuses on the conflict and debates that have arisen around GMOs as a site of controversy. Finally, scholars have examined how publics perceive and understand GMOs. Of course, many individual publications cover concerns that cut across these categories. However, these four categories provide a basic structure for understanding the scholarship on GMOs to date. I provide an overview of the literature on GMOs according to these four categories, which I use to situate my own research and its contribution to the field.

*2.2.1 GMOs and culture*

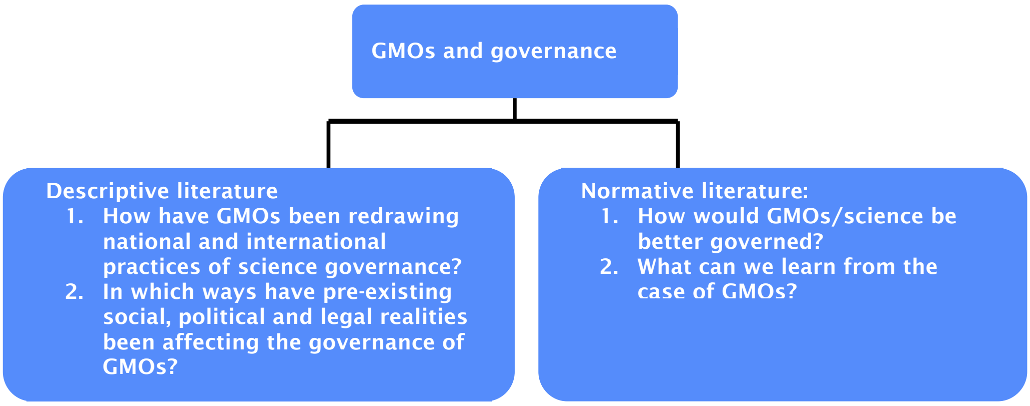



Working in parallel on nanotechnology and agricultural biotechnology, a group of British social science scholars suggest thinking about GMOs as nodal points around which numerous non-scientific issues condense, specifically a range of institutional and cultural factors (Kearnes et al, 2006). In particular, academics ask in what ways the scientific and socio-political nature of GMOs has been affected by pre-existing cultural values or, conversely, how the introduction of GMOs has contributed to shaping culture. The methodology used to explore these issues typically focuses on comparative studies. These have either taken the form of cross-country comparisons (Jasanoff, 2005) or have focused on the differences across various social groups within the same nation (Heller, 2007; Bonneuil et al, 2008).

Jasanoff's works (1995; 2005) contribute significantly to this area of inquiry. Comparing the UK, US and Germany, she explores the ways in which historical and cultural contingencies have influenced, and have been influenced by, the development of biotechnology. She identifies three specific approaches used by each of these nations when addressing GMOs. These approaches, which reflect tendencies that were already present in each country, have emerged in tandem with the development of biotechnology and led the US to understand GMOs as a product, the UK to consider GMOs as a process, and finally Germany to talk about GMOs as a programme. Along these lines, but specifically focusing on the EU-US contexts, social scientist Clare Herrick (2005) argues that as the public naturalizes biotechnology, new 'cultures of GMOs' are generated. These do not simply tell us what people think about biotechnology, but also unveil the ideological foundations of national regulations.

Nevertheless, GMOs have not only been the subject of cross-country comparisons. As American philosopher Zahra Meghani (2007) notes, technologies such as GMOs are not neutral, but rather embody numerous social, ethical, or political values that coexist within the same nation. Focusing on Frence, anthropologist Chaia Heller's (2007) work on GMOs indicates that, while small farmers refer to food production in terms of *techne,* scientists frame this process in terms of *technoscience*. As a consequence, while researchers normally recognise a rupture between nature and culture, small farmers believe agriculture guarantees a historical continuity between the two, one that is only interrupted by GMOs. Continuing within the French context, Christophe Bonneuil, Pierre-Benoit Joly and Claire Marris (2008) underline the historical transformation of people's understandings of GM-crop field trials. Somewhat similarly to Jasanoff's (2005) work on GMOs, albeit on a different comparative level, the group of sociology scholars conclude that this technology, along with the different social actors who participated in the GM debate, has been both the object as well as the subject of fundamental cultural transformations.

*2.2.2 GMOs and governance*




GMOs raise interesting questions about governance at both the national and international levels (Coleman and Gabler, 2002). Social scientists Les Levidow, Joseph Murphy and Susan Carr (2007: 4) define governance as a political concept that addresses the relations between different actors when dealing with collective problems and conflicts. Methodologically speaking, scholars take a cross-country, comparative perspective to explore governance issues (Jasanoff, 2005; Pellegrini, 2005; Levidow et al 2007; Satterfield and Roberts, 2008). Here, social scientists describe and normatively reflect upon GMOs as a case study in science governance.

Typically, descriptive studies of GMO governance take two different approaches. First, scholars explore how GMOs have affected national and international practices in science governance. Examples focus either on the state as an organism of power (Satterfield and Roberts, 2008) or on legislation (Lezaun, 2006). For example, in his study on legislation of GMOs, British social scientist Javier Lezaun (2006) suggests GMOs represent a 'momentous change' in the nature of governance of biotechnology. Specifically, he argues that, in concert with the spread of GMOs, the EU needed to develop a new bio-legal entity, which he calls a 'transformation event' and was used by the EU to define any conventional organisms transformed through the introduction of modified DNA sequences (2001). As such, the scholar uses this example to highlight the several intersections between science and regulation. Focused on the state as an organism of power, Australian scholars Terre Satterfield and Mere Roberts (2008) use GMOs to identify existing frailties in the power exerted by the Australian and New Zealand governments when governing science. More specifically, the scholars argue that, following public resistance to agricultural biotechnology, the governments of both these countries were forced to encourage public dialogue experiments. These were genuinely pursued in New Zealand, but remained a mere rhetorical instrument within the Australian context.

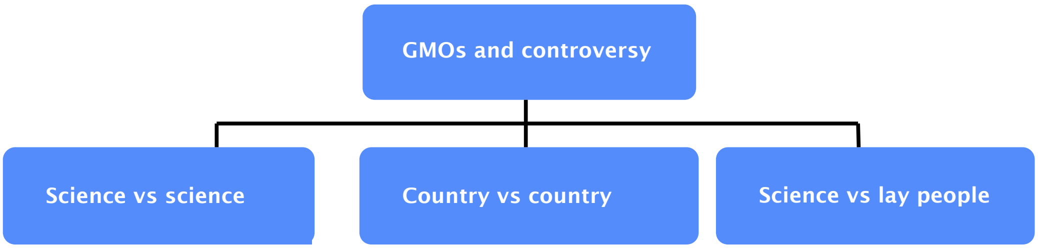
The second approach used to describe the governance of GMOs addresses the question from the opposite way around, exploring the ways in which pre-existing social, political and legal realities have affected the governance of GMOs (Murphy et al, 2006; Dibden et al, 2008; Levidow et al, 2007; Ramjoué, 2007). Murphy et al (2006), for example, highlight how European and American policymakers have used GMOs differently to support and move forward their own agendas. Within this same US-EU comparison, social scientists Aseem Prakash and Kelly Kollman (2003) use GMOs to explore the tensions between international policies and national legal and political frameworks.

Finally, scholars address the governance of GMOs from a normative perspective. In this context, they have asked two main questions: 1) how should GMOs be governed (Tallacchini, 2005; Hindmarsh and Plessis, 2009), and 2) what can we learn from the GMO case that can help us shape the future of science governance (Kearsen et al, 2006). The most common answer to the first question is exemplified by the work of an Italian group of STS scholars. Tallacchini (2005) and

Pellegrini (2005) specifically understand the problem of governance as a problem of democracy. Real democracy, they argue, is achieved only on those occasions in which an open dialogue among all the relevant actors involved in the debate is realised (Tallacchini, 2005). In this context, Pellegrini's (Pellegrini, 2005: 330-331) work demonstrates that, whilst the Italian government showed no willingness to include the public in the debate on GM field trials up until 2003, the UK activated several initiatives to facilitate lay people's and NGOs' engagement on the matter since 1999.

A normative approach to the study of GMOs has also been used by scholars to ask what went wrong in the governance of this technology and whether it could be avoided in the future (see for example, Einsiedel and Goldenberg, 2005; Mayer, 2002; Brumfiel, 2003; Wolfson, 2003; Mehta, 2004). Over fifteen years ago, French scholars Callon, Lascoumse and Barthe wrote a book on this matter. Its English translation, only published in 2009, is called *Acting in uncertain worlds* (2009). In this book, the authors contend that GMOs, like other modern technologies, challenged the double break between science and lay people, and politicians and citizens, imposed by institutional forms of delegative democracy. This has upset the normal balance between science and society, on the one hand, and citizens and politicians, on the other. In order to successfully overcome this situation, the scholars call for the development of hybrid forums, in which experts, non-experts, politicians and citizens come together to govern science and new technologies. Kearnes et al (2006) also talk about the lessons to be learned from GMOs. Unsurprisingly, and in line with the other normative works explored above, they emphasise the limits of the *deficit* model[11] and argue for a richer, more complex, nuanced and mature model of public engagement. Taking a different perspective, the UK House of Commons recently published a report reviewing stem cell and GMO national policies and regulations (House of Commons, 2010). In this document, we read about the failures of the government and GM scientists to engage members of the public in the process of knowledge construction and how the relationship between science and society is now changing with synthetic biology.

*2.2.3 GMOs and controversy*




Many historians and philosophers of science focus their work on the role that controversies play in the process of knowledge formation (e.g. Robert Merton, Thomas Kuhn, Ludwick Fleck). In addition, according to sociologist Dorothy Nelkin (1995), controversies provide interesting insights into our societies, 'offer a perspective on the politics of science and a means to explore public attitudes' (Nelkin, 1995: 445).

The early stages of the biotechnology controversy were set in 1975 at the Asilomar conference[12]. Since then, any biotechnology topic, ranging from stem cells to cloning and GMOs, has been a key site for studying the relationships between science and society through the lens of controversies.

[11] See section 2.1 'Public Understanding of Science'.
[12] See Biotechnology Policy for more detail.

Within the GM debates, scholars identify three tensions that resulted in controversy:

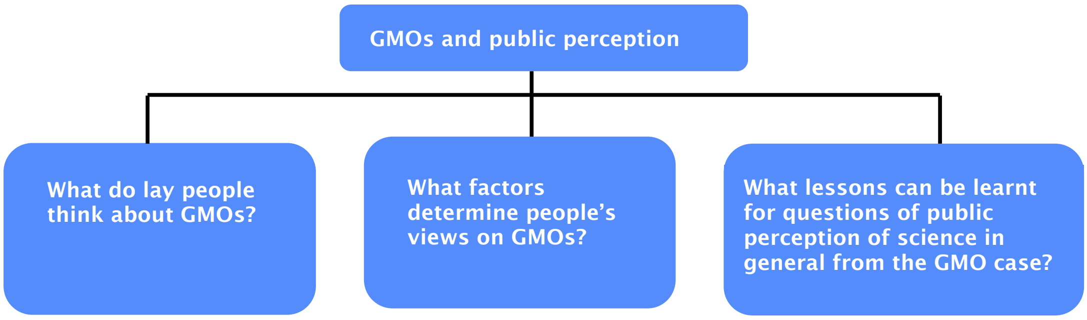
a) Individual researchers opposing GMOs against the majority of the scientific community;
b) Political cultures in favour of plant biotechnology versus ones against it;
c) Conflict between experts and non-experts.

Traditionally interested in the study of science as practice, the STS community typically explores controversies within science's boundaries (Latour, 1987). In the context of agricultural biotechnology, American scholar Jason Delborne (2005) highlights three major events that caused controversy within the GM scientists' community: a) the publication of Ignatio Chapela's work on the GM contamination of Mexican Maize (Quist and Chapela, 2001), b) John Losey's warnings about the harmful effects of Bt maize on monarch butterflies (Losey et al, 1999), and c) Arpad Pusztai's research on health risks associated with GM potatoes (Pusztai, 1998). The analysis of these episodes allows the scholar to illustrate the role of controversy in knowledge production and its variation within different social practices.

Interestingly, as the American zoologist and philosopher Donna Haraway (1997) notes, science is not independent from policy, and controversies take this concern to the forefront, calling attention to the policy within and around science (Delborne, 2005). In this context, the subject of GMOs is proven to be a successful site to observe power relations and contrasts between different political approaches and beliefs. American social scientist Tom Josling (1999), who compares EU and US policies on GMOs, observes how the two have fundamentally different understandings of the relation between policy and legislation, science and the public, respectively. Further, in his study on GMOs in developed and developing countries, Robert Paalberg (2002), American academic and journalist, argues that the decision taken by some high-income countries, such as certain EU nations and Japan, to stop imports from GM-growing countries represents a great disincentive to the production of GM crops in several developing countries.

Finally, controversies over GMOs have been increasing the number of encounters between science experts and members of the public. Nelkin (1995: 450) interprets dichotomies between experts and non-experts as signalling moral tensions between social actors who have different views on the role that science should play in our society. In this context, it is interesting to note that supporters of GMOs, such as scientists and researchers, argue that this technology will bring numerous benefits to society, from increased crop productivity to the reduction of pesticide consumption and the improvement of food quality (Dale, 1999). In stark contrast are the opinions of GMO opponents, who argue that GMOs will end up increasing the gap between rich and poor countries, upset the environment and ultimately lower food quality by increasing the presence of allergens (Ruibald-Mendieta and Lints, 1998; Gaskell et al, 2006). So, although GMO supporters seem to consider the science to be too important for the long-term interest of our society to let it be constricted by public concerns, GMO opponents campaign for the inclusion of ethical concerns in science policy, as well as increased public participation in scientific practices.

*2.2.4 GMOs and public perception*




As several academics argue, the controversy surrounding GMOs has probably been one of the most explored topics in terms of public perception of science (Jasanoff, 2005; Pellegrini, 2005). The literature on this matter asks three fundamental questions:

1. What do lay people think about GMOs?
2. What factors (e.g. knowledge, trust, risks-benefits, mass media etc.) determine people's views on GMOs?
3. What lessons can be learnt for questions of public perception of science in general from the GMO case?

In order to answer the first question, scholars have implemented different methods[13] and of course their results vary from country to country. For the purpose of this thesis, I concentrate on the literature that studies Europeans' views on GMOs, with a specific focus on Italy and the UK.

According to the PABE (2001), a qualitative study run in five EU countries[14] in the early 2000s, respondents were aware of both the strengths and weaknesses of

[13] Typical methods to inspect public perception of GMOs have included public perception surveys (Eurobarometer 2002, 2005; Observa public surveys on biotechnology, 2003; International Biotechnology Survey, 2005), qualitative studies (PABE 2001; Conférence de Citoyens 1998; UK National Consensus Conference on Plant Biotechnology 1994), and, less frequently, mixed methods research (UK Public Consultation in the Biosciences, 1999).
[14] The five countries inspected by the PABE are Italy, UK, Spain, Germany and France.

GMOs and shared ambivalent opinions about this technology. In addition, study participants showed more concern about the institutional contexts behind GMOs, rather the technology itself (Marris, 2001). Interestingly, as the *Eurobarometer* series of studies on biotechnology run between 1990s and 2005 highlight, interviewees perceived GMOs as a heterogeneous group of applications, distinguishing between GM food and GM crops. In this context, the 2002 *Eurobarometer*'s findings indicate that in EU countries where a majority of interviewees opposed GM crops, a majority also felt negatively about GM food. The study also notes that even certain nations supporting GM crops still opposed GM food (i.e. Belgium, UK, Germany and the Netherlands). Overall, this clearly points to GM food as the more controversial application under the broader GMO umbrella.[15] Finally, the survey emphasises that, even when comparing GM food with three other controversial technologies, such as nanotechnology, pharmacogenetics and gene therapy, study participants rated GM food as the most dangerous of the four (Gaskell et al, 2006).

The material produced by these public perception studies, which proliferated over the 1990s, represents a rich body of data to test different hypotheses on the factors that might determine public attitudes towards science. In relation to this, studies on the perception of GMOs fail to support the traditional hypothesis that holds there is a positive association between public perception and knowledge (Evans and Durant, 1995; Gaskell, 1999). In addition, recent studies on the relation between perception and trust (Gaskell, 1999; Knight, 2007; Sinemus and Egelhofer 2007) suggest considering the latter variable as a good indicator of the perceived benefits lay people associate with GMOs.

[15] In 2005, for example, 55% of Europeans indicated that they were supportive of GM food and 80% of them said they were familiar with this technology (Eurobarometer, 2006).

The mass media is another popular focus of scholars' attention in examining public perception of GMOs. This group of studies has to date shown contrasting results. In their work on press coverage on GMOs in the US, American scholars Susanna Priest and Allen Gillespie (2000) highlight that the tone of mass media is only weakly correlated with public perception. These findings, nevertheless, do not come as a surprise considering Alan Mazur's theory on mass media's impact on public perception of new technologies. In this context, the scholar significantly downplays the importance of mass media's tone in favour of levels of coverage. According to his studies on nuclear power, in fact, high levels of coverage are negatively correlated with people's support towards this technology (Mazur, 1981). Along these lines, it is interesting to note that recent studies on biotechnology (Gutteling et al, 2002; Gutteling, 2005) contradict Mazur's theory. In this context, social psychologists and expert in public opinion Martin Bauer George Gaskell (2001; 2002) propose an alternative strategy that, without arguing for any direct association between mass media and public perception, combines these two analytical tools in order to learn about public opinion. Explaining this idea, Bauer wrote: 'public opinion comprises two arenas that of the mass media and of everyday conversations and public perception.' (Bauer, 2005: 9)

Focusing on both mass media levels of coverage and content/tone, the scholars successfully overcome popular simplifications of public opinion to public perception surveys and are able to draw comprehensive pictures of national and international climates of opinion on GMOs (Durant et al, 1998; Bauer and Gaskell, 2001; Gaskell and Bauer, 2002).

Academics' reflections on the lessons that can be learned from the GMO case for questions of public perception of science in general, can be grouped into three main areas:

1. First of all, scholars emphasise that there is no standardized way to predict public perception of GMOs, just as there is no perfect way to communicate and govern GMOs across countries (Gaskell et al, 1999; Sinemus and Egelhofer, 2007). Furthermore, rather than seek a universal solution to frame the relation between science and democracy, scholars should try to develop 'an open and critical discussion between researchers, policy makers and citizens' (Irwin, 2001: 16).
2. Following a recent review of the GM debate in the UK, scholars such as Wynne and Irwin (Irwin, 2006; Wynne, 2006) contend that policymakers and scientists hold pre-conceived views of the public that might have a negative impact on the development of a constructive relation between public and science. In relation to this, it has been suggested that scientific uncertainties should be communicated openly to the public, rather than assuming that the public cannot appropriately deal with such uncertainties (Wynne and Irwin, 2003).
3. Finally, despite the clear intention to facilitate public dialogue with science that has been stated by several countries, including Italy and the UK, research on the GMO case demonstrates that such practice is yet to be realised (Irwin, 2006; Wynne, 2006). This reveals the persistence of unresolved questions concerning the epistemological role of the public in science and its governance, which urgently need to be answered in order to

take a step forward and either abandon the dialogue model or fully realise it (Irwin, 2006).

Undoubtedly, the ways in which publics have resisted GMOs (Bauer, 1995) have challenged not only science per se, but also some of the core assumptions of *classical* PUS research (Wynne, 1996; Bauer et al, 2007). In particular, this case has raised questions regarding how publics form opinions about science (Evans and Durant, 1995; Aldhous et al, 1999), with more cultural questions regarding nature/culture (Jasanoff, 2005) emerging alongside institutional questions of trust (Gaskell et al, 1999; Bauer et al, 2007). Reflecting on these issues, *classical* PUS scholars have proposed and developed new engagement and dialogue models (Bauer et al, 2007). However, according to *critical* PUS, this new mood for dialogue fails to substantially change PUS actions, but rather contributes to opening up new theoretical and, as we read below, practical questions (Irwin and Michael, 2003; Wynne and Irwin, 2003).

> In particular, as demonstrated by the House of Lords Select Committee Report, although the case of 'public dialogue' has been convincingly made, there is a substantial gulf between such discussion and particular examples of practical engagement. As the public consultation discussed in the previous chapters indicates, it may be easier to criticise the deficit model than it is to devise new mechanisms and methods of procedure. (Irwin and Michael, 2003: 62)

In this context, for those who believe that dialogue might represent the way forward to improve the relation between science and society, it is crucial to understand what the causes of such failures are, how to prevent them and what the important factors are that need to be changed to facilitate dialogue. In order to begin to answer some of these questions, this study focuses on science as its object of inquiry, building on the work of prominent sociologists such as Mike Michael, Brian Wynne and Sarah Franklin who focused on scientists, how they perceive the public, themselves and public engagement. In particular, I assume that dialogue must be reciprocal and suggest that the scientific end of the communicative process has been under-theorised. Finding inspiration in Jasanoff's concept of public civic epistemology, which I extend to scientists, the thesis focuses on how science is situated at the receiving end of the communicative process to ask if, how and under what conditions scientists 'listen' to public opinion, which I position as an active communicator, or 'speaker'. This new perspective requires significant reflections within both the *classical* and *critical* PUS scholarship and aims to enable a better understanding of the relations between science and society.

**3. Why compare Italy and the UK**

As a final note before I propose a summary of the entire thesis, I would like to spend some time discussing what convinced me to compare Italy and the UK. Many of the reasons behind this decision emerged as the chapter unfolded. However, I feel it necessary to review them before moving on with the thesis' methodology and content.

Comparison between two or more countries has often been used to propose 'the best' idea, practice or solution to a problem. Nevertheless, Sheila Jasanoff (2005) suggests that comparisons can also be used as a means of investigating the interactions between science and policy. In this thesis, I try to use comparison to look at the interactions between science and society. My aim is to explore the linkages between members of the public, science, technology, and other political, social and economic factors typical of modern democracies like Italy and the UK.

Following Jasanoff (2005), I assume that the comparative method works best 'when entities to be compared are different enough to present interesting contrasts, yet similar enough for the variations to be disciplined' (Jasanoff, 2005: 29).
As it turned out, Italy and the UK share these characteristics.

The similarities between Italy and the UK are considerable and fairly easy to identify. Both countries are economically and technologically advanced. They are both democracies, which balance freedom of research with ethical concerns. Furthermore, both countries are members of the EU. This is an element of similarity as it means that they share the same general regulations and approach towards new technologies. Finally, both countries experienced similar, negative, public reactions to GMOs, which made me wonder if science reacted in the same way.

Differences are also relevant. It should be noted that, although several studies concentrate on the European Union as a unit, as my study and others show (Torgersen et al, 2002; Jasanoff, 2005), the EU umbrella hides many interesting variations. These have largely been underestimated in the literature. For practical reasons, I organise the differences between Italy and the UK into three main groups. First of all, Italy and the UK have a different political approach to science. While the UK government opts for an expert-based approach to governing science and technology, one that tends to separate moral and scientific issues, in Italy, where humanitarian sciences are championed, ethical and social matters are mixed with scientific evidences. Second of all, it can be argued that the UK has initiated much of the modern PUS debate over the relation between new technologies and society, while this discourse only reached Italy in response to EU policy. Finally, whereas Italy is a latecomer in regards to GMOs and biotechnology policy, as this country delayed any regulations on biotechnology until the EU had developed a policy on this matter, the UK is the first EU country to develop national regulations on biotechnology. In addition, and with regards to GMOs, the Italian government's negative stance is notable even compared to the general uneasiness towards GMOs that characterises the EU; instead, the UK is usually considered the most supportive EU nation towards this technology.

A comparison along these lines is likely to be inspiring from the standpoint of increasing our understanding of the relationship between science and the public and how scientists listen, if at all, to public opinion.

**4. Overview of the thesis**

As many PUS scholars have argued, controversial topics such as GMOs often demonstrate the frailty of the dialogue/public engagement model. However, drawing on the literature review on PUS and GMOs, I found that far too little attention has been devoted to understanding the public as speaker and scientists as listeners. Therefore, I hypothesised that the latter approach might provide interesting insights to PUS scholarship, opening up new ways to think about dialogue and engagement. In order to explore this possibility, this thesis takes the case of agricultural biotechnology in Italy and the UK, and asks if, how and under what conditions scientists listen to public opinion on GMOs.

Chapter Two – Methodology

In Chapter 2, I present the methodology of this dissertation. I contend that asking if, how and under what conditions scientists listen to public opinion requires a mixed method approach. In this chapter I propose a description of each of the methods used throughout the thesis, including descriptive statistics, narrative analysis, case study and situational analysis. Finally, I argue that this approach tries to reduce the gap between qualitative and quantitative methods that has traditionally polarised PUS scholars.

Chapter Three – Public Opinion and Scientific Output of GMOs in the UK and Italy

In Chapter 3, I take my first step towards answering this thesis' broad question and ask if there is an association between public opinion of GMOs and agricultural biotechnology scientific output. The chapter is informed by quantitative measures and statistical analysis of both public opinion and scientific output. In this section, scientific output indicators include publications, patents and field trials, which are three common markers of GMOs scientific activities (Oldham 2006; 2007; Vain 2005). In addition, the analysis of public opinion merges secondary analysis of the *Eurobarometer* surveys with primary analysis of the content of opinion leading newspapers, which, as previous studies demonstrated, have led to successful analysis of public opinion of science (Gaskell and Bauer, 2002; Gamson and Modigliani, 1989). A graphically represented timeline serves to highlight specific trends and to identify ‘key moments’ within the development of either public opinion or science output.

This chapter does not aim to either ‘prove’ that there is an association or ‘determine’ a causal relation between public opinion and science output, but rather tries to establish whether such an association is at all possible.  Indeed, my findings do not allow for any definite conclusions regarding an association.  However, this analysis helps me hypothesize two possibilities, one in favour and one against an association between public opinion and scientific output, which I further define in the following chapters.

Chapter Four – GM Scientists’ Narratives of Public Opinion on GMOs in their Work

Chapter 4 draws upon the results and limits of Chapter 3. This chapter asks how researchers on GMOs perceive public opinion, its role on their own work and in their field of research more broadly. In order to answer these questions, I met with 21 Italian and British scientists in the field of agricultural biotechnology. Here I present the results of my interviews, which I analyse through narrative analysis. My approach exclusively focuses on what is ‘told’.

Looking through scientists’ eyes, I use these interviews to learn about how they experience their relations with the public, what kinds of narratives they develop in order to make sense of public opinion, how these affected their work, how scientists’ explanations differ across countries and finally, which factors researchers consider determinant in agricultural biotechnology practices. My analysis indicates that British scientists tell a story where public opinion indirectly affects their work and their field, through the government and private companies' actions. The story Italian scientists tell me is similar. However, in Italy all the attention is focused on the government, and how this influences GM research, whereas little room is allocated to public uneasiness towards GMOs. These findings not only shed light on Chapter 3's conclusions, but also allow me to talk with scientists, who are both the main object of inquiry of this study and the core actors behind my questions. In addition, this chapter helps me prepare for the following ones, in which I continue to focus on science, this time however looking at the process of listening and the social, economic and political factors that influence this.

Chapter Five – Comparative Analysis of Two Case Studies on GM Research in Italy and the UK

Chapter 3 shows that public support towards GMOs experienced a significant decline in both Italy and the UK. In addition, in both countries variations in the frequency of three main scientific output indicators of agricultural biotechnology are registered. Nevertheless, it leaves me unclear about the relation between science and society. In a way, it can be argued that this ambiguity in my data suggests that in order to understand if and how scientists listen to the public, I need to consider which factors, besides scientists and public opinion, inform this relation. Therefore, after extensively exploring public opinion and agricultural biotechnology, which are the key actors behind this thesis's questions, in Chapter 5 I take two research projects, the *Farm Scale Evaluation* (FSE) in the UK and *OGM in Agricoltura* study in Italy, and ask what political, social or economic factors contribute to scientific responses to negative public opinion.

The characteristics of these two case studies make them exceptionally useful to highlight the similarities and differences between Italy and the UK. In both cases, I choose a government-funded project, and in both cases I find it was popularised as a way to respond to public concerns on GMOs. Nevertheless, interesting differences emerge when looking at the ways in which the projects were designed, as well as the ways their results were communicated, or not communicated, to the public.

The data I use for this chapter range from mass media reports, government documents, scientific papers, websites and interviews with journalists and researchers. Through this comparative case study, I aim to situate this project in its social context. In addition, through situational analysis, I use this chapter to study which political, social and economic factors contribute to shape the relation between science and society.

Comparing these two case studies, I contend that there are six main factors that influence scientists' listening capacity. These include government, position and culture of science, private companies, types of publics, mass media and PUS academic debate. Finally, I contend that, as Wynne (2006) suggests, discourses of communication between science and society are positioned in close relation with the local cultures of science and policies.

# Chapter Six – Listening Capacity

This chapter provides a more substantial analysis of the listening process. Here, I take a different approach than the previous chapters, as I am using Italian and British interviews together to understand how scientists listen to public opinion on GMOs. This means that I temporarily put aside the comparative character of this thesis. This analytic approach allows me to investigate listening as a threefold process, which includes hearing, interpreting and responding to public opinion. The analysis of these moments suggests that scientists rarely hear public opinion directly from members of the public, while they frequently hear it through the mass media, NGOs or the mediation of the government and private companies. I contend that scientists frequently use deficit model discourses to interpret public opinion and that these interpretations also influence the way they hear, or fail to hear, the public's concerns about GMOs. Finally, I argue that, by following the deficit model, scientists are easily let off the hook and legitimize their decision to ignore public opinion. Other responses to public opinion include changes in the topics and forms of GM scientists' research projects and the GM field more broadly.

In concluding this chapter, I examine the two most common listening patterns, which I call *manufactured public opinion* pattern and *mediated public opinion* pattern, as well as some variations on them. Typically, the *manufactured public opinion* pattern starts with scientists hearing public uneasiness towards GMOs and interpreting it as manufactured by one or more malign actors, such as the mass media, NGOs and multinational companies. This pattern ends with scientists ignoring public opinion. In the *mediated public opinion* pattern, scientists hear the uneasiness of the public through the mediation of the government or private companies. Interpreting this uneasiness, scientists draw upon the deficit model, and end up proposing some changes to their research projects. Notably, only in the variations to these two patterns do public engagement repertoires emerge. I suggest that these patterns represent an example of scientists' civic epistemologies. Ultimately, I contend that this chapter brings the crucial role that government and private companies play in the listening process to the fore, but also shows that significant problems in this dialogue interfere with the ways scientists' listen to public opinion.

Chapter Seven – Conclusion

In this chapter I summarise the findings of this thesis, reflecting on their relevance in the PUS body of literature. In addition, I use this chapter to reflect on the possible implications of this study for both scientists and PUS scholars and ultimately make suggestions for future work.

## Chapter Two

## Methodology

> A methodology refers to the philosophical framework and the fundamental assumptions of research. (van Manen 1990 in Clarke, 2007:4)

This chapter is set up to present the methodological framework I use to analyse my data. As the epigraph indicates, the methodology of a project tells us about its philosophical approach and assumptions. As such, the methodology one uses influences significantly the procedures of research.

Sociology scholars have traditionally debated over the differing worldviews or belief systems that guide much of qualitative and quantitative research (Tashakkori and Teddlie, 2008 [1998]). Within this debate, positivists and constructionists are typically understood as the two opposite 'warriors' (Tashakkori and Teddlie, 2008 [1998]). Positivism, whose origins date back to French philosopher Auguste Comte, argues that the world out there is real and waits to be discovered. Thus, the task of sociologists is to develop general theories that *explain* how society works. Seeking causality and prediction in order to test hypotheses, positivist scholars normally use quantitative methods (Tashakkori and Teddlie, 2008 [1998], Creswell and Plano Clark, 2007; Alexander et al, 2008). Constructionists, in contrast, are typically associated with qualitative methods. Their goal is to explore and *understand* social life, assuming that there is no single reality out there, but instead a milieu that is socially constructed by those who inhabit it. The researcher is here considered part of the social construction of social life (Tashakkori and Teddlie, 2008 [1998], Creswell and Plano Clark, 2007; Alexander et al, 2008).

So-called 'purists' argue that quantitative-positive methods are incompatible with qualitative-constructivist approaches (see Guba and Lincoln, 1988). However, numerous scholars propose creative integrations between qualitative and quantitative methods (Tashakkori and Teddlie, 2008 [1998]). A paradigmatic example is American scholars Donald Campbell and Donald Fiske's (1959) multi-methods approach to psychological traits. This approach proposes a flexible alternative to the philosophical bypass that contrasts positivism with constructionist, opening the way for mixed methods studies.

Traditionally, mixed methods scholars frame the combination between qualitative and quantitative methods according to three possible philosophies. First, some associate mixed methods research with a third worldview, namely pragmatism. This philosophical approach makes the following assumptions: a) the research question, rather than the methods or the philosophical framework, should be at the centre of scholars' attention; b) a practical philosophy should guide research design, hence qualitative and quantitative methods may be used in a single study; c) the dichotomy between positivism and constructionism, as well as the metaphysical concepts of 'reality' and 'truth', should be abandoned (Tashakkori and Teddlie, 2008 [1998]). Somewhat in contrast, scholars such as Greene and Caracelli (1997) believe that multiple paradigms can coexist in mixed methods research. Coexistence, however, does not mean that the fundamental contradictions and oppositions between positivists and constructionists are overcome. Furthermore, the scholars argue that the dialectic approach that therefore characterises mixed methods research translates into a unique chance to elicit new and interesting perspectives. Finally, there are those, such as Creswell et al (2008, [2003]), who use mixed methods as a set of research practices that do not necessarily fit with a specific worldview, be it pragmatism, positivism, or constructionism.

Researchers who employ mixed methods are strongly encouraged to articulate and discuss their philosophical assumptions. The present study takes the third stance, defining mixed methods as a research design that typically integrates qualitative and quantitative methods (Creswell and Plano Clark, 2007) without prescribing a philosophical approach. This means that I do not necessarily follow the pragmatism perspective, nor do I suggest that positivist and constructionist approaches can co-exist. While I have been influenced by positivism, as I will discuss shortly, I believe that a constructivist perspective best describes my analytic perspective. Indeed, exploration and understanding are central to both the quantitative and qualitative analysis presented in this thesis. And, throughout this entire work, I will continually acknowledge the relevance of my role as researcher and its implications for my results. I am ultimately convinced that my interpretation represents one of the possible ways to understand scientists' capacity to listen to their public.

In following sections, I explore how scholars have been implementing mixed methods, and I give some details about this project's methodology and the main methods – descriptive statistics, narrative analysis, case study and situational analysis – that shape this thesis.

**1. Mixed Methods**

The history of mixed methods takes us back to the $19^{th}$ century (Alexander et al, 2008). However, over the last two decades there has been a renewed interest in defining mixed methods as a distinctive approach to sociological enquiries. Today, it is possible to find several books that collect, describe and explore the different issues related to mixed methods research (Greene and Caracelli, 1997; Newman and Benz 1998; Tashakkori and Teddlie, 2008 [1998]; Creswell and Plano Clark, 2007; Plano Clark and Creswell, 2008). Furthermore, in April 2007 the *Journal of Mixed Methods Research* was launched, with the specific aim of developing an international forum to communicate the latest developments in mixed methodology and establish common grounds to facilitate future progress (Tashakkori and Creswell, 2008). Finally, it has been noted that numerous private and public foundations, such as the National Institute of Health (NIH), the National Science Foundation (NSF) and the Robert Woods Johnson Foundation, have begun to sponsor research and workshops on mixed methods (Creswell and Plano Clark, 2007).

Somewhat central to the historical development of mixed methods is the discussion of which procedural guidelines make mixed methods independent and unique from other research designs. In this context there has been extensive use of visual representations (Steckler et al, 1992), notation models (i.e QUAL+quan, qual -› QUAN) (Morse, 1991) and design classifications (Greene et al, 1989; Patton, 1990; Morse, 1991; Steckler et al, 1992; Greene and Caracelli, 1997; Morgan, 1998; Creswell, 1999; Tashakkori and Teddlie, 2008 [1998]). According to John Creswell, Vicki Plano, Michelle Gutmann and William Hanson, experts in education and psychology from the University of Nebraska-Lincoln (Creswell et al 2008 [2003]), there are four core factors that need to be considered in developing and reading mixed methods studies: a) the implementation of data collection, b) the level of priority given to either quantitative or qualitative methods, c) the purpose and stage of integration, d) the theoretical perspective.  I draw upon these four factors to review the criteria behind the research designs of different mixed methods studies.

An important decision in designing a mixed methods study is the timing of data collection. It might be that both qualitative and quantitative data are collected together, or they can be collected separately. This decision usually depends on the research inquiries. For example, researchers in sport and exercise psychology Cecile Thogersen-Ntoumani and Kenneth Fox (2008 [2005]) prefer to collect their data in sequence, using the results of the cluster analysis of on-line surveys to develop and design 10 semi-structured interviews, which describe the degree of fit of each cluster. In contrast, American sociologist Darrell Luzzo (2008 [1995]), in his work on gender differences in students' careers, opts to conduct his interviews contemporaneously with his survey intervention.

It is somewhat more difficult to decide on the priority that should be given to the quantitative or qualitative research in mixed methods design. There are several factors that can motivate the emphasis given. It might be that data collection constraints determine emphasis.  For example, quantitative data collected first receive greater emphasis than interview data collected in a second stage, in Jill Aldridge, Barry Fraser and Tai-Chu Iris Huang's (2007 [1999]) study on the differences between classrooms in Taiwan and Australia. Sometimes, in contrast, the emphasis depends on scholars' genuine interest to understand one group of data more than another. For example, Karen Myers and John Oetzel (2007 [2003]), interested in developing a survey that effectively measured the degree of assimilation of new employees in a company, focus their attention on the quantitative phase of their study as a matter of choice.  Finally, researchers might be guided by their audience's preferences (Creswell, 2008 [2003]). As the American scholar Margarete Sandelowski (2008 [2003]: 301) argues, '[m]ixed methods studies present researchers with many challenges. Not the least of these challenges […] is how to present mix methods studies for mix methods audiences of researchers'. Nonetheless, qualitative and quantitative methods serve rhetorical purposes (Sandelowski, 2008 [2003]), and researchers might strategically highlight one method over the other in order to communicate new knowledge effectively to a particular audience.

I now turn the attention to the purpose and stage of integration of qualitative and quantitative data. Integration can be defined as the combination of qualitative and quantitative data (Creswell, 2008 [2003]). Importantly, as Sandelowski (2008 [2003]) notes, using qualitative and quantitative methods does not automatically mean that the two types of data and analysis will necessarily come together and be integrated. To demonstrate this point, she metaphorically associates qualitative and quantitative methods with apple and orange juice, arguing that researchers can drink both at varying ratios, either separately or blended together 'to create a new kind of juice that is either more apple juice than orange juice, more orange that apple juice or equally apple and orange' (Sandelowski, 2008 [2003]: 308). The first instance is, what Sandelowski calls, 'mixed company'. This is a design that she and her colleagues used to analyse the transition to parenthood in infertile couples (Sandelowski et al, 1992). This study combines qualitative and quantitative data, but analyses the data sets separately using 'like-to-like techniques' (Sandelowski, 2008 [2003]: 308). As the author explains, this means that 'qualitative techniques are used to analyse qualitative data', while – she continues –

‘quantitative techniques are used to analysed quantitative data’ (Sandelowski, 2008 [2003]: 308). Here, inferences may be drawn from findings across the data sets, but there is no need to combine the two methods. Alternatively, the second instance represents integration. The key here is that, because of the characteristics of the study, the two methods are necessary to each other and blended together in order to be interpreted.

Reviewing 57 articles on mixed methods, social science scholars from Cornell University Jennifer Greene, Valerie Caracelli and Wendy Graham (Greene et al 2008 [1989]) identify five possible purposes for integration, namely *triangulation, complementarity, development, initiation* and *expansion*. *Triangulation* recalls the paradigmatic work by Campbell and Fiske’s (1959) and involves viewing the same phenomenon from two or three different perspectives. For example Luzzo (2008 [1995]) utilises surveys and semi-structured interviews, merging the results in a final discussion where he argues that perception of boundaries might serve as a motivational factor in students’ career development. Somewhat similarly, sociologists Ellen Idler, Sawana Hudson and Howard Leventhal’s (2008 [1999]) use qualitative and quantitative data to examine perceptions and definitions of health, finding that those people who hold broader definitions of health, which go behind bio-medical conditions, typically overestimate their health conditions. Like Luzzo (2008 [1995]), Idler et al (2008 [1999]) only focus on one phenomenon; however, the scholars proceed to translate, not just merge, the quantitative data into qualitative.

*Complementarity* denotes those projects where qualitative and quantitative methods are used to understand overlapping phenomena, or different facets of the same phenomenon (Greene et al, 2008 [1989]). For example, professor Victoria

Alexander and her colleagues (2008) use quantitative data to understand general aspects of vulnerability and qualitative interviews to explore how respondents experience vulnerability and avoid risks. Similarly, Australian scholars Aldridge et al (2007 [1999]), in their cross-country comparison between Taiwan and Australia classroom environments, use their interviews in order to follow up questions left open or raised by the survey analysis.

*Development* studies use one method to inform the development of the second. For example, results from a survey can be used to inform and direct qualitative interviews, as in Thogersen-Ntoumani and Fox's (2008 [2005]) study on physical activity and mental well being typologies.  Or, qualitative data may be gathered in order to explore a problem so that a quantitative instrument can be developed, as the work by Judy Milton and her colleagues form the University of Georgia on the factors that determine changes in adult graduation programmes illustrates (2008 [2003]).

For a given mixed methods study, *initiation* occurs when the first method leaves researchers with unexpected, or contradictory results. For example, Maria Kryson (1999) studies racial equality in Detroit uses surveys and, unexpectedly, finds that people are becoming more liberal in terms of residential integration and more conservative in terms of employment equality. She hypothesises that this finding may be the result of significant differences between the researcher's and respondents' understandings of the questionnaire's queries. In response, she conducts a series of semi-structured interviews, which ultimately supports her hypothesis.

Lastly, in an *expansion* mixed methods study, researchers seek to 'extend the breadth and range of inquiry by using different methods for different inquiry components' (Greene et al, 2008 [1989]: 140). According to Greene et al's review, almost half (47%) of the authors who use mixed methods suggest *expansion* as the main purpose for integration. For example, sociology scholar Anne Rogers and her colleagues [2007 (2003)] begin their study with an experimental trial to test the effectiveness of a new treatment aimed at improving patients' adaptation to antipsychotic medications. The results they gather are proven sufficient to determine the effectiveness of the treatment, eliciting the authors' interest in the treatment experience more generally. In response, they decide to expand their inquiry to include a series of interviews to understand patients' perceptions of the treatment.

Finally, Creswell et al (2008 [2003]) discuss how the theoretical perspective may also be relevant in mixed methods design. In general terms, the theoretical perspective is the lens through which the scholar inspects and reflects on his or her topic. It represents the combination of personal and theoretical assumptions that the researcher brings to the study. It is strictly related to the worldview used by the researcher, but also closely associated to the specific characteristics of the study. According to Creswell et al (2008 [2003]), mixed methods scholars have been choosing between three possibilities, namely exploratory, explanatory and transformative perspectives. Explanatory studies are those in which the quantitative/positivistic worldview typically prevails, driving the scholars to look for explanations and causal relations (e.g. see Lynd and Lynd, 1927). In contrast, exploratory research, largely influenced by the constructionist perspective, is keener to explore the phenomenon of study, aware that different realities might coexist and that researchers play a significant role in shaping the final results (e.g. see Aldridge et al, 2007 [1999]). A transformative study, on the other hand, gives priority to the research area itself and advocates changes that would improve specific social realities or the lives of those being studied (e.g. see Rogers et al, 2007 [2003]).

*The project in the context of mixed methods*

This project started with quantitative data collection and analysis, including primary data (i.e. mass media articles, publications, patents and field trials of GMOs) and secondary data (i.e. public perception surveys on the topic of agricultural biotechnology). Trained as a scientist, it seemed natural to look for statistical explanations. I intended to prioritise the quantitative data and analysis throughout the study, which was going to be supported by a series of interviews with researchers. In other words, this study was meant to explain the relation between science and the public, prioritising the quantitative stage through a sequential *triangulation* design.

While collecting the quantitative portion of my data and beginning the analysis, I started meeting with scientists. This timing was crucial. The quantitative analysis suggests some causal relationship between public opinion and scientific output, but the nature of that relationship was unclear. Meanwhile, I was learning through the interviews that many different factors contributed to scientists' perceptions and experiences of public opinion, which could not be elucidated using a quantitative approach. Specifically, I realised that the way scientists listen to public opinion is nested in national cultures of science and science policy. I began to ask myself whether my research question was feasible, what my role in the study was, and finally how I could make better use of my data. While my research question was in line with the PUS dialogue model, I decided that I had to initiate a different configuration of the quantitative and qualitative in my mixed methods project in response to unexpected, and unclear, results. I also realised that the question I was asking required *exploration*, rather than a causal *explanation*.

My research question changed from: 'has public opinion affected science? If so, how?' to 'if, how and under what conditions do scientists listen to public opinion?'. This shift had a great impact on my research design, which is still sequential, but prioritises qualitative over quantitative data. Furthermore, this thesis integrates the methods for the purpose of *complementarity*, in order to explore overlapping but also different facets of the relation between science and lay people. Finally, even if I do not yet fully know the content of my conclusions, I am becoming aware that I am part of the research situation and that my conclusions represent one way to portray this topic.

According to Creswell and Plano Clark (2007), one of the great strengths of a mixed methods approach is that it helps answer questions that neither qualitative nor quantitative approaches alone can answer. I believe this is true of the relation between science and lay people. Thus, in this thesis I begin by asking if there is, in fact, an association between science output and public opinion on GMOs, using quantitative measurements and descriptive statistics. I then go on to ask how scientists perceive public opinion on GMOs, its role on their own work, and in their field of research more broadly. To answer these questions, I analyse 21 in-depth, semi-structured interviews using narrative analysis. Finally, I use a multiple-case study to compare two national research programmes on GMOs in the UK and Italy, using situational analysis as my analytical lens. This strategy helps me understand what political, social and/or economic factors contribute to the ways public opinion informed these research programmes. I draw on all three of these data sets in order to ask if, how and under what conditions scientists listen to public opinion and develop a tentative model of scientists' listening process.

In the following sections of this chapter I provide a brief, and hopefully exhaustive, description of the quantitative and qualitative methods used. A more detailed description of the data sets and analytic procedures is provided in each individual chapter.

**2. Descriptive statistics**

The use of numbers in sociology dates back to the origins of this discipline. Auguste Comte was very explicit about the relevance of statistics in sociology (Raftery, 2000). Following his example, several key figures in the history of sociology, from Max Weber to Emile Durkheim, have made extensive use of statistical data (Raftery, 2000). When applied to sociology, statistics has been used in order to produce new and objective knowledge. More specifically, statistics helped sociologists in both designing their research and analysing their results through descriptive and inferential approaches (Agresti and Franklin, 2006). Describing and making inferences indicates two different moments, as well as kinds, of data analysis. Typically, description comes first and allows researchers to map out the data, describe patterns, simplify the information and highlight which areas might be interesting to further analyse. Inferential statistics has instead been used to test hypotheses, determine causal relationships and make predictions.

The systematic character and rigour proper to statistics endows an aura of 'scientificity' to this discipline, attracting many sociology scholars. In this context, classical examples of quantitative studies in social sciences include survey analysis (for example see Gaskell et al, 1999; 2002; 2006; Jenkins, 2008 [2001]), content analysis (for example see Krippendorff, 1980; Gaskell and Bauer, 2002; Gutteling, 2005) and tests of association between two variables, i.e. knowledge and attitude (Gaskell et al, 1999).

When looking at surveys, for example, the relevance of statistics is immediately apparent. From design through analysis, researchers consistently employ statistical concepts such as sampling, reliability, validity and missing data. For example, a description of a sampling technique might look like this:

> A multi-stage sampling design was used for this Eurobarometer. In the first stage, primary sampling units (PSU) were selected from each of the administrative regions in every country (i.e., Statistical Office of the European Community, EUROSTAT regions). PSU selection was systematic with probability proportional to population size, from sampling frames stratified by the degree of urbanization. In the next stage, a cluster of addresses was selected from each sampled PSU. Addresses were chosen systematically using standard random route procedures, beginning with an initial address selected at random. In each household, a respondent was selected, by a random procedure. Up to three recalls were made to obtain an interview with the selected respondent. No more than one interview was conducted in each household. Interviews were conducted face-to-face in respondents' homes in the appropriate national language. (Gaskell et al, 1998: 10 from codebook)

The analysis of the same survey begins with a descriptive section, in which researchers observe that, when asked about their levels of familiarity with biotechnology, 55% of Europeans answered that they had heard about it in the previous 3 months, and 50% stated they had talked about it before (Gaskell et al, 1998: 191). Within a cross-country comparison study like the *Eurobarometer*, researchers make comparisons across different countries and, for example, find that, in 1996, the Swiss were the most familiar with biotechnology among Europeans, with almost 80% of the interviewees saying they had already heard about it. In contrast, findings show that Greek people were the least familiar with this technology, with only 30% of the respondents mentioning they had either discussed or heard about it before the interview was conducted (Gaskell et al, 1998: 191). Taking these results to a broader level, scholars explain these data in light of the distinctive examples of public engagement experienced in Switzerland and Greece.

Inferential analysis follows, in order to test this and other hypotheses. For example, Gaskell and his colleagues (1998) use the 1996 *Eurobarometer* to test the hypothesis that knowledge increases the level of support towards new technologies. Their findings show that, while it is clear that knowledge plays a crucial role in determining people's attitudes, this relation is quite complex. The correlation between six different applications of biotechnology and 'textbook' knowledge is quite weak, with the largest correlation coefficient ($r$=0.13) with medical applications. Further analysis show that study participants with higher education levels were more likely to have a clear opinion about biotechnology, whether positive or negative. Therefore it is suggested that knowledge is an important resource in opinion formation, although it is not a straightforward indicator.

It has been argued that statistical analysis focuses too much on numbers, treats individuals as mere objects (Bauer and Gaskell, 2000), and calls for causal relations across the variables under study. Nonetheless, even critics of quantitative approaches do concede that, in certain circumstances, generalised data and statistical results can prove very useful. For example, large-scale research questions are normally not pragmatically possible to address by qualitative methodology; so, whilst the use of statistics does tend to lose sight of the details of individual cases, its strengths lie in the wide scope it can achieve. Also, the use of statistics can reveal patterns and trends that could not be captured by in-depth studies of individual cases (Cicourel and Knorr-Cetina, 1981). For example, scholar in women studies Charlotte Rutherford (1992) uses statistical tools to show the inequality that characterises American women's access to abortion through the 1980s.

A common criticism is that qualitative methods are more critical and emancipatory than statistics. However, as Bauer and Gaskell (2000) argue, the critical stance of any piece of research is not per se related to the methods chosen, but rather to the researcher's willingness to challenge the status quo. It has been shown (see Rowntree, 1901) that statistics can be emancipatory when it unveils undiscovered conditions.

I use statistics to reveal and illustrate patterns, opening the way to this study's analysis. In Chapter 3, I combine primary and secondary analysis to map and explore relevant changes in both public opinion of GMOs and agricultural biotechnology output in Italy and the UK over the last two decades. These results allow me to explore the question of whether or not there is an association between public opinion and scientific output. In addition, this analysis allows me to assess key moments in the debates over GMOs in both countries, which are further explored in the next two chapters.

**3. Narrative Analysis**

The word narrative derives from the Indo-European term *gna,* which means both 'to know' and 'to tell' (Elliott, 2005). Sociologists' interest in narrative can be traced back to 1967, when American scholars William Labov and Joshua Waletzky (1967) published their study on English vernacular and the rituals of insults in American inner-city adolescents. However, it was only in the 1980s, following the publication of French sociologist Daniel Bertaux's collection *Bibliography and Society* (1981), that this field really flourished.

When a concept is used across different fields and disciplines, as has happened with narrative, it is difficult to identify one single and comprehensive definition that includes all the possible ways to understand that concept. For the purpose of this study, I define narrative as 'a discourse that consists of a sequence of temporally related events connected in a meaningful way for a particular audience in order to make sense of the world and/or people's experience in it' (Hinchman and Hinchman 1997:xvi). As British social scientist Barbara Jane Elliott (2005) highlights, this definition pinpoints three crucial features of narratives. Narratives are chronological and marked by a series of events. In addition, they give that sequence of events meaning within the sociological context of production. As social worker and sociologist Catherine Riessman (1993) underlines, meanings are typically co-produced through a process of negotiation between the informants, the researchers and their social contexts.

Following the increase in popularity that characterises narrative studies, this approach has been used to analyse almost every kind of data. Traditionally associated with interviews (Gaskell and Bauer, 2000), narrative analysis has been used to study bibliographical documents (Tamboukou, 2003), newspaper articles (Curtis, 1994), ethnographic data (Cain, 1991), images (Bell, 2002) and even quantitative data such as surveys (Singer et al, 1998). Thus, when talking about narrative analysis, it is useful to distinguish between two broad categories, namely thematic and structural analysis (Riessman, 2008). Drawing on Elliot Mishler's classic work on narrative, Riessman suggests that thematic analysis focuses on the 'told', or *what* experiences or events are recalled or described, while structural analysis investigates the 'telling', or *how* the story is being told.

Riessman (2008) argues that, when performing thematic analysis, the content of the story, obvious focus of narrative analysis, becomes the exclusive centre of attention. In this context, the scholar emphasises:

> [t]here is minimal focus on how a narrative is spoken (or written), on structures of speech a narrator selects, audience (real and imagined), the local context that gathered the narrative, or the complexity of the transcription. (Riessman, 2008: 54)

Traditionally, thematic analysis is the most common approach to narrative analysis. When employing thematic analysis, scholars are careful to leave the story intact, and usually keep track of times and places. The interpretation of the data is developed in light of the themes identified by the investigator, who might be influenced by previous theories, the data themselves, or other factors and constrictions, like political commitments or concrete purposes of the investigation. In addition, examples of thematic analysis vary in terms of the nature of the data analysed. These usually consist of interviews, sometimes combined with fieldwork notes, and bibliographical material like letters, but might also include many other kinds of oral or written data.

A classic example of thematic analysis in the field of illness is represented by the study on rheumatoid arthritis published in 1984 by medical sociologist Gareth Williams. The scholar's work on chronic illness asks how individuals make sense of the biographical disruptions determined by rheumatoid arthritis. To address this question, he met 30 individuals affected by rheumatoid arthritis. Focusing on three cases, selected from the interview data set, Williams argues that, in this context, narratives represent an attempt to 'reconstitute and repair ruptures between body, self and world' (Williams, 1984: 197). In selecting these case studies, the author is deliberatively guided by the theoretical argument he intends to discuss; he does not fracture the story, but instead focuses on the whole biographical account (Riessman, 2008). Although the scholar never makes his definition of narrative explicit in the text, it can be argued that Williams proposes narrative as the biography as a whole that unfolds throughout the interview.

In 2003, American sociologists Patricia Ewick and Susan Silbey published their work on the role of law in everyday life. The study explores how people who occupy subordinate positions resist law. In the paper, the researchers start from a strong theoretical framework, which, drawing on Foucault and others, argues that acts of resistance to powerful institutions are usually hard to detect by the law and can be used to learn about individuals' understanding of concepts like fairness and justice. The attention is on brief and short excerpts taken from their interviews, rather than the biographical account as a whole. In order to develop a straightforward plot, the authors focus on a subsample of accounts, which they transcribe, clean up, code, categorise and group. This analytic strategy, which is category-centred and might recall grounded theory method, is deeply committed to the participants' stories, which are kept to the fore.

While both the above examples focus on interview transcripts, numerous scholars have been using thematic analysis in relation to ethnographic studies. Anthropologist Caroline Cain, for example, studies identity acquisition practices between members of Alcoholics Anonymous (AA). The scholar uses thematic analysis to approach written documents by the AA organisation, fieldwork from her observations at AA meetings, and synopsis of interviews written in third person, with occasional quotes. Below is an extract from her notes on one of her interviews.

> Hank begins his narration with an orientation in which he says who he is: a person who wants to educate young people about alcoholism […] He described the kind of person he was before he started drinking […] He began to have serious physical effects and was taken to the hospital several times […] Eventually when he was in the service, he was caught drinking on the job, and had to cut back on the amounts he drank […] One morning he found out he could not get up even after several drinks […] When he did get up he found AA. (Cain, 1991 in Riessman, 2008: 71-72)

This kind of material allows the scholar to easily move back and forth between different biographical accounts and cultural contexts. Cain contends that social conventions act on personal narratives, forcing AA members to conform their personal stories to the formal medicalized vision of alcoholism embraced by the organisation. As Riessman argues, Cain's decision to focus on the synopses limits her access to the 'telling'.

Scholars who concentrate on the 'telling' pay attention to pauses, breaks in the narration, problems finding the right word, and usually ask questions like 'how is the story organised?', 'how does the speaker attempt to persuade the listener?'

and ‘are the speakers using different narrative styles?’ (Riessman, 2008: 77). Because of its focus on the narrative structure, rather than the themes, this kind of analysis has been classified as structural. As it happens with thematic analysis, scholars have been using structural analysis in numerous ways and for different purposes.

Sometimes, when scholars concentrate on the telling, they end up marginalizing the told. This might happen for different reasons. One distinctive example is represented by American professor of literacy James Gee’s (1991) study on mental illness. To avoid getting lost in the women’s incoherent accounts’, Gee concentrates on the respondents’ tone of voice, the form and organisation of utterances. This strategy allows the author to successfully slow down the interviewee’s ‘stream of talk’ and ‘examine how each part fits into the whole and what each topic shift contributes to the overall effect’ (Riessman, 2008: 94).

Another paradigmatic example of structural analysis is represented by Labov and Waletzky’s (1967) study on Afro-American English vernaculars spoken by youths in Harlem. The scholars, combine participant observations with interviews to young members of the Harlem Afro-American community, and identify six distinctive elements of narratives. These include a) abstract (summary of the story), b) orientation (time and place), c) complicating action (the plot[16]), d) evaluation (in which the narrator steps back), e) resolution or outcome of the story, and f) coda, which brings the actions back to the present. Comparing how different interlocutors narrate the same sequence of events, the researchers are able to unpack the *sequence of moves* that typically lead to violence, i.e. an explicit request is made by

[16] I define plot as the sequence of events in the order they were being narrated, which ultimately represents how the narrator learned about them (Franzosi, 1998).

one interlocutor, a second interlocutor refuses to listen to it, reducing the actual status of the first part, which ultimately resorts to violence.

Finally, there is a group of works that successfully combine thematic and structural analysis. Sometimes, integration happens quite naturally (see Riessman, 1989), other times it is more formalised. Tom Wengraf's (2001) book 'Qualitative research interviewing: semi-structured, biographical and narrative methods' introduces a formalised way to mix thematic or structural analysis known as Biographic Narrative Interpretive Method (BNIM). BNIM combines dry biographical accounts developed through thematic analysis with a structural analysis of the narrative that reflects upon the sequence of events as they have been recalled by the interviewee (Wengraf 2001). As shown in this book, and in numerous others cases (Chamberlayne et al, 2000), combing structural and thematic analysis has proven successful to closely analyse narrative accounts.

The chronological component of narrative analysis is one of the main reasons for my use, in Chapter 4, of this method to analyse scientists' narratives about GMOs and the role of public opinion in their work. Scientists' temporal reconstruction of the evolution of negative public opinion on GMOs, along with their own reactions to it, is crucial to expand upon the findings presented in Chapter 3. Just like Ewick and Silbey (2003), I interpret these interviews by focusing on the 'told'. The episodes I select vary in length - some are short, others are longer. I code, categorise and group them according to the central question that guides this thesis, and the theoretical concepts I learned from the PUS literature. During my analysis, I am committed to scientists' stories, and my goal is twofold. On the one hand, I want to capture how scientists tell the story of public opinion and GMOs in their country. On the other hand, I want to unmask how concepts like public, education, deficit of knowledge and dialogue, which I have frequently encountered in the PUS literature, work in scientists' everyday lives.

**4. Case study**

> A case study is both the process of inquiry about the case and the product of that inquiry. (Stake, 2000: 435)

The literature on case studies is extensive, spanning from natural to human sciences. Definitions vary according to the context, the academic background of investigators, their aims and purposes. I understand a case study as a bounded system, which I wish to investigate in order to respond to specific questions (Stake, 2000; Gillham, 2000). As American scholar in education Robert Stake suggests, case study is not a methodological choice, but rather a choice of what is to be studied. That is, a case study allows scholars to investigate interesting phenomena, in their real-life contexts. Also, scholars choose case study because they deliberatively intend to cover the contextual conditions in which the phenomenon is developed, as they believe they might be highly relevant to the phenomenon studied (Yin, 1993).

The history of case study alternates periods of great interest to moments of decline. Originally used in France, case study analysis spread in the United States in the early 20th century. Here this methodology was mostly associated to the Chicago School, and until 1935 gained considerable attention and support among sociologists (Tellis, 1997). In the following years, numerous scholars criticised this approach. One popular critique to case study contends that the singularity and local nature of the object investigated does not allow for generalizations, and at best provides readable stories for complicated phenomena. Social scientist Jacques Hamel (1992) responds to this argument suggesting that, differently from other methodologies, case study allows scholars to investigate the singularity of the global in the local.

Originally developed to serve qualitative purposes, case study methodology is a constant in qualitative research methods manuals, and university programmes (Gillham, 2000; Stake, 2000; Yin, 1992; 1993). Reviewing case study methodology lecturer in psychology Bill Gillham contends that when using this methodological tool scholars' primary scope is to unfold a story that takes into account all the positions and opinions of the actors involved in the case. To return to the epigraph that opens this section, the story that is produced by the investigator, just like the process of inquiry, will become a constitutive part of the case study.

In order to produce a story of the case study, scholars need to look for evidences. These constitute the raw material available on the case study. Typically, evidences might take different formats, which include policy documents, journal articles, reports, archive materials, interviews and quantitative data. Because of the variety of materials, and the singularity proper to case study, scholars' strategies for analysing the data vary significantly. Gillham suggests scholars should look for a strategy of analysis that is peculiar to the case study, and appropriate to represent the material, without deforming the findings.

For research purposes, it is useful to classify case studies into different categories. American historian and expert in brain and cognitive studies Robert Yin (2000) divides case studies into four categories. Although other scholars have grouped case studies in different ways (see Stake, 2000), Yin's classification is both comprehensive and accessible. As with any classification, there are conspicuous grey areas in the spaces between categories.

Yin's first category includes those studies aiming to describe the phenomenon in real life as it occurred. The scholar calls these studies *descriptive* case studies. Following the recent rise of interest in life sciences, medical anthropologist Sarah Shostak (2005) uses the case on toxicology to describe the uneven character of the process of molecularisation. With this work, the scholar contends that while some disciplines, such as biology, are extensively molecularised, others, such as toxicology, have continued to operate well above the molecular level (Shostak, 2005: 368).

The second category consists of those studies whose primary focus is to explore situations that are unclear or might need further understanding. In these occasions, Yin talks about *explorative* case study. Sociologists Renee Fox and Judith Swazey's (2001) work on artificial heart transplants represents a good example of this category. Here, the scholars focus on the series of events that brought to the implantation of the first artificial heart, and the debate generated between the medical practitioners involved in this project. Their scope is to 'write a narrative that would serve as base line for our analysis of the wide-ranging medico-moral issues the case seemed to epitomize' (Fox and Swazey, 2001: 151).

Quite differently, when scholars use case study approach to test, check or disprove how explanations function in real life contexts, Yin talks about *explanatory* case study. Interested in understanding the dynamic of universities' expenses in relation with the number of proposal submissions, Yin (2002) and his colleagues select twenty universities with different characteristics in terms of geography, size and academic orientation to research. Combining the data provided by the National Foundation of Science with local visits to the universities and interview material, they conclude that, contrary to economies of scale assumptions, universities that submit more proposals are also the ones that spend more time on each proposal.

Yin talks about *multiple*-case study when the number of cases studied is more than one. Scholars have used multiple-case study with two, or more cases. A paradigmatic example of multiple-case study in STS is represented by Jasanoff's book, *Design Nature* (2005). As I have already noted while revising the literature for this thesis, in this work the scholar takes the UK, Germany and the US to explore how different societies cope with the challenges that followed the introduction of modern biotechnologies.

I use case study to look at which social, economic and other factors affect scientists' listening. I take two case studies of projects developed on GMOs in Italy and the UK, and I compare them in a multiple-case study. I combine different kinds of evidences and use situational analysis as my primary analytic strategy and framework.

**5. Situational analysis**

Situational analysis is a methodological tool developed by Adele Clarke to take grounded theory around the postmodern turn (Clarke, 2005).

The origins of grounded theory date back to the publication of *The Discovery of Grounded Theory* (1967), which represents the outcome of the unconventional collaboration between two social scientists, namely Barney Glaser, well known for his rigorous quantitative training, and Anselm Strauss, whose qualitative background was influenced by the Chicago School. According to Strauss and Glaser, grounded theory begins with data, which is crucially analysed throughout the data collection phase rather than at the end. This allows for 'theoretical sampling' (Glaser and

Strauss, 1967), or the acquisition of further data that will help the researcher better understand the phenomenon being studied. The goal of grounded theory is not (only) to describe a social phenomenon, but to provide theoretical explanations that unveil the characteristics of the social process that is being studied. The key is to derive this theoretical formulation by collecting and interpreting data, rather using pre-existing categories. While grounded theory method finds its original disciplinary home within sociology, it has recently been spreading to other disciplines that broadly involve human subjects (Bryant and Charmaz, 2007).

Grounded theory has been developed to study social processes and the basic actions that occur in the situation of concern. Notably, social processes are best articulated in gerund tense, e.g. *discovering* chronic illness (Charmaz, 1990), *recasting* hope following the discovery of foetal anomalies (Lalor et al, 2009) and finally *managing* genetic disease (Bombard et al, 2007). The focus on social process means that this method is useful for understanding how scientists listen to publics as a social process.

The primary way in which grounded theory explores these processes is through coding mechanisms used to interpret textual data, ranging from interviews to extant documents. Coding proceeds along three main phases: a) an initial line-by-line coding, which fractures the data by opening up the text, b) a focused and selective process through which the more significant codes are sorted and organised into categories and finally c) axial coding, which brings the data back together through the generation of relations across different categories (Charmaz, 2006). As the analysis proceeds through this process, researchers will constantly compare and contrast their codes. In this context, it becomes crucial to complement the codes with memos, which are used to elaborate personal comments and reflections. Some of the initial codes will endure and become part of larger categories. Others might reveal gaps in the data, taking scholars back to the field where they started or re-directing them somewhere else.

There are some key weaknesses to grounded theory that warrant discussion. First, while the process of coding is meant to make the analytic process transparent, it remains unclear how a scholar can construct theoretical sensibility without drawing on prior knowledge, while having enough knowledge to distinguish between relevant and insignificant data required to produce valid theories (Kelle, 2001). Second, according to Charmaz (2006), the grounded theory method is flawed from its very beginning because a positivist perspective is assumed, where a clear reality exists and can be discovered. Finally, the basic social processes produced through grounded theory are often suspended in time and space (Burawoy, 2000, 2003).

Strauss and Glaser's more recent works attempt to address some of these critiques. Crucially, their efforts take the scholars in different directions. Glaser reiterates the positivist assumptions of this method and argues that in order to develop a valid grounded theory, it is crucial to start research 'fresh', with no prior knowledge of the topic (Glaser, 1978; 2002). Meanwhile, Strauss moves in a more constructivist direction. His works takes a more liberal position with regards to the literature review (Kelle, 2005), the use of prior knowledge and grounded theory as a method. Rather than viewing grounded theory as a set of prescriptive rules that researchers have to follow, Strauss views grounded theory as a toolbox that could be varyingly used by researchers in the context of their specific projects.

Following Strauss and Corbin's (1987) reformulation of grounded theory methods, American sociologist Adele Clarke proposes situation analysis as possible solution to the second and third weaknesses of grounded theory. This methodological tool arises from years of teaching and researching on grounded theory and other qualitative methods. It takes inspiration from feminist theories, interactionist theory, Foucault, and cultural studies of science and technology (2003; 2005). Clarke contends that situational analysis allows scholars to go beyond the actions, natural focus of grounded theory, and concentrate on the full situation of interest. The situation becomes the unit of analysis and understanding how it functions becomes the investigator's primary scope. In order to reach this end, Clarke proposes three cartographic approaches:

> - situational maps that lay out the major human, non-human, discursive and other elements in the research situation of inquiry and provoke analyses of relations among them;
> - social worlds arena maps that lay out the collective actors, key non-human elements, and the arenas of commitment within which they are engaged in ongoing negotiations, meso-level interpretations of the situation;
> - positional maps that lay out the major positions taken, and *not* taken, in the data *vis-à-vis* particular axes of variation and difference, concern, and controversy around issues in the situation of inquiry. (Clarke 2005: xxii)

Clarke considers these three maps as different analytic exercises, which aim to provide 'fresh ways into social science data' (Clarke 2005: xxii). In addition, the scholar contends that this analytic exercise is especially suitable to modern multi-site research, as it combines different kinds of data. Deliberatively working against positivist simplifications, situational analysis operates what Clarke calls 'social inversion', that is, making all the elements, social worlds and positions that are both constitutive and nested in the situation of interest finally visible.

Carrie Friese's (2007) study on endangered animal cloning shows how situational analysis works in practice. In her work, Friese specifically asks 'how nuclear transfer technology has been taken up *in* specific situations tracing the kind of implications in these specific situations as well as the other situations' (Clarke and Friese, 2007: 377). In order to answer this question, she draws upon multiple data sources, which include interviews with a broad range of individuals differently involved with cloning endangered animals, mass media reports, scientific journal articles and book chapters, websites of organisations, position statements, and legal documents. Among the different situations she analyses and compares, those on cloning a gaur and a banteng distinctly show the analytic power of situational maps. Friese begins her study by framing these two endeavours into one situation, since, as she underlines, they involve the same organisations (Clarke and Friese, 2007). However, creating situational maps helps her reconsider her early assumptions and split the endeavours into two different situations. Following these adjustments and through her analysis and constant comparison, she ultimately discovers the extremely local nature of animal cloning, as well as the broad range of logics this technology draws upon.

Regarding my own work, there are several elements that convinced me to choose firstly case study, and secondly situational analysis, in order to analyse two national scientific research projects on GMOs. After talking to scientists and using descriptive statistic as my filter to analyse public opinion and science output, I felt it necessary to ground my project into its sociological context. Using multiple-case study allows me to do so, and shift my focus to the contextual situation. For this reason, I focus Chapter 5 on the *Farm Scale Evaluation* (FSE) project (1999-2003) and

*OGM in Agricoltura* study (2003-2006). With the primary scope to tell the stories of these two projects, I find in Clarke's analytic approach a perfect venue to enter my data. Situational analysis allows me 'to confront the problem of 'where and how to enter the data" (Clarke and Friese, 2007: 371). I use this analytical exercise to focus on the political, economic, social and other factors that shaped scientists' relationship with members of the public. The analysis of these factors, which is not foregrounded in either the statistical or narrative analysis, ultimately strengthens my understanding of if, how, and under what conditions, scientists listen to public opinion.

My analysis starts by presenting the FSE and *OGM in Agricoltura* studies using situational maps, in order to describe and compare the full array of actors involved in these two projects. As Friese's study suggests, situational analysis encourages multisite data sources. Thus, I use a broad array of data sources in making these maps, including mass media reports, government documents, scientific papers, websites and interviews with journalists, researchers, government officials and/or industry partners. I then use these maps as a guide while writing the stories of these two case studies. In the end, I use the comparison between the two cases as my analytical lens to identify which social factors are implicated in the relationship between science and public opinion, and how they function in real life contexts.

## 6. Conclusions

The purpose of this chapter was to present the methodological framework I use in this study. As emerges from the chapter, my methodology has been crucial for the development of this project. Since the beginning of my work, I have grounded this thesis into a mixed method approach. Initially, I intended to explain the relationship between science and the public, prioritising the quantitative stage through a sequential *triangulation* design.

As I proceeded to gather my data, and I began to analyse them, I realised that the way scientists listen to public opinion is embedded into its social context. In order to unpack this complexity, I decided to initiate a different configuration of the quantitative and qualitative in my mixed methods project. This brought me to change my research question to 'if, how and under what conditions do scientists listen to public opinion?'

This shift meant that my study, which is still sequential, prioritises qualitative over quantitative data. Integrating my data and analysis, my purpose is to explore overlapping and different facets of the relation between science and lay people for the purpose of *complementarity*. In order to do so, I use descriptive statistics to analyse public opinion and scientific output; narrative analysis to learn about scientists' stories of the relationship between science and public opinion; case study and situational analysis to ground the relation between science and public opinion in its social context and learn about which political, social and other factors shape scientists' relation with public opinion.

## Chapter 3

## Public Opinion and Scientific Output of GMOs in the UK and Italy

Recent PUS literature suggests that dialogue is a way to guarantee an effective relationship between science and lay people. So far, however, efforts at science communication have focused on how information and knowledge can be communicated *from* scientists *to* a lay public. Nonetheless, communication, if it is not to be thought of as authoritarian lecturing, should generally be considered a two-way process. In the PUS scholarship, however, far too little attention has been devoted to understanding the public as speakers and scientists as listeners. In order to begin filling this gap, throughout this thesis I question if, how and under what conditions scientists listen to lay people's concerns about GMOs in Italy and the UK.

The primary focus of this chapter is to explore public opinion on and scientific output of GMOs over time, asking if an association between the two is at all possible. The aim of this chapter then is not to either 'prove' an association or 'determine' a causal relation between public opinion and science output, but rather to try to determine instances where notable changes in scientific output occur *after* specific events or changing trends in public opinion. These explorations are meant to be the basis upon which I interpret interviews conducted with scientists and presented in Chapter 4. I also determine key events that may signal which economic, social and political factors influence scientists' listening capacity, a topic I further explore through in-depth case studies in Chapter 5.

In the following, I present the results of my analysis, which I obtained through the means of descriptive statistics. I begin by describing how I operationalised public opinion and scientific output in a discussion of the materials and methods used. I then provide a descriptive overview of each observed data set individually, focusing on the UK first and Italy second. This section is quite technical and simply reports the results of my analysis, without discussing them. Discussion, in fact, represents the core of the final section of this chapter.

**1. Materials and methods**

I present here the materials and methods I use to analyse public opinion and agricultural biotechnology output. Noticeably, as I show below, these combine primary data, such as newspaper articles, scientific publications, patents and field trials, with secondary data, such as the *Eurobarometer* survey. In each case, I limit my analysis to the period between 1990 and 2007.

**1.1 Measuring public opinion on GMOs**

Over the last few decades, definitions of public opinion, alongside the methods to analyse it, have been largely debated. Critiques of George Gallup's representative samples technique, which allowed the scholar to correctly predict the outcome of the US presidential election in 1936, suggest this technique has changed the meaning of public opinion, as well as the images usually associated with it (Herbst, 1992). At the moment, there is an open discussion about what public opinion is and how this should be measured. For the purpose of this study, I define public opinion as 'fiction, which refers to some kind of volonté général, reminding us of the elementary semantics of democracy' (Neidhardt, 1993: 339). Typically, I confine this term within national boundaries, and as Martin Bauer (2007) noted in one of his lectures, I believe that even if nobody can touch public opinion, or see it, everybody can feel it.

Among the several methods used to address public opinion, I decided to follow the model proposed by social psychology scholars Gaskell and Bauer (2001). As I explained in the literature review (see section 2.2.4, Chapter 1), the scholars view public opinion as a complex system made up of public perception and mass media. With public perception, the scholars indicate all those ideas, images, fears or expectations that people associate with different issues. Mass media, on the other hand, is a channel that frames and allows for mass communication (Durant et al., 1998)[17].

Overall, I am aware that this method simplifies public opinion for the benefit of research, even though it avoids simplistic reductions of public opinion as in public perception surveys, and ultimately captures the complexity of this phenomenon (Durant et al., 1998; Gaskell and Bauer, 2001, 2002; Bauer, 2005). Accordingly, I limit my discussion of public opinion to study how this phenomenon has been represented in public perception surveys and mass media, rather than try to capture what the Italian and British public thought about GMOs.

My data set includes the *Eurobarometer* series of surveys on biotechnology as well as a collection of articles referring to agricultural biotechnology, taken from British and Italian opinion-leading newspapers.

[17] In their studies on public opinion (Durant et al., 1998; Gaskell and Bauer, 2001, 2002), Gaskell and Bauer combine the analysis of mass media level of coverage, which, according to Mazur, is negatively correlated with public support, with the analysis of the content, through which he specifically looks at tone and themes of selected samples taken from opinion-leading newspapers.

*The Eurobarometer survey*

The *Eurobarometer* is a public perception survey established by the European Commission in 1973[18]. Normally, it is run twice a year with a range of 1000 face-to-face interviews per participating country[19]. It examines public opinion on issues that are nationally or internationally relevant (e.g. the European Union enlargement). However, its range of topics has continued to expand, and presently, there are numerous so-called *Special Eurobarometer* surveys, which are run less frequently and investigate specific issues including culture, science and technology. As such, the *Eurobarometer* surveys have been used extensively by academics in order to map out Europeans' knowledge of, attitudes about and perceptions of a wide range of topics over time (Wolpert, 2007; Scheufele et al., 2009), to study cross-national differences (Deschepper et al., 2008; Hohl and Gaskell, 2008) and to reflect on the role of the public in modern democracies (Jasanoff, 2005; Wynne 2001, 2004).

This thesis focuses on the *Eurobarometer Special Series on Science and Technology*, which has been run roughly every three years in all European Union countries since 1991. This series includes several questions on agricultural biotechnology, addressing knowledge, attitudes, risk perception, trust and behaviour. Taking Gaskell and Bauer's studies on Europeans' opinions on biotechnology (Durant et al 1998; Gaskell and Bauer, 2001) as a model, I focused on four questions. These examine the level of people's encouragement of particular technologies, their risk and benefit perceptions and their beliefs about the moral

[18] The primary intention of the survey has been to compare and describe national trends over time, improving communication across member countries.
[19] The UK is one of the few countries for which there is a different sample size, as 1,300 respondents are normally interviewed.

acceptability of new technologies. Within this range of questions, I chose the two that capture risk perception and level of support towards GMOs.

According to Gaskell et al (2004), there is a positive direct association between the level of Europeans' support towards agricultural biotechnology and both their perceived benefits and moral acceptability. In other words, when public support increases, the level of perceived benefits and the moral acceptability of GMOs also increase. It follows that by looking at Italians' and Britons' support towards biotechnology scholars can also address moral acceptability and perceived benefits of GMOs by nation. Finally, the two questions I chose were subjected to only limited word re-framing throughout the period surveyed, enabling a meaningful comparison over time[20]. The questions I chose to analyse are as follows:

1. To what extent do you tend to agree that this application is risky for society?
2. To what extent do you tend to agree that this application (is worthwhile and[21]) should be encouraged?

As they were asked about GM crops[22] and GM food[23], a total of four questions were selected. Respondents had a scale on which to position themselves that included the following answers: 'definitely agree', 'tend to agree', 'tend to disagree' or 'definitely disagree'. In the years 1991, 1993, 1996, 1999 and 2002 no major changes were introduced in the questionnaire. In 2005, however, no questions were asked on GM

[20] Several scholars discussed the potential bias that the survey questions' structure and wording could have on people's answers, and how these effects could be prevented (see Tourangeau et al., 2000; Schuman and Presser, 1981 and Dillman, 2000 for an introduction to the extensive research on this subject).

[21] This portion of the question was deleted after 1993.

[22] The Eurobarometer definition of GM crops is 'plants modified in ways that may be quicker or more precise than traditional breeding programmes, in order to make the plants more useful' (Eurobarometer, 1993, Appendix 4: 2).

[23] The Eurobarometer definition of GM food refers to 'products with better taste, higher protein, or a longer shelf life' (Eurobarometer, 1993, Appendix 4: 3).

crops. The number of valid responses ranges from 57% to 95% and from 62% to 96% in Italy and the UK respectively[24]. Following Gaskell et al (2001), to minimise the effect of variation in the responses range I decided against including 'don't know' answers. Hence, from here onwards, all references to percentages of British or Italian respondents will refer only to those who actually expressed an opinion on GMOs, disregarding those who did not have one.

*Mass media*

In their extensive studies on biotechnology and public opinion, George Gaskell and Martin Bauer (Durant et al 1998; Gaskell and Bauer, 2001; 2002) argue that opinion-leading newspapers introduce issues to public attention and can be considered an early indicator of public discourses and awareness (Bauer and Gaskell, 2001). As we read below, they assume that the rest of the media, such as television or other newspapers, follow their agenda.

> Our analysis of the media focuses largely on the elite or opinion-leading press in each country. This we assume can be taken as a good proxy for the tone of the wider media arena in the country. It is the press that is read by the decision takers and by journalists working in other media

[24] It has been argued that the difference in valid answers per year is mostly due to the addition of a filter question after 1996, which served to determine whether or not respondents had heard of GMOs before participating in the survey (Gaskell and Bauer, 2001). As a consequence of this prior question, a time-line comparison of the percentages, including the non-response categories, would be meaningless, as it would be comparing differing populations. Gaskell et al (2001) coped with this problem by excluding from their analysis all the respondents who did not provide a decisive answer to the full set of key attitude questions. This strategy requires having access to the raw data of the Eurobarometer for the entire time period investigated. Because I did not have the access to this material in full, I could not follow study participants throughout the full range of answers they provided to the *Eurobarometer* questionnaire, and exclude any of those who responded 'don't know' to any of the questions I selected in the *Eurobarometer*. Thus, I opted for a different solution. In my case, I focus on one question at a time and exclude all 'don't know' answers from the analysis. This is certainly an approximation, which, as any of its kind, does not pretend to be perfect. Nonetheless, it should not be forgotten that the analytic approach I use to study public opinion through this chapter does not rely exclusively on public perception surveys, but rather combines this data with mass media content analysis. Furthermore, through the thesis I do not aspire to propose what Italians and Britons think about GMOs, but rather portray an image of how public opinion of GMOs has been represented by the *Eurobarometer* and mass media in Italy and the UK respectively. Having said that, I conclude that this approximation is sufficient for the purpose of this study.

> outlets. Pragmatically these newspapers make relatively convenient and accessible sources for the purpose of data collection and analysis. (Gaskell and Bauer, 2001: 7)

Following this suggestion, I started by identifying the national opinion-leading newspapers, i.e. *The Independent* in the UK and *Il Corriere della Sera* in Italy. Then, I proceeded to select and analyse the articles included in these newspapers that were associated with agricultural biotechnology.

*Il Corriere della Sera* merges broadsheet and tabloid daily newspaper genres and is the Italian newspaper with the largest circulation (estimated at around 600,000 copies in 2005). Traditionally placed at the centre of the political spectrum, it is sometimes associated with the industrial north, but remains a nationwide elite opinion leader. In contrast, *The Independent*, aligned with the British centre-left, is a quality daily paper and one of five national broadsheets. During the period investigated, *The Independent* had a circulation of approximately 250,000 and a readership of 870,000 (Durant et al., 1998)[25]. Thus, although the two papers differ in their political leanings as well as in their relative distance to tabloids, which is mainly due to the very different media landscapes in the two countries, they do share the common trait of being opinion leaders within their respective countries. This latter attribute is the basis on which they are comparable for the purpose of this and previous studies (Durant et al., 1998; Gaskell and Bauer, 2001).

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[25] Recent data on 2010 indicates that *The Independent* has a circulation of around 190,000 and a readership of 600,000 http://webcache.googleusercontent.com/search?q=cache:fdygFvjCrHEJ:www.nmauk.co.uk/nma/do/live/factsAndFigures%3FnewspaperID%3D6+the+independent+readership&cd=2&hl=en&ct=clnk&gl=uk&client=safari

For both newspapers I accessed their online databases to search for articles that mention agricultural biotechnology. The only exception was for the articles published between 1990 and 1992 in *Il Corriere della Sera*, as access to those is not available. My final databases contain roughly 2,500 articles for *The Independent* from 1990 to 2007 and 1,000 for *Il Corriere della Sera* for the years 1992 to 2007. These databases encompass the entire population of articles containing any of the chosen keywords, which include: agricultural biotechnology, agrobiotech*[26], GMOs, GM Food*, GM Crop*, genetically modified food*, genetically modified crop*, frankenfood*[27]. In order to build two representative samples from these two populations of articles, for each country I established a total number of items to be analysed, in other words a quota[28]. The number of sampled articles per year was then selected according to the frequency distribution of the two populations of articles[29]. Following this process, I ended up with two quota samples of roughly 150 items for the UK and 130 items for Italy.

### 1.2 Measuring scientific output

In order to study agricultural biotechnology scientific output, I use scientific publications, patents and field trials. I argue that each of these data sources tells

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[26] The asterisk (*) indicates that the remaining part of the word is left open. This means that, for example, a keyword like agrobiotech* allows me to find all articles that mention agrobiotechnology or agrobiotechnologies.

[27] For each country I used slightly different terms according to the two languages' semantic differences, while to decide on my keywords I relied on both my master's thesis on agricultural biotechnology and public opinion in the UK and US, and Gaskell and Bauer's (2001, 2002) works.

[28] My decision in the selection of these quotas was primarily pragmatic. It considered both the total population of items as well as the time it would have taken to analyse each document. In the space of this PhD, and considering this was only the second time I had carried out this kind of analysis, it made sense to focus on a rather limited number of items that I could select and analyse carefully. Notably, I followed a similar logic in order to establish the sample size of publications and patents.

[29] E.g. in 2000 *The Independent* published 355 articles, from which I selected 10 in total, i.e. one every 35 articles. On the other hand, in 2005 the UK opinion leading newspaper only wrote 94 articles somewhat related to GMOs; in this case, I selected a total of 6 items, that is one every 16 articles.

something different about the state and progress of agricultural biotechnology research. Together, they provide a general overview of this research field. In the following, I briefly present each of these indicators and describe how I collected my data and prepared my analysis.

Scientific papers are a central feature of academics' activities (Callon, 1986) as well as being the primary tool to communicate new knowledge. Counting publications is, by now, an established means of mapping out the total volume of research output (King, 1987; Debackere et al., 2002). Following Philippe Vain's (2005) strategy, I collected the population of Italian and British scientific papers on GMOs. I constructed a set of five terms, each of which combines between 100 and 300 keywords related to agricultural biotechnology[30], which I then searched for in the ISI Web of Knowledge and the CAB abstract databases[31]. To link an article with a nation, I relied on the university affiliation of the first author. After eliminating overlaps between the populations of articles indicated by the CAB abstract database and ISI Web of Knowledge, I ended up with 5,360 papers for Italy and 11,268 for the UK. From the total population of articles, I constructed two quota samples, one for each country. These include approximately 5%[32] of the articles that British and Italian researchers published on agricultural biotechnology (560 articles for the UK and 271 for Italy).

[30] For more detail see Appendix 1.
[31] The CAB Abstract database is one of the most comprehensive and specific databases of its kind. The subjects covered span from agriculture to environmental science and plants biology (http://gateway.ovid.com). On the other hand, the ISI WOK is one of the most used online databases for scientific research (http://wok.mimas.ac.uk). It covers approximately 250 different disciplines and provides extensive information about publications, patents and conference proceedings.
[32] See note 28 for more detail.

The second form of agricultural biotechnology scientific output I considered is intellectual property rights, or patents[33]. According to the OCSE, counting patents provides information on the innovation output, national productivity and ultimately the structure and the development of a technology (OCSE, 2007: 8). Widely used as a means to study, and compare, national levels of innovation, patents are an extremely detailed source of information, which is also easily available from patent offices. In particular, patents tell researchers about the nature and content of the invention[s], the nation of the owner[s] and the year in which patent applications were first requested and then published. Finally, they are interesting, as they take science outside the laboratories, providing researchers with a measurement of the potential economic viability of new technologies (Zoltan et al., 2002).

This study follows Paul Oldham's (2006, 2007) method. According to a code strategy, I used the European Patent Office database *esp@cenet*[34] and collected all biotechnology inventions related to agriculture, new plant varieties and the processes used for obtaining them[35] (Oldham, 2006: 15). The overall populations of patents awarded to agricultural biotechnology inventions by the UK and Italian patent offices, between 1990 and 2007, include 1,980 patents in the UK and 71 patents in Italy. National differences in volume meant that, while I

[33] A patent is a legal certificate that guarantees a monopoly over the claimed invention for a period of time that generally does not exceed two decades. In order to patent an invention, it should be a) new (or novel), b) non-obvious and c) useful for society (Oldham, 2006). Presently, within the World Trade Organization (WTO), patents are regulated under the Trade-Related Intellectual Property Rights (TRIPS, 1994) agreement, which has extended intellectual property rights to living organisms or parts thereof (Oldham, 2006). Since this extension, numerous patents have been delivered all over the world in order to protect life forms, such as new plant varieties or genes (Semal, 2007).

[34] The *esp@cenet* is the largest freely accessible database of its kind (Oldham, 2006).

[35] According to the IPC, the two codes I have used for this research are C12N15 and A01H (Oldham, 2006).

could read and analyse all the patents released in Italy, I had to construct a sample in order to analyse the content of the UK patents. A quota of 213 documents[36], which I selected in reference to annual frequency distribution, makes up the UK sample.

The last scientific output indicator is field trials, which release GMOs into the environment. Following EU legislation 90/220 and the subsequent Directive 2001/18[37] on the deliberate release of GMOs into the environment, scientists interested in testing new GM varieties in the field are asked to formally request consent from the national competent authority[38]. The latter is responsible for approving, or denying, the trial on a case-by-case basis. Amongst different scientific output, field trials have been considered an exceptional indicator to analyse trends of GMO research (Reiss et al., 2007). In addition, it can be argued that the nature and the process of approval for field trials, which is nested in science as much as its policy, makes them a proxy not only of the state of GM research, but also of the government's support for this technology. Presently, the archive of all European field trials conducted between 1990 and 2007 includes 2,350 documents, 278 and 237 of which were carried out by Italian and British scientists respectively. In contrast to the strategy I used with publications and patents, this relatively limited number of items allowed me to analyse the content of all Italian and British trials.

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[36] See note 28 for more detail.

[37] See section Biotechnology policy, Chapter One – Introduction.

[38] Italy appointed an inter-ministerial committee coordinated by the Ministry of Environment, which includes representatives of the latter Ministry, the Ministry of Health, the Ministry of Agriculture and the Regions. The Department of Environment, Food and Rural Affairs (DEFRA) is responsible for assessing applications to release GMOs into the UK environment. DEFRA consults different authorities, such as the Advisory Committee on Releases to the Environment (ACRE), the Health and Safety Executive and the Food Standards Agency, and, as appropriate, English Nature.

### 1.3 Establishing associations

In order to establish whether there is an association between public opinion and scientific output, my analysis has been guided by two questions. The first refers to a momentary state, while the second entails dynamic change. In a sense, the questions ask 'what was it?' and 'how has it changed?' Therefore, my analysis of public opinion asked 'what was the representation of public opinion on agricultural biotechnology?' and 'how has this changed over time?' When looking at the survey answers, I asked 'what kinds of answers feature (in) *the Eurobarometer* public perception survey?' and 'how have these changed throughout the six surveys?' When looking at mass media, I asked 'what was reported by the media?' and 'how has this changed over time?' Similarly, with regards to scientific output, I asked 'what was the content of scientific output?' and also 'how has this changed through time?'

Following this approach, I concentrated on the frequency distributions within the datasets, their content and their evolution. In the following, I present an overview of these three dimensions. I obtained the overview of both the representations of public opinion and the scientific output by means of descriptive statistics. A graphically represented timeline serves to highlight specific trends and to identify 'key moments[39]' within public opinion's representations and scientific output. Hence, the following analysis aims to determine instances where notable changes in scientific output occur *after* key events and changing trends in the representations of public opinion.

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[39] Throughout this thesis, I call 'key moments' those periods of time (usually years) in which my analysis suggests that the variable I am observing reaches an extreme value, whether positive or negative, maximum or minimum, highest or lowest.

## 2. Association between the representations of Britons' opinions on GMOs and agricultural biotechnology scientific output

In this section I focus on the UK context and ask if there is an association between a very specific way of representing public opinion on the topic of GMOs, which merges public perception surveys and mass media analysis, and scientific output. I begin with the analysis of public opinion on GMOs and then move on to study scientific production in the UK between 1990 and 2007. In doing this, I identify relevant moments in each of my indicators, which are then compared in order to identify instances for an association between the representations of public opinion on GMOs (in *The Independent* and the *Eurobarometer*) and GM scientific output.

### 2.1. Representations of Britons' opinions on GMOs

As discussed above, I study the representations of public opinion through the analysis of newspaper articles, which I analysed for content (articles on agricultural biotechnology published in *The Independent*), and the *Eurobarometer* series of surveys on biotechnology. I initially discuss each data source separately, and then reflect on these indicators together.

#### *2.1.1 Britons' perceptions of GMOs*

As noted, the *Eurobarometer* distinguishes between two applications of agricultural biotechnology, namely GM crops and GM food. Questions address risk perception and level of support for both applications. Figure 1 presents the results obtained by the *Eurobarometer* to assess the extent to which Britons agree/disagree with the following statements: a) GM crops are risky for society, b) GM crops should be encouraged, c) GM food is risky for society and d) GM food should be encouraged.

More specifically, the lines in the figure show the total percentages of those who answer 'tend to agree' or 'definitely agree', excluding 'don't know' answers[40].

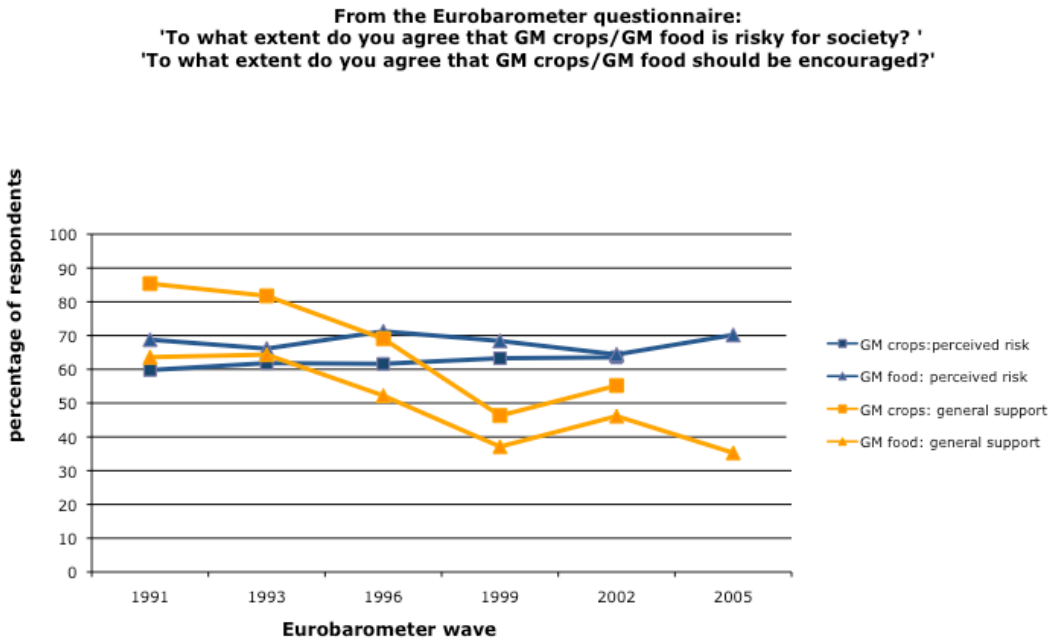


**Fig. 1: GM crops and GM food – risk perception and general support, 1991–2005**

The description of this figure is twofold. I begin with an overview of the data that compares the *Eurobarometer's* representations of Britons' perception of GM crops and GM food, and then focus on each of the two applications (i.e. GM crops and GM food) separately, reflecting on the evolution of respondents' attitudes throughout the last two decades.

The analysis of Britons' answers to the *Eurobarometer* surveys (1991, 1993, 1996, 1999, 2001, 2005) indicates a preference towards GM crops as opposed to GM food. This difference is especially notable in the early 1990s. In 1991 over 80% of

[40] For further discussion, see section 1.1 in this chapter.

respondents claimed to be supportive towards GM crops; in contrast, in the same year only 63% of Britons' answers are in support of GM food. Over the years, the difference in support between the two applications diminishes. In 2002 respondents supportive of GM crops were only 10% more than those in favour of GM food. Between 1991 and 1999 Britons' levels of encouragement towards both these applications decrease significantly, -39% and -27% for GM food and GM crops respectively. In addition, with the turn of the century the *Eurobarometer* indicates an up and down trend that bottoms out, for support to GM food, in 2005. According to the *Eurobarometer*, the levels of Britons' risk perception towards GMOs experience fewer fluctuations. Furthermore, the data show that Britons associated similar levels of risk to the two applications. The greatest difference between GM crops and GM food occurs in 1996, when 62% and 72% of the participants associated some degree of risk to GM crops and GM food respectively.

Looking at the questions one at a time can be informative to further clarify the *Eurobarometer* data. The *Eurobarometer* shows that between 1991 and 2002 roughly 3/5 of the UK public either 'tend[ed] to agree' or 'definitely agree[d]' that GM crops are risky for society. However, it is only after 1999 that respondents' perception of risk towards GM crops reaches its highest values (i.e. in 1999, and again in 2002, the 'agree' answers peak at 63%). Looking at the levels of support towards GM crops, the *Eurobarometer* indicates an overall downward trend: in 1991 roughly 85% of the participants declared to be supportive of this technology, while less than a decade later this percentage drops to 46%.

Similarly to GM crops, the highest levels of support for GM food fall between 1991 and 1993, when over 60% of the surveyed sample supported it. In contrast, the least favourable period for GM food occurs after 1998, when on average less than 40% of the UK respondents encouraged this application. With the turn of the century, answers in support of GM food gain 9 percentage points, but register a 35% decrease in 2005. With regards to Britons' risk perception of GM food, the *Eurobarometer* shows fewer fluctuations, which parallels GM crops' trends. The range of answers that connoted GM food as a dangerous technology for society is between 66% (1993) and 71% (1996). With the turn of the century, the *Eurobarometer* indicates a decrease in Britons' levels of concern with regards to GM food; however, this trend does not solidify, as public resistance increases again around 2003 and has persisted since.

Another way to look at the *Eurobarometer* data is to analyse the extent of polarisation in public perception. With polarisation I denote the extent to which answers are firm in contrast to those that are more ambiguous. Accordingly, I summarised all the responses that indicate clear, unambiguous answers by adding the number of respondents who chose 'definitely agree' to those who replied 'definitely disagree'.

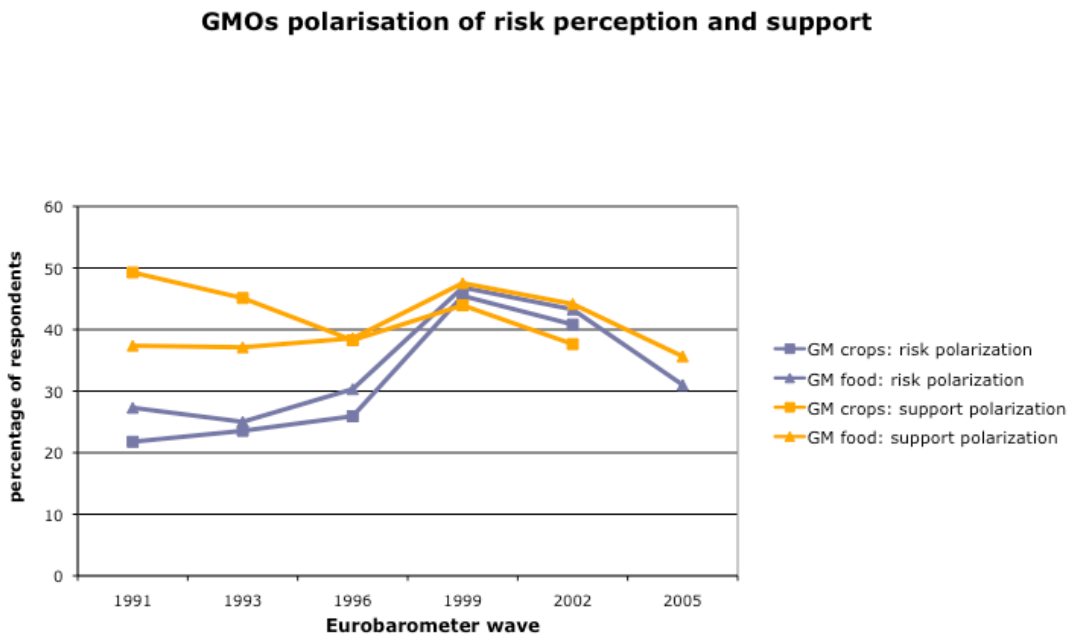


**Fig. 2: Public opinion on GMOs in the UK: polarisation or risk perception and general support over time**

Figure 2 shows the development of Britons' polarisation over time, for the four variables 'support for GM food', 'support for GM crops', 'risk of GM crops' and 'risk of GM food'. As the figure highlights, polarisation increases through the 1990s, peaking in 1999 for three of the four questions. The exception is support for GM crops, which reaches its highest level of polarisation in 1991, with roughly half of respondents choosing either 'definitely agree' or 'definitely disagree' answers, and then rapidly decreases between 1991 and 1996.

It appears, however, that the degree of polarisation that characterises Britons' responses in 1991 is largely an artefact of the original, very high level of public support for GMOs in the UK, which decreases drastically over time. Looking closely at *Eurobarometer* data indicates a gradual shift in the nature of Britons' polarisation. In 1991 only 13% of British respondents strongly disagreed that GM food should be encouraged, while 24% strongly agreed with this statement. By 1999, however, the tables have turned, with 35% strongly opposing research on this application and just 12% definitely supporting it. A similar change of opinions can be found in the *Eurobarometer* data on GM crops. Overall, this indicates an increase in UK respondents' dissatisfaction with regards to GMOs through the 1990s. This, noticeably, peaks in 1999, which, according to the *Eurobarometer*, is characterised by a strong perception of risk and low encouragement towards both GM applications.

In summary, the analysis of Britons' answers to the *Eurobarometer* suggests a general preference for GM crops as opposed to GM food, which, however, gradually disappears over the time frame of this study. Furthermore, the data represent Britons as somewhat concerned with regards to GMOs. In addition, the level of support towards this biotechnology bottom out in 1999, with only 37% and 46% respondents feeling somewhat supportive towards GM food and GM crops respectively. Given also that the polarisation analysis points at 1999 as the least supportive period in the UK towards GMOs, the *Eurobarometer* indicates this year as a 'key moment' in the representations of Britons' perceptions of GMOs, with high perception of risks and low levels of public support.

### *2.1.2 Mass media*

The database of articles that refer to GMOs published in *The Independent* between 1990 and 2007 contains roughly 2,500 items. These articles are spread across all different sections of the newspaper (i.e. opinion pieces, scientific reports and letters to the editor). In the following sections I give a general overview of the data set, which will be followed by the analysis of two of the core questions guiding this chapter, i.e. 'what were the representations of public opinion on GMOs?' and 'how did these change over time?'

*Overview of the data*

Agricultural biotechnology has been discussed in the British mass media since the early 1990s. However, roughly 80% of the coverage is concentrated in the years between 1998 and 2003. Within this timeframe, the number of articles per year always exceeds 150 items, peaking in 1999 with a quota of 772 articles related to GMOs published by the newspaper. This figure is more than double the second highest frequency peak of 355 articles in the year 2000.

To clarify these data, I analysed the content of selected articles and found that a number of events, both scientific and political, caused wide coverage of GMO-related topics.

On 10th August 1998 Dr Arpad Pusztai released the results of his study on GM potatoes, warning both the public and scientists about the negative health effects of GMOs (Pusztai, 1998). This episode was publicised in an extensive article, along with opinionated comments just a few days later (Arthur, *The Independent*, 1998), and stayed in the news until 1999, when 4 out of the 20 articles sampled for that year refer to Pusztai. Significant media coverage was also dedicated to the UK Department of the Environment, Transport and the Regions' (DETR[41]) discussion of a possible moratorium on the commercial planting of GMOs (1998), which features in half of the 1998 sampled articles. In addition, in 1998 HRH the Prince of Wales made

[41] After 2001 the DETR was split into the Department of Transport and the Environment portfolio, which in turn merged with the Ministry of Agriculture, Fishery and Food into the Department for Environment, Food and Rural Affairs (DEFRA).

headlines in *The Independent* following the publication, on his website[42], of an essay that criticises GMOs. Becoming vocal and decisive in his opinion on GMOs, Prince Charles features in 1/5 of *The Independent* sampled articles that year.

The peak of media attention on GMOs (1999) coincides with a number of political events. First, during the Seattle WTO[43] summit GMOs were used to exemplify the power and control that developed countries, such as the US, exert on developing nations, as it appears in 1/3 of that year's analysed articles. In addition, in 1999 the European Union enforced a four-year de facto moratorium (1999–2003) of the cultivation and commercialisation of GMOs, receiving high coverage in *The Independent* with 20% of the sampled articles featuring this episode.

Contemporaneously, Britain was busy launching and developing the first trial of the four-year *Farm Scale Evaluation* (FSE)[44] programme, which, as explained in 1 out of 5 of the sampled articles for 1999, aimed to study the environmental effects of the cultivation of four GM crops: maize, beet, spring and winter oilseed rape. Further, between 2001 and 2002 the European Union finalised Directive 2001/18 on the release of GMOs into the environment (Castle, *The Independent,* 2001; Lean, *The Independent*, 2001; Woolf, *The Independent,* 2001), considerably tightening up the requirements necessary to commercialise GM products (Adcock, 2006), and numerous African countries, such as Zambia, declared their refusal to import GM maize from the US (Lean, *The Independent*, 2002). Finally, in 2003, when coverage by

[42] http://www.princeofwales.gov.uk/speechesandarticles/an_article_by_the_prince_of_wales_titled_the_seeds_of_disast_1857887259.html (last visit 24/07/2010)
[43] http://www.wto.org/english/thewto_e/minist_e/min99_e/min99_e.htm (last visit 24/07/2010).
[44] The Farm Scale Evaluation programme (1999–2003) is a government-funded programme that was run in the UK. The project cost approximately £6 million and found that while growing conventional beet and spring rape is better for wildlife, no particular difference in the quality and quantity of wildlife emerges when comparing conventional and GM winter rape, and finally, a significant increase in wildlife is found when growing GM maize as opposed to its conventional variety. More about this project can be found in Chapter 5.

*The Independent* falls just under 300 items, the EU ended the moratorium on GMOs, the European Commission (2003) circulated its recommendations to develop national coexistence plans for GM and non-GM cultivations[45], and a substantial part of the FSE results were published[46]. The latter event, which appears in 1/3 of the sampled articles for 2003, was featured by *The Independent* as a turning point for the British government, which was ultimately being forced to take a final decision on the future of GMOs (Lean, *The Independent*, 2003).

[45] http://ec.europa.eu/agriculture/coexistence/index_en.htm (last visit 24/07/2010)
[46] http://webarchive.nationalarchives.gov.uk/20080306073937/http://www.defra.gov.uk/environment/gm/fse/fse03.htm (last visit 24/07/2010)

**Table 2: *The Independent*'s frequency distributions by type from content analysis 1990–2007**

| *The Independent* 1990 – 2007 | Frequency (full population) | Sample size (number of articles) | Percentage of articles on 1st generation GMOs | Percentage of articles on 2nd generation GMOs | Percentage of articles on 3rd generation GMOs | Percentage of articles on basic research |
|---|---|---|---|---|---|---|
| **1990** | 14 | 6 | 17 | 33 | 0 | 50 |
| **1991** | 12 | 6 | 33 | 50 | 0 | 17 |
| **1992** | 14 | 6 | 17 | 50 | 0 | 34 |
| **1993** | 21 | 6 | 0 | 100 | 0 | 0 |
| **1994** | 20 | 6 | 17 | 33 | 17 | 33 |
| **1995** | 14 | 6 | 17 | 66 | 17 | 0 |
| **1996** | 48 | 6 | 33 | 50 | 0 | 17 |
| **1997** | 62 | 6 | 33 | 50 | 0 | 17 |
| **1998** | 158 | 10 | 10 | 60 | 0 | 30 |
| **1999** | 772 | 20 | 30 | 30 | 0 | 40 |
| **2000** | 355 | 10 | 60 | 10 | 0 | 30 |
| **2001** | 214 | 10 | 20 | 30 | 0 | 50 |
| **2002** | 164 | 10 | 50 | 0 | 0 | 50 |
| **2003** | 291 | 10 | 50 | 50 | 0 | 0 |
| **2004** | 126 | 10 | 40 | 40 | 10 | 10 |
| **2005** | 94 | 6 | 50 | 17 | 0 | 33 |
| **2006** | 74 | 6 | 67 | 33 | 0 | 0 |
| **2007** | 16 | 6 | 17 | 66 | 0 | 17 |
| **Total** | 2,469 | 146 | | | | |

*Theme and tone*

Figure 3 and Table 1 present the distribution of articles published in *The Independent* between 1990 and 2007 according to their theme ($1^{st}$, $2^{nd}$ and $3^{rd}$ generations of GMOs and basic research). The different columns in Table 1 indicate the frequency distribution of *The Independent* articles on GMOs per year, the frequency of my representative sample and the percentage of coverage per each of the four themes of agricultural biotechnology (1st, 2nd, 3rd generations of GMOs and basic research) according to my sample. In Figure 3 I represent the estimated frequency for each theme.

As the table shows, the content analysis of a sample of 146 articles reveals *The Independent* featured, with almost equal emphasis, issues surrounding GMOs developed for the benefit of the producers (1st generation GMOs), plants and foodstuff with improved quality and tailored to the consumers (2nd generation GMOs), and GM basic research. In contrast, almost no coverage at all was provided on the 3rd generation GMOs. The latter is still in the early stages of research and aims to use plants as bio-farms for industrial or pharmaceutical compounds.

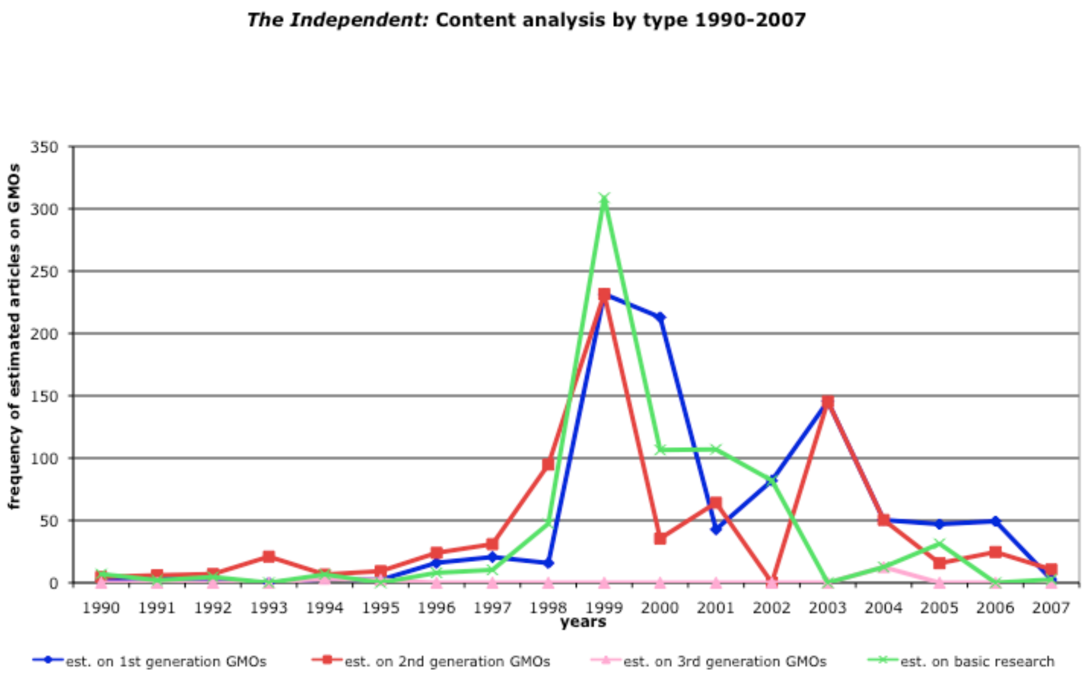


**Fig. 3: *The Independent:* Content analysis by type 1990–2007**

Counting the number of articles featuring one topic shows the level of public interest and awareness elicited by GMOs (Gaskell and Bauer, 2001; 2002); however, it tells us little about the opinions discussed in the newspaper. To explore how supportive or critical of GMOs *The Independent* was, I coded a selected sample of articles with one of five categories[47]. As Figure 4 shows, between 1990 and 2007 the tone of the newspaper frequently fall below the midpoint level (2). The tone average is greater than 2 only in 1994 and 1997 (2.2 for both years). Furthermore, over the years *The Independent* has become increasingly critical towards GMOs, with a major change registered between 1997 and 1998. Since 1998 the annual tone average has never exceeded 1.5, reaching a low point of 0.7 in tone average in 2002 and again in 2005. Notably, negative coverage seems to overlap with the years of greatest mass media attention.

In this context, it is interesting to note a decrease of tone between 2006 and 2007, with a total of 90 articles on GMOs. Looking for more clarifications in the articles' content, I found that nothing exceptional happened during these years[48]. The explanation, if not given by external GMO-related events, may lie in an internal change of policy. Perhaps *The Independent,* by that time, had taken upon itself the responsibility of denouncing the government's intention to push ahead with planting and consuming GMOs.

Finally, while checking for meaningful patterns in my data, I looked for associations between the theme and tone variables; however, the chi-squared test result was invalid[49].

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[47] Categories range between: very positive=4, positive=3, neutral=2, negative=1 and very negative=0.

[48] It occurred to me that the relatively small number of articles sampled per year might affect this data. In order to check this hypothesis I repeated my analysis on two new samples, one per each year, however I did not find any particular difference.

[49] For more detail see Appendix 3.

In summary, this analysis shows that *The Independent*, which split its attention between basic research issues, 1st and 2nd generation GMOs, has on the whole been somewhat negative in its coverage of GMOs. In addition, it is interesting to note that periods of high coverage such as 1998 and 2003 coincide with particularly low levels of support coming from the newspaper[50].

[50] As mentioned earlier, the UK is characterised by two varieties of newspapers, namely tabloids and broadsheets. Following Gaskell and Bauer (2001; 2002), I use *The Independent* to learn about public opinion on GMOs. However, in order to check for reliability and also considering that in Italy the newspaper I chose was both the opinion-leading newspaper as well as the most read, I decided to check how GMOs have been covered in the *Daily Mail*. The latter has been chosen for two main reasons: a) the fact that the *Daily Mail* is second in the UK after *the Sun,* for its readership (http://www.guardian.co.uk/media/table/2009/aug/14/abcs-national-dailies-july-2009), and b) the fact that the *Daily Mail* was formally against GMOs and launched, in June 1999, a successful campaign against this technology, popularising the word 'Frankenfood'. Notably, I did not find any remarkable difference between the two newspapers. More specifically, compared to *The Independent*, the *Daily Mail* had a rather lower coverage of the topic (total frequency of GM articles 1,804), but a similar frequency distribution in terms of both peaks and trends (see Appendix 5 for more detail). In terms of the tone, which I have checked over a sample of 49 articles spread between 1998 and 2007 that I selected with a similar sampling technique to the one used for *The Independent*, I noted that the *Daily Mail* has generally been less supportive than *The Independent*. Nevertheless, the tone variables for the two newspapers were very similar in terms of trends. Finally, looking at the theme, I found that the *Daily Mail* largely talked about the 1st generation of GMOs (54%) and basic research topics (34%), while almost completely ignored the 2nd and 3rd generation GMOs (6% and 2% of the sampled articles respectively). With regards to my thesis, the lower frequency of the *Daily Mail*, within a similar pattern of tone and coverage, supports my decision to focus on *The Independent,* where more articles were written on GMOs. In terms of the less supportive tone in the *Daily Mail* as opposed to *The Independent*, it did not surprise me, but just reflects the strong stance against this technology taken by the newspaper. In this context, avoiding using this newspaper as my primary source of data seems to be a good choice considering it might provide a biased representation of other British media coverage. Finally, in terms of the themes, the greatest difference between the two newspapers lies in the fact that the *Daily Mail* dedicated less attention towards 2ndgeneration GMOs and greater coverage to the 1st generation's products. Nevertheless, since there is an extent to which 1stgeneration GMOs are also the most criticised by the mass media, it might also be that this difference in coverage is due to the anti-GM campaign embraced by the *Daily Mail* and might be misleading for my analysis. (For further details, see Appendix 5).

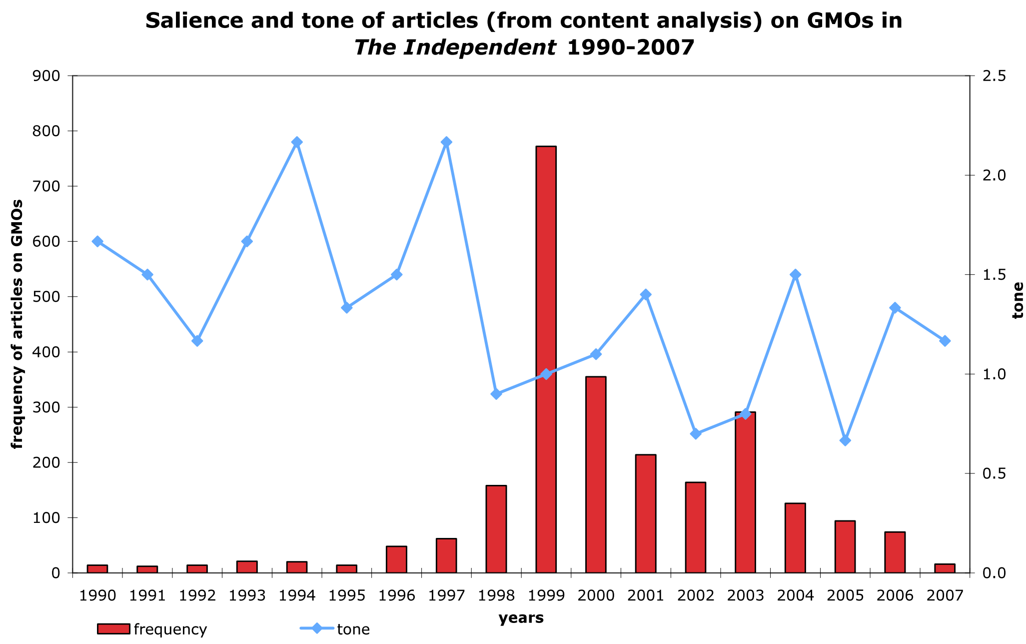


**Fig. 4: *The Independent*: Salience and tone 1990–2007**

### *2.1.3 Summary: Representations of public opinion on GMOs in Britain*

The above analysis was intended to explore: 'what were the representations of Britons' opinions on GMOs according to the *Eurobarometer* and mass media?' and 'how have these changed over time?'

Drawing on the representations of public opinion proposed by the two data sources, it appears that between 1990 and 2007 Britons shared certain concerns with regards to GMOs. Within this general uneasiness, the *Eurobarometer* indicates that Britons differentiated between GM crops and GM food. However, this distinction, which was clear throughout the 1990s, has recently become less evident as public support for GM crops is also decreasing.

In addition, according to my data, uneasiness towards this biotechnology increases throughout the 1990s. Public concern over GMOs peaks in 1999, when the *Eurobarometer* respondents provided highly polarised answers and showed the highest levels of scepticism towards this biotechnology. Notably, the content analysis of newspaper articles is in line with these findings.

Overall, I consider the end of the 1990s a 'key moment' within the British panorama, which is characterised by a solidification of public uneasiness and lack of support for GMOs.

**2.2 UK scientific output on agricultural biotechnology**

The following section explores the content of science output on agricultural biotechnology in the UK, and how this has changed over time. Accordingly, I follow publications, patents and field trials, which I will initially study separately and then merge together to assess scientific output in the UK more generally.

*Publications*

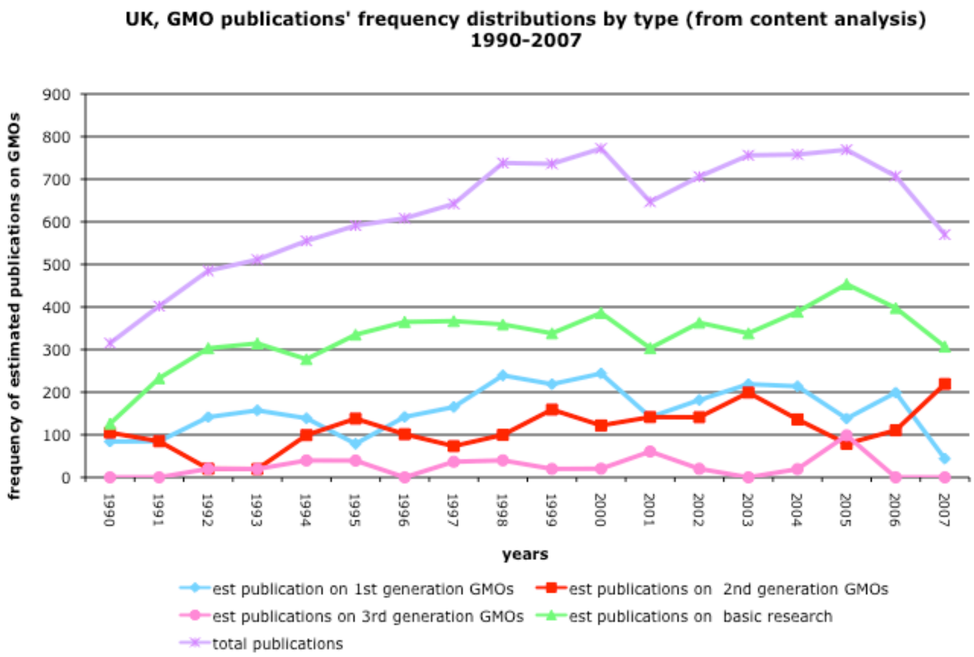


**Fig. 5: UK, GMO publications' frequency distributions by type (from content analysis) 1990–2007**

Figure 5 shows the frequency distribution of UK scientific publications on GMOs between 1990 and 2007, shown by the lilac line. The figure also represents the estimated distribution of publications into the four main research themes of agricultural biotechnology research, namely the 1st, 2nd and 3rd generations of GMOs and basic research, according to the sample analysis of 560 items.

Overall, between 1990 and 2007 UK scientists published 11,268 papers related to GMOs. In 1990, when this study starts, a total of 315 were written. In the following years, this figure gradually increases, reaching its highest point in 2000 with 772 publications. After 2000, the frequency of publications experiences first a decline of 19% (2001), then a period of recovery and stabilisation between 2002 and 2005 and finally a further decrease from 2006 onwards.

The content of a selected sample of GMO-related publications shows that British scientists wrote mostly on ‘basic research’ issues. Over half of all papers address general research questions, using GMOs as a scientific tool to increase basic knowledge of plant biology and genetics. The remaining half of the publications are split between studies on GMOs developed for the benefit of either producers (53%) or consumers (38%). In contrast, British GM scientists almost ignored 3rd generation GMOs or research aiming to use plants to produce pharmaceutical or industrial compounds, which only feature in 3% of the sampled papers.

Since the majority of papers deal with basic research topics, there is no doubt that this ‘theme’ has a great impact on the overall distribution, and might have hidden interesting information. Accordingly, I excluded for a moment this theme, and turned my attention to the other three distributions. The latter not only have different total frequencies, but also peak at different times, namely 1998 (and 2000) in the case of 1st generation GMOs, 2003 with regards to 2nd generation GMOs and 2005 in the case of 3rd generation GMOs. In addition, a timeline comparison of the content shows that the distribution of basic research papers mirrors that of 2nd generation GMOs. Specifically, when one distribution increases or peaks (i.e. basic research in 2005), the other decreases or reaches its trough.

Assuming there is a time lag between the start of a research project and its conclusion, as well as between the submission and publication of a paper, which in the case of biotechnology tends to vary between three and six months (Dong et al., 2006), I have asked myself how to interpret these data? Also, what does the figure say about the content and the evolution of publications on GMOs in the UK?

The content analysis of publication is not so clear to allow decisive interpretations, except for the fact that basic research topics are those that receive the greatest attention among British GM scholars. In addition, it should be noted that each research project takes a different amount of time to be realised and certain publications might take longer than others to be published. In this context, it seems more sensible to focus on the overall general trend, as this is not affected by approximations or other kinds of errors that might have occurred during the analysis/interpolation of the data. Looking at the shape of the total distribution of UK scientific publications on GMOs is sufficient to identify the turn of the century as the ‘key moment’ in the evolution of scientific publications on GMOs, one that has since stabilised and begun to decline.

*Patents*

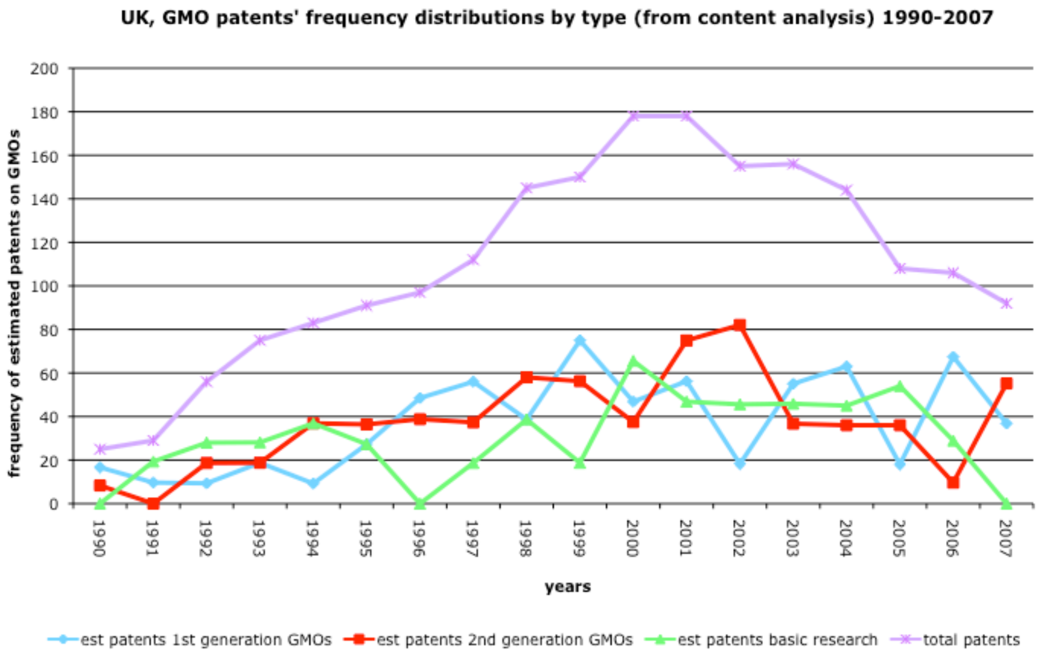


**Fig. 6: UK, GMO patents' frequency distributions by type (from content analysis) 1990–2007**

In Figure 6 I look at the total number of patents owned by UK residents (lilac line) and how these are distributed according to the content analysis of 213 documents, across the different themes of agricultural biotechnology, i.e. 1st and 2nd generation GMOs and basic research. Contrary to the publications, I decided against representing patents on plants used to produce industrial or pharmaceutical compounds[51].

[51] In this case, 3rd generation GMOs patents happen to be very few; hence it made more sense to exclude them from the graphical representation. Nevertheless, in Appendix 4 a detailed table reports the sample data and the frequencies for all the three generations of GMOs, basic research patents and the items I was not able to classify in any of these categories.

Overall, 1,980 patents to protect GMO inventions were requested in the UK between 1990 and 2007, at an average of 110 per year[52]. As the figure shows, the annual frequency of patents, which is just 25 at the start of this study in 1990, sharply increases over the decade. Between 1990 and 2000, which is when the peak of patent frequency occurs (178 patents), the average annual frequency change shows an increase of roughly +24% year on year. After 2001, when the number of patents equals that of the previous year (178 items), a downward trend begins. Specifically, between 2001 and 2007 the average annual decrease in the number of patents is approximately 10%. Especially notable are the -13% of 2002 and 2007, as well as the 25% decrease in 2005. In 2007, when this study ends, less than 100 new patents on GMOs had a UK owner.

The content analysis of UK patents shows that they are split between basic research (28%), 1st generation GMOs (34%) and 2nd generation GMOs (34%). In addition, the frequency of 1st generation GMO patents begins to decline after 1999, a year before the frequency of patents on basic research and three years before the distribution of patents on 2nd generation GMOs reaches an all-time peak.

According to Oldham (2006), the time lag between the submission and the publication of a patent is roughly 18 months. However, each patent has its own characteristics and might take different lengths of time to realise. Therefore, as with publications, we can only reflect on the moment at which either the patent or the publication was published, not when the study actually started or ended. This creates some problems in the interpretation of the data. Nonetheless, for a timeline analysis, it remains interesting to look at the distribution of total patents, as this is

[52] For comparison, between 1990 and 2004 the UK granted approximately 69,000 patents on all different kinds of inventions, with an average of 4,500 per year.

not affected by analytical errors that might occur when analysing the content of a restricted sample of documents. In this context, it appears that the turn of the century indicates a 'key moment' in the GM research panorama that is characterised by the earliest signs of decline and delay in the levels of innovations and production for this field. In addition, we can gather from the findings that in most of the cases British scientists decided to protect GM applications either belonging to the 1st or 2nd generations of GMOs.

*Field trials*

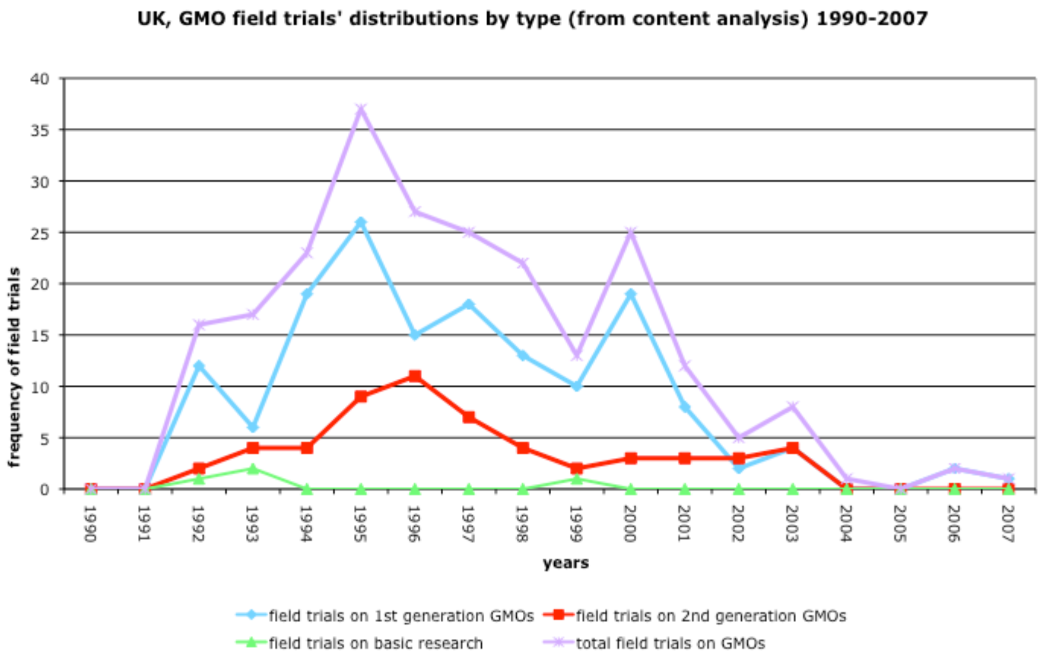


**Fig. 7: UK, GMO field trials' frequency distributions by type (from content analysis) 1990–2007**

Figure 7 represents the distribution of field trials on GMOs undertaken in the UK between 1990 and 2007, as well as the type of genetic modification that the trial tested. As with patents, I excluded 3rd generation GMOs from the graphical representation because I could not find any field trial of that kind[53].

Between 1990 and 2007 the UK's competent authority approved a total of 234 field trials. As the figure illustrates, the annual frequency of field trials rapidly increases until 1995, when it peaks with 37 requests. In 9 out of the 12 years that followed, field trials' annual frequency declines. The exception of 2000, with 25 requests, almost two times the annual frequency of 1999, is of particular interest. This can be explained by the fact that the *Farm Scale Evaluation* (FSE) programme, which is the largest experiment in GMO release in the UK, was about to start a significant number of trials in the following year.

The content analysis of field trials shows that British scientists released particularly 1st generation GMOs into the field (2/3 of total field trials), and of the remaining trials, 93% deal with GMOs developed for the benefit of the consumers, while the rest were carried out to answer basic research questions on plant genetics. Interestingly, throughout the sample period the ratio between 1st and 2nd generation GMOs is approximately 3:1; even so, after 2001 the data show a slight increase in 2nd generation GMO trials, so that 7 out of the 17 requests approved by the DEFRA between 2002 and 2007 fall in this category.

Similar to publications and patents, the annual frequency of field trials increases in the first half of the 1990s. However, the number of field trials begins to decline in 1996, four years earlier than publications (2000) and five years before

[53] Appendix 4 reports a detailed table with the sample data and the frequencies for all the three generations of GMOs, basic research field trials and the items I was not able to classify in any of these categories.

patents (2001). This suggests that 1996 is a ‘key moment’ for the frequency of field trials in the UK.

The discrepancy of field trials with publications and patents raises interesting questions (i.e. why does the frequency of field trials decrease before other science outputs? Are field trials more sensitive than publications to negative public opinion?) and hypotheses. One possibility is that the nature of the indicators themselves explains this discrepancy. Field trials are an integral part of the research project and occur especially at the beginning or in the middle of GMO study. Publications and patents, on the other hand, are usually part of the final outcome of a research project. In addition, one should consider that field trials, because of the way they are obtained and realised, closely intersect with the government, which might have had an impact on the early decrease of this output. Finally, it might be that field trials, as an indicator, are more sensitive to public opinion on GMOs, and so decrease in the early stages of the GM controversy.

*Scientific outputs of GMOs*

Throughout this section, I have questioned the amount and content of three UK scientific output indicators on agricultural biotechnology over time. Overall, my findings show that an initial increase in the frequency distributions of the selected GM research output has been followed by a similar, and even more rapid, decrease. Within this context, publications and patents are consistent and begin their decline in 2000 and 2001 respectively. This raises a question about the decline of field trials, which starts in 1996.

Moving on to the content of GMO scientific output, the study found that, for both publications and patents, the annual frequency of 1st generation GMOs declines a few years before the frequency of papers on 2nd generation GMOs.
However, the differences seem much more interesting here. Specifically, my findings show that while with regards to publications basic research questions (52%) prevail, when looking at patents and field trials, GMO applications developed for the benefit of either the producers or the consumers are more frequent (68% and 90% of patents and field trials requests respectively). It seems quite likely that this difference is associated with the nature of the three scientific output indicators adopted when related to GMOs. Publications, being the first and most popular academic output, are the most suitable tool to question basic research issues; in contrast, intellectual property rights are usually expensive and it is not presumptuous to assume that they are mainly requested where there is a final product that will ultimately be sold, such as 1st or 2nd generation GMOs. Similarly, it is difficult to imagine someone requesting field trials to explore basic research questions considering that, in most cases, basic research questions can be easily answered inside the laboratory.

Overall, this suggests that the three scientific output indicators employed by this study are more likely to provide a comprehensive overview of the GMO scientific milieu than any single one of them on its own would be able to.

Beyond the relevant answers this science output analysis provided, there are important questions that it leaves open, such as: why do the UK field trial requests start to decrease so early? Is it because this indicator is more sensitive to public opinion than publications and patents? What does this tell us about Britons' scientific activity on GMOs?

Clearly, the range of data I had in front of me proved insufficient to answer most of these questions. I will, however, further explore them in the following chapters.

**3. Association between the representations of Italians' opinions on GMOs and agricultural biotechnology scientific output**

This section begins by discussing the representations of Italians' opinions on GMOs. This is followed by an overview of the content and path of agricultural biotechnology output through the analysis of publications, patents and field trials. These results, together with the section above, represent the basic material that I use in order to address the main question of this chapter, which is limited to the UK and Italian national contexts, and asks if an association between scientific output and the representations of public opinion, according to the *Eurobarometer* and mass media articles, is at all possible.

**3.1 Representations of Italians' opinions on GMOs**

My analysis of Italians' opinions on GMOs draws on the representations of public views on GMOs provided by the *Eurobarometer* special report on science and technology (1991–2005) and *Il Corriere della Sera* articles on GMOs. Starting with the *Eurobarometer*, I reflect on the survey's representations of Italians' perception of risk and support of GMOs. I then examine how *Il Corriere della Sera* has covered the GM debate, and conclude with a discussion of Italians' opinions on GMOs, how public opinion evolved between 1990 and 2007 in Italy, and its relationship to scientific output.

*3.1.1 Italians' perceptions of GMOs*

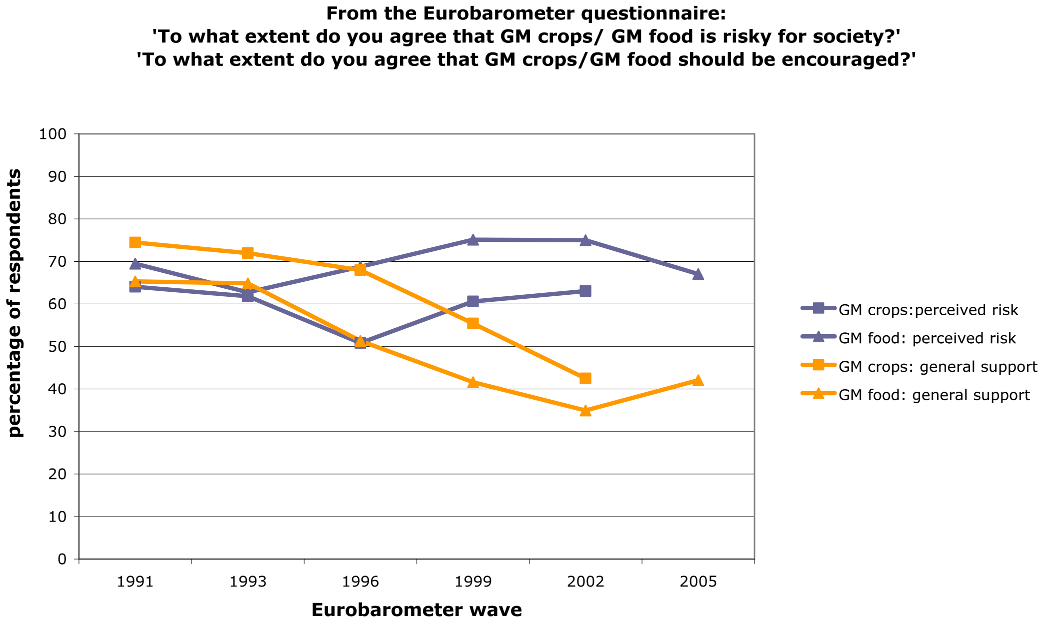


**Fig. 8: GM crops and GM food – risk perception and general support, 1991–2005**

In order to assess Italians' perceptions on GMOs, the *Eurobarometer* asks four questions. Just as in the UK, these questions address the extent to which respondents agreed that either GM crops or GM food are a) risky for society or b) should be encouraged. Figure 8 refers to the respondents who gave an answer other than 'don't know'[54] and shows the percentages of those who gave positive answers ('definitely agree' or 'tend to agree') to these questions.

As the chart shows, in the early 1990s the majority of answers are in support of both GM crops (74%) and GM food (65%). Nevertheless, in the same year 64% and 69% of respondents expressed their concerns with regards to GM crops and GM food respectively. In the following years, the survey indicates a decrease in support

[54] For more detail on why 'don't know' answers have been excluded. See the Material and methods section 1.1.

towards both applications, accompanied by an increase in perceived risk. Interestingly, from 1991 onwards, Italian respondents viewed GM crops as less risky for society than GM food, which also attracted less of the nation's support. This discrepancy is particularly evident in 1996, when 68% and 51% of the survey respondents were supportive towards GM crops and food respectively, while 51% and 69% declared to be worried about these same technologies. With the turn of the century, however, the *Eurobarometer* representations of Italians' perception of GM crops become more similar to those of GM food.

Figure 8 is not only useful to compare respondents' attitudes towards GM crops and GM food, but also to study their evolution over time. With regards to GM crops, the *Eurobarometer* shows that in 1991 74% of respondents encouraged these technologies, while 64% said they represent a risk to society. Between 1993 and 1996 the survey indicates minimal decreases in respondents' support towards this application, -2% and -4% respectively, which are coupled with a decrease in risk perception of -2% and -11% respectively. Risk perception of GM crops reaches its lowest level in 1996, with just half of respondents considering it a risky application. This situation does not last for long, as the 1999 *Eurobarometer* reports a 10% increase in Italians' risk perception and a 13% decrease in support. According to the *Eurobarometer*, Italians' concerns about GM crops does not change significantly in subsequent years, while their levels of support continue to fall, reaching a low point in 2002 when just 42% of the respondents showed some support towards this technology.

Compared to GM crops, the *Eurobarometer*'s representations of Italians' perceptions of GM food normally result a bit lower in terms of support and higher in terms of risk perception, albeit following a similar pattern. Paralleling GM crops, in the early 1990s respondents were ambivalent with regards to GM food, combining concern with support. Between 1991 and 1993, on average 66% of answers indicate GM food as risky for society, while 65% suggest it should be encouraged. It is then striking to find a 14% decrease in support in the *Eurobarometer* 1996, coupled with an increase in risk perception of 6 percentage points. Furthermore, the *Eurobarometer* localises the peak in risk perception in 1999, when 75% of Italian respondents expressed some concerns about GM food. This level of concern is confirmed three years later, which is also when this application reaches the lowest levels of public support, with only 35% of the observed respondents agreeing that GM food should be encouraged.

In order to further study the representations of Italians' perception of GMOs in the *Eurobarometer*, I looked at how strong, or ambiguous, respondents' opinions are. Figure 9 (below) was created with this particular purpose. Similarly to the UK, the percentages were calculated by adding 'definitely agree' and 'definitely disagree' answers and are intended to show the levels of polarisation among Italians' perceptions of GMOs.

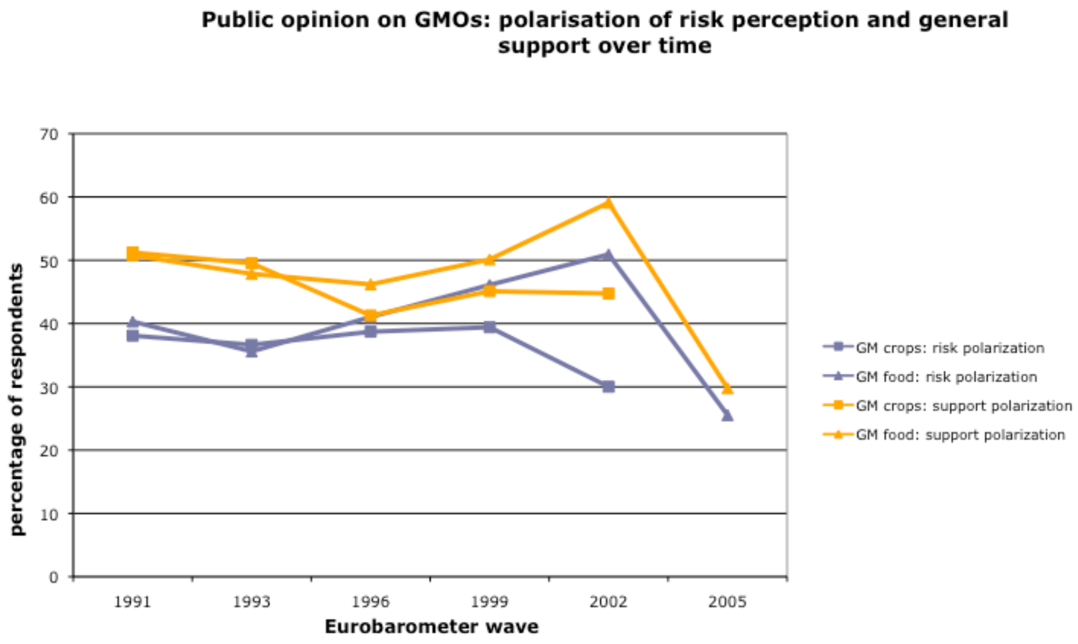


**Fig. 9: Public opinion on GMOs in Italy: polarisation of risk perception and general support over time**

The figure shows that the lowest levels of polarisation in respondents' perceptions of GMOs are positioned at the end of the x-axis, when approximately one out of three answers on GM food questions are unambiguous. In contrast, the *Eurobarometer* 1991 shows that, when asked about their level of support towards either GM crops or food, 51% of respondents chose one of the two extreme answers. In addition, in the same year on average 39% of *Eurobarometer* respondents either strongly agreed or strongly disagreed that GM crops and GM food are risky to society. Typically, these data parallel their overall averages[55]. The highest levels of polarisation for both questions about GM food fall in 2002, when 51% and 59% of the respondents gave unambiguous answers. It is striking to note

[55] Overall averages for GM crops risk polarisation 37%, for GM crops support polarisation 46%, for GM food risk polarisation 40%, for GM food support polarisation 47%.

that in the same year the *Eurobarometer* registers the lowest degree of polarisation (30%) in risk perception of GM crops.

Further analysis shows that in 1991 the greatest component of polarised answers can be explained by the strong support for GMOs and low levels of risk perception. However, by 2002 this picture is completely reversed. The percentages of answers strongly in favour of GM crops drops from 43% in 1991 to 18% in 2002. Furthermore, between 1993 and 2002 the percentage of respondents strongly concerned about GM food escalates from 25% to 38%. Overall, this analysis points to 2002 as a 'key moment' within the *Eurobarometer*'s representations of Italians' perception that is characterised by strong and unsupportive opinions regarding GMOs.

In summary, the section highlights that Italian respondents have generally been slightly more supportive of GM crops than GM food. This finding mirrors the *Eurobarometer*'s representations of risk perception, which indicate that Italians were more worried by GM food than GM crops. With regards to the evolution of respondents' perceptions of GMOs, the *Eurobarometer* indicates that in the early 1990s Italians shared ambivalent feelings for GMOs and combined concerns about with support for this technology. This was followed by a diversification in the respondents' answers, which specifically indicates an increase in their risk perception and a decrease in their support. The *Eurobarometer* 2005 represents an increase in support for GM food coupled with a decrease in risk perception and polarisation. Overall, the *Eurobarometer* points to 2002 as a 'key moment' in Italians' perception of GMOs, characterised by low support and high risk perception. As such, I will pay particular attention to this year in the analysis of mass media reporting on GMOs.

*3.1.2 Mass media*

This sub-section explores the coverage of agricultural biotechnology in the Italian, opinion-leading newspaper *Il Corriere della Sera*[56] for the years between 1992 and 2007. Similarly to the UK, I begin with an overview of the data and then analyse the theme and tone of the articles.

*Overview of the data*

The *Il Corriere della Sera* online database allows access to all articles published since 1992. The overall population of articles mentioning GMOs that were used for this study totalled 1,011. These articles, which were published between 1992 and 2007, spanned from opinion articles, letters to the editor and scientific reports.

Figure 11 plots the estimated frequency of GMO articles for each of the four themes according to the sample analysis of 130 articles. The figure indicates the newspaper ignored agricultural biotechnology until 1996. The following year, which coincides with the birth of Dolly the sheep, marks the first mention of these techniques by the Italian opinion leading newspaper, with more than 10 articles. In 1999 *Il Corriere della Sera's* coverage of the GM debate averages one article per week. Noticeably, this increase overlaps with the beginning of the EU's de facto moratorium of GMOs and opens the way to five years of extremely intensive media coverage of GMOs. Between 2000 and 2004 *Il Corriere della Sera* published

[56] Contrary to the UK, the Italian newspapers' panorama does not differentiate between tabloids and broadsheets. In Italy, in fact, there is only one kind of newspaper, which mixes the characteristics of British tabloids and broadsheets. For this reason, by selecting Il Corriere della Sera, which is the newspaper with the greatest readership, I did not encounter the same difficulties that have, in the UK, brought me to analyse the *Daily Mail* in parallel with *The Independent*.

approximately 70% of the 1,011 articles on GMOs (726), with an average of three articles per week. The number of articles peaks in 2003, when 216 articles on GMOs were published. Undoubtedly, by that time GMOs were being included in the mass media agenda. One question that needs to be answered is why this attention peaked during this period, which requires turning to the content of the articles.

In April 2000 Alfonso Pecoraro Scanio[57], a Green Party representative openly opposed to GMOs (Lazzaro, *Il Corriere della Sera,* 2000), was appointed Minister of Agriculture and Rural Affairs. Furthermore, the same year Italy appealed to the security clause in article 12 of the European Union regulation 258/97, calling for the suspension of commercialisation of products that contain four GM corn varieties[58]. This document, also known as the *Amato Decree*[59], features in 1/3 of the sampled articles for the year 2000. Noticeably, it represents the first time a European Union country appealed to the security clause, bringing a matter of food to the attention of the European Union Scientific Committee on Food. Importantly, the negative decision of the committee[60] generated a long and tedious debate[61], which did nothing to facilitate the introduction of these products into the Italian market.

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[57] Green Party Minister of Agriculture in the second Amato government from 25th April 2000 to 11 June 2001.

[58] The four GM varieties include BT-11 (Novartis), MON-809, MON-810 (Monsanto) and T25 (Aventis).

[59] Giuliano Amato was Prime Minister of Italy twice, first between June 1992 and April 1993, and second between April 2000 and June 2001.

[60] The Committee concluded that 'the information provided by the Italian Authorities does not provide detailed scientific grounds for considering that the use of the novel foods in question endangers human health' (Opinion of the Scientific Committee on Food, 2000).

[61] A petition was filed by Monsanto Agriculture, Novartis Seed Spa (today Syngenta Seeds Spa), Pioneer Hi Breed Italy and Assobiotec. The subsequent court case concluded on 29th November 2004 when the Administrative Tribunal (T.A.R.) of Lazio nullified the *Amato Decree,* but denied the companies any monetary compensation for the moratorium.

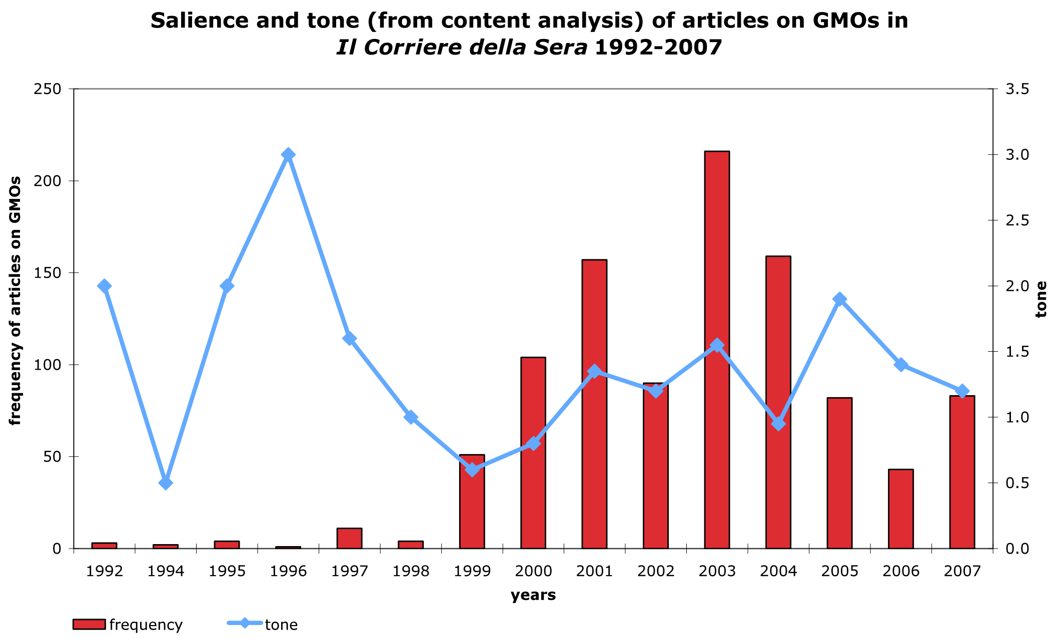


**Fig. 10: *Il Corriere della Sera*: salience and tone between 1992 and 2007**

In May 2000 Italian researchers organised a protest in Rome in response to Minister Pecoraro Scanio's attempts to halt field trials on GMOs in Italy (Polacchi, 2000[62]). In this circumstance, scientists called for government and public attention towards the block of environmental release of GMOs and the general state of stagnation that characterised Italian scientific research (Cazzullo, *Il Corriere della Sera,* 2001). Interestingly, *Il Corriere della Sera* ignored this action. In the following year Giovanni Alemanno was appointed Minister of Agriculture. The new minister, with an unprecedented action, put into practice Pecoraro Scanio's resolutions, suspending all field trials being run by the research institutes financially dependent on the Agriculture Ministry (Meldolesi, 2002). Noticeably, *Il Corriere della Sera* only vaguely mentioned this episode, while covering broadly the FAO summit on biotechnology (June 2002). On that occasion Alemanno publically declared his intentions to

[62] http://lgxserver.uniba.it/lei/rassegna/000504e.htm (last access 01/07/2010)

continue the moratorium on GMOs on a national if not a European level (Alemanno, *Il Corriere della Sera*, 2002). By the end of this period of high coverage, the government launched a €6 million project called *OGM in Agricoltura*[63] and began to work on the *Coexistence Decree* (2004, Decreto Legislativo n. 279). While *OGM in Agricoltura* was entirely ignored by the newspaper, the decree features in 8 of the 30 sampled articles between 2004 and 2005. Becoming law in January 2005, *Coexistence Decree* delegates the task of developing coexistence programmes for GM and non-GM crops to the regions (20 overall in Italy). In March 2006, after a few regions approved their coexistence programmes (Collavin, 2007), the Italian Constitutional Court found the law on coexistence unconstitutional[64].

As the figure shows, after 2004 mass media attention on GMOs decreased. The average number of articles published between 2005 and 2007 is 69, slightly above the overall period average of 67. In this context, it is nonetheless interesting to note that by 2007 a new anti-GM campaign, organised by activist Mario Capanna[65], was taking shape in the country and features in 2/5 of the sample articles (Caizzi, *Il Corriere della Sera,* 2007; Capanna, *Il Corriere della Sera,* 2007). This may partially explain why the GM debate continues to be an issue of discussion in the Italian mass media.

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[63] 'OGM in Agricoltura' (2003–2007) is a four-year project funded by the government and coordinated by the Institute of National Research for Food and Nutrition, which is intended to address a wide variety of topics associated with GMOs, ranging from scientific to social matters. An attentive review of this material will be included in Chapter 5 of this thesis.
[64] http://lists.peacelink.it/consumatori/2006/03/msg00044.html (last visit 01/07/2010)
[65] Mario Capanna is known as one of the leaders of the Italian student movement during the 1960s.

**Table 3:** ***Il Corriere della Sera*****'s frequency distributions by type from content analysis 1990–2007**

| *Il Corriere della Sera* 1992 – 2007 | Frequency (full population) | Sample size (number of articles) | Percentage of articles on 1st generation GMOs | Percentage of articles on 2nd generation GMOs | Percentage of articles on 3rd generation GMOs | Percentage of articles on basic research |
|---|---|---|---|---|---|---|
| **1992** | 2 | 2 | 50 | 50 | 0 | 0 |
| **1993** | 0 | 0 | - | - | - | - |
| **1994** | 2 | 2 | 100 | 0 | 0 | 0 |
| **1995** | 5 | 5 | 60 | 0 | 0 | 40 |
| **1996** | 1 | 1 | 0 | 0 | 0 | 100 |
| **1997** | 11 | 5 | 60 | 0 | 0 | 40 |
| **1998** | 5 | 5 | 100 | 0 | 0 | 0 |
| **1999** | 51 | 10 | 20 | 0 | 0 | 80 |
| **2000** | 104 | 10 | 60 | 10 | 0 | 30 |
| **2001** | 157 | 20 | 40 | 10 | 0 | 50 |
| **2002** | 90 | 10 | 20 | 10 | 0 | 70 |
| **2003** | 216 | 20 | 30 | 0 | 0 | 70 |
| **2004** | 159 | 20 | 20 | 0 | 0 | 80 |
| **2005** | 82 | 10 | 30 | 0 | 0 | 70 |
| **2006** | 43 | 5 | 0 | 40 | 0 | 60 |
| **2007** | 83 | 5 | 20 | 20 | 0 | 60 |
| **Total** | 1,011 | 130 | | | | |

*Theme and tone*

It is not only interesting to reflect on the coverage of GMOs, but also to look at how the opinion leading newspaper covered the debate. In order to do so, I turn to Figure 10. The blue line is an indicator of the tone[66] used by the newspaper to address

[66] The tone variable I constructed has five possible categories (very positive=4, positive=3, neutral=2, negative=1 and very negative=0, giving a midpoint=2), and in the figure I have represented the average of the variable for each year according to my sample analysis.

GMOs. In this case, I coded the 130 articles of my representative sample in a range of categories from 1 to 5.

As the figure shows, the tone ranges between 3 (1996) and 0.5 (1994) points on the tone scale, with an average of 1.4. Furthermore, while before 1996 the tone fluctuates both above and below the midpoint, after that year *Il Corriere della Sera* became consistently unsupportive. The average tone between 1998 and 2007 is 1.2 and exceeds the overall average (1.4) only twice, specifically in 2003 (1.6) and 2005 (1.9).

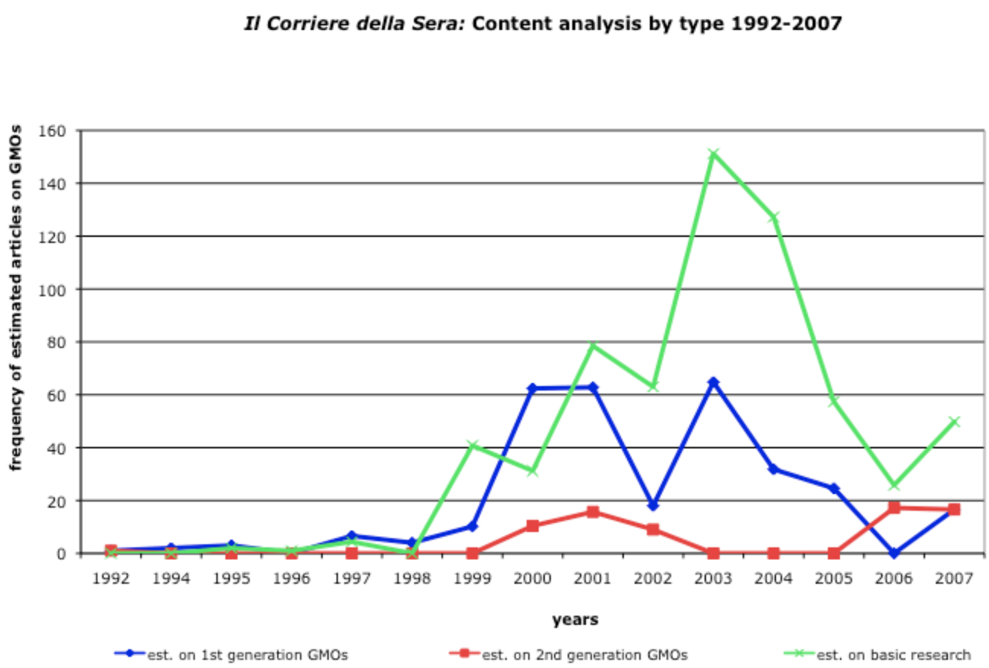


**Fig. 11: *Il Corriere della Sera:* Content analysis by type 1992–2007**

Continuing with the analysis of the content, but moving on to the topics discussed by *Il Corriere della Sera*, my findings highlight a relevant disproportion between the Italian newspaper's coverage of basic research questions (56%), 1$^{st}$ generation GMOs (38%), 2$^{nd}$ generation GMOs (6%) and 3$^{rd}$ generation GMOs (0%). This suggests that up to 2007 the Italian opinion leading newspaper, in the majority of cases, viewed GMOs as either a matter of research or as a product that would bring benefits to the producers. Finally, it should be noted that the data were proven insufficient to study the association between theme and tone[67], which might be an interesting question to elaborate on in future studies.

Overall, this analysis indicates that until 1998, GMOs were not included in the Italian mass media agenda. Nevertheless, mass media attention increased over the years, peaking in 2003 with 216 articles. Afterwards, the GM issue continued to be part of the mass media agenda in Italy. This raises a question about if, and when, this trend will change. Furthermore, it can be noted that as the frequency of reporting rises through the years, so has the critical tone of the writing, with an average tone variable stabilising around 1.2 after 1997, which is far below the positive peak of 1996 (3 points on the tone index). Finally, the analysis shows that the mass media agenda did not generally discuss GMOs in reference to consumers or as a means to produce new pharmacological or industrial compounds.

*3.1.3 Summary of Italians' opinion on GMOs*

The *Eurobarometer*'s representations of Italians' perception of GMOs indicate a spread level of concern over the period investigated. In addition, respondents' support towards GMOs has been characterised by a downward trend, which bottoms out in 2002. Interestingly, in the following year falls a peak of mass media attention, with over 200 articles mentioning GMOs and related issues published by *Il Corriere della Sera*.

[67] For more detail see table in Appendix 3.

Overall, the analysis of the representations of public opinion provided by the *Eurobarometer* and *Il Corriere della Sera* point to the period between 2002 and 2003 as a 'key moment' in terms of public opinion on GMOs, one that is peculiar for the lack of support and the high levels of coverage that characterised mass media.

Finally, it should be noted that the *Eurobarometer* indicates a distinction between GM crops and GM food according to Italian respondents, who preferred the former to the latter application. Notably, GM food received less coverage than GM crops in the Italian opinion-leading newspaper.

**3.2 Italians' scientific output on agricultural biotechnology**

This section reviews Italians' scientific output (i.e. publications, patents and field trials) on agricultural biotechnology. The development and the content of these indicators is discussed one by one and, at the end of the section, I take the results together in order to provide a general overview of the evolution and the topics that matter, looking at the Italian agricultural biotechnology output.

*Publications*

Between 1990 and 2007, 5,362 papers related to GMOs were published by Italian scientists, with an average of 298 papers per year. As Figure 12 highlights, the distribution of total publications follows a fluctuating upward trend until 2004, when the frequency of papers on GMOs peaks with 466 publications. In 2005, and then again in 2006, the annual frequency of publications registers a decrease of 8%. These take the annual frequency back to under 400 publications per year, or else the frequency registered at the end of this study's time horizon.

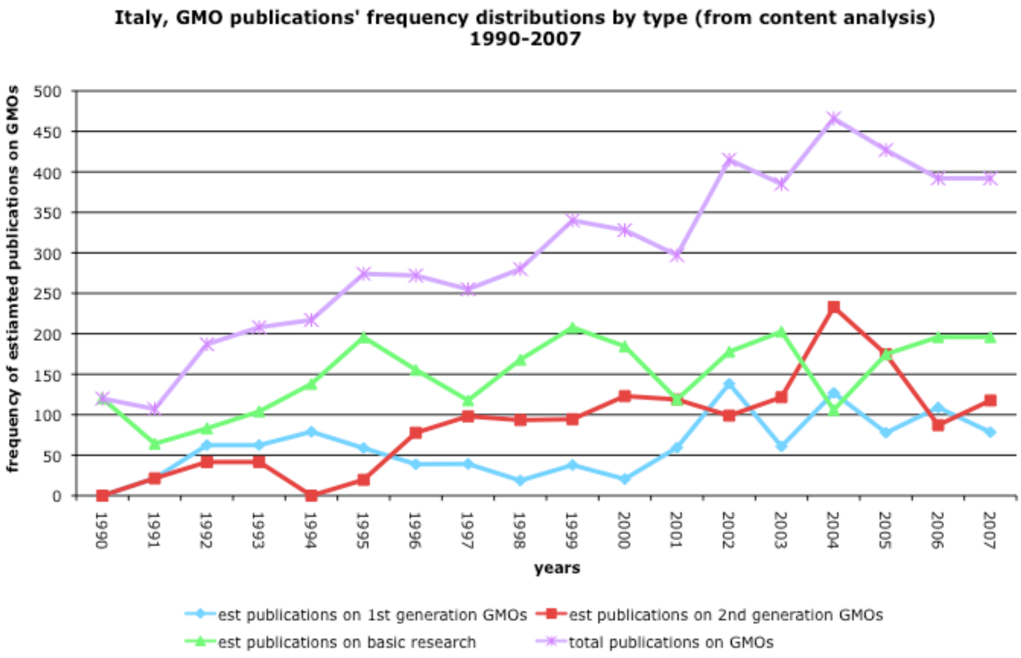


**Fig. 12: Italy, GMO publications' frequency distributions by type (from content analysis) 1990–2007**

Figure 12 also plots the distribution of the estimated frequencies for the different topics addressed by Italian researchers. These, which are estimated on the content analysis of 271 papers, are spread between basic research issues (50%), 2nd generation GMOs (30%) and 1st generation GMOs (20%), while almost no attention is given to 3rd generation GMOs[68] (>1%). While the distribution of basic research articles continues to fluctuate throughout the period observed, the distributions of the total Italians' papers on GMOs, 1st generation GMOs and 2nd generation GMOs peak at specific times. Typically, the distribution of 2nd generation papers and total publications on GMOs peak in 2004, while 1st generation GMOs distribution peaks two years before (2002). In this context, it is worth highlighting the results of the

[68] Considering the extremely low number of 3rd-generation GMO papers, I have decided against including these in Figure 12; however, in appendix 4 a detailed table with the frequencies per each of the four categories of scientific papers is reported.

content analysis in 2004. Almost half of the articles discuss modifications aimed at improving food quality with an impact on the consumers, 30% deal with GMOs for the benefit of the producers and the remaining 20% cover basic research questions.

Looking at these findings, it emerges that, aside from basic research, which is covered in half of the articles, scholars have written, in order of frequency, on GMOs developed for the benefit of the consumers (30%) first and on those aimed at facilitating producers' work (20%) second. Noticeably, the latter group of publications peaks two years earlier than the former. However, as the time lag between submission of a paper and its publication is subject to variations across different papers, some publications might take less time than others to get published. This might have flattened out differences or compromised the peaks discussed above, making it more interesting to look at the overall trend that is not affected by estimation errors and other mistakes I might have made during the content analysis. In this context, a timeline analysis shows that the last increase in the frequency of Italian publications on GMOs is registered in 2004. This, which raises questions about the current state of Italian publications on GMOs, suggests that 2004 was a 'key moment' for this indicator, one that is characterised by a decline in the frequency and possibly an increase in attention towards 2$^{nd}$ generation GMOs.

*Patents*

Between 1990 and 2007 Italy granted 71 patents to cover new inventions broadly related to agricultural biotechnology, averaging at 4 patents per year, which corresponds to just over 1% of the total number of patents granted in Italy between 1990 and 2004[69].

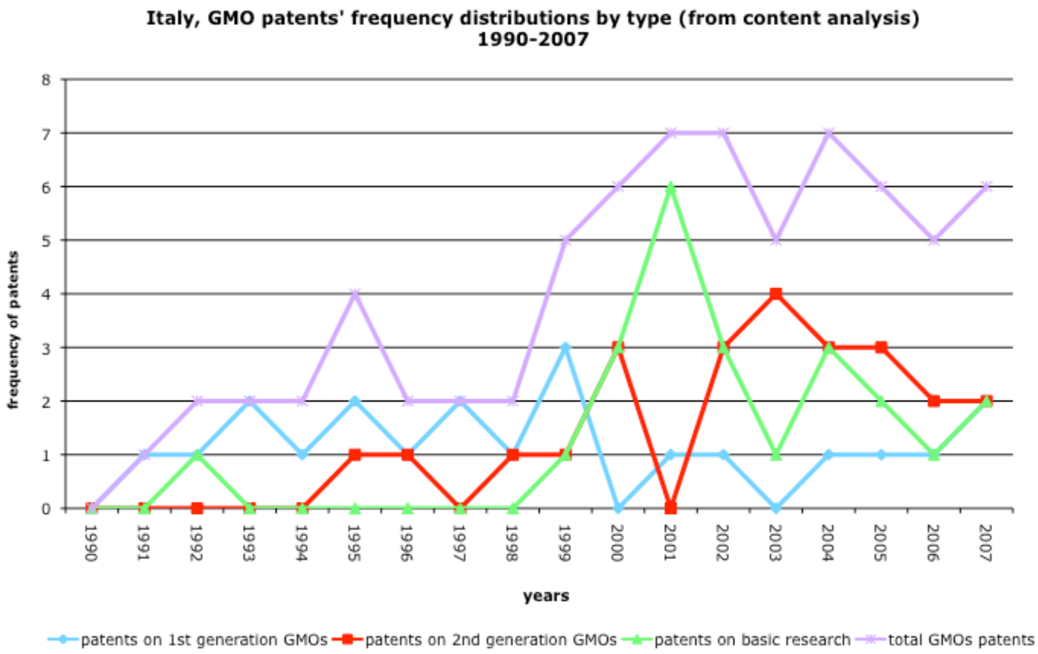


**Fig. 13: Italy, GMO patents' frequency distributions by type (from content analysis) 1990–2007**

In Figure 13 I represent both the total frequency and the content of this scientific output. Perhaps the main limitation of this figure is that, due to the small numbers of patents per year across types of research, the changes are difficult to interpret. Concentrating on the overall development, it is interesting to find that after 1998, the number of patents granted in a year did not fall below five. Furthermore, as the figure shows, Italy used patents to protect 1st and 2nd generation GMOs as well as basic research issues, as each of these three categories takes up 1/3 of the total documents, leaving once again no attention to 3rd generation GMOs.

[69] For comparison, between 1990 and 2004 Italy granted approximately 48,000 patents on all different kinds of inventions, with an average of 3,200 per year.

What is interesting in this data has less to do with quantification and more with what these numbers may represent in terms of patenting practices in Italy. The extremely low figure of patents raises important questions about the value of patents as a measure of scientific output of agricultural biotechnology in the Italian context. This suggests that there may be different cultures of patenting, and of science, according to national context.

*Field trials*

The analysis of approved field trials of GMOs concludes this study's exploration of science output. Unlike patents, Italian researchers requested and undertook numerous field trials, especially when compared to the rest of the European Union. With its 278 field trials and an average of just over 15.5 trials per year, Italy ranks third in the European Union, followed by the UK and only surpassed by France and Spain.

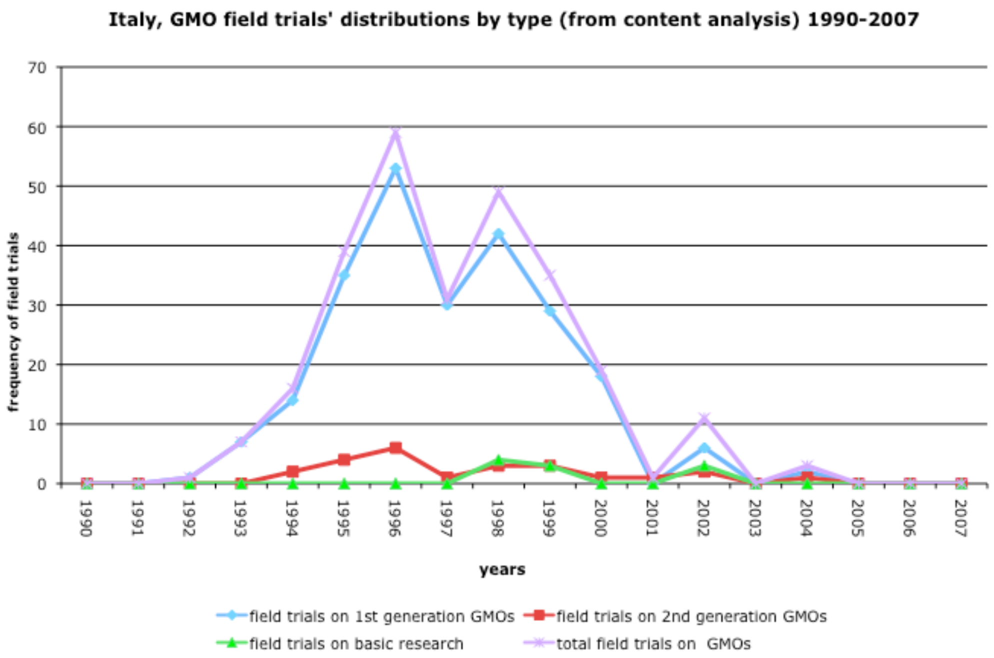


**Fig. 14: GMO field trials' distributions by type (from content analysis) 1990–2007**

It is immediately apparent from the figure that, between 1992 and 1996, the annual frequency of approvals to release GMOs into the environment increases rapidly. In addition, in 1996 the number of approved field trials reaches an overall peak, with a frequency of 59. This figure dramatically decreases in the following five years, so that in 2001 Italian authorities only approved one request. In this context, it is interesting to note the fluctuation in frequency of field trials that characterises the years 1996–1998. As we can see, a 47% annual decrease between 1996 and 1997 is followed by a 58% increase between 1997 and 1998. After 1998, no further increase in the frequency of field trials is registered, with the exception of 2002, when the number of approved requests totals 11.

Moving onto the content, my finding indicates, once again, a disproportion in the type of modification tested in the trials. In particular, starting from the lowest extreme, I found no field trials studying bio-farm plants (3rd generation GMOs). Meanwhile, approximately 4% of the requests focus on basic research experimentations, roughly 10% study GMOs developed for the benefit of the consumers (2nd generation GMOs) and the majority of field trials (85%) explore GMOs developed for the benefit of the producers[70] (1st generation GMOs).

In summary, this analysis shows that Italian researchers used the majority of Italian field trials to test 1st generation GMOs. In addition, 1998 represents a 'key moment' in terms of GMOs released into the Italian environment, which

[70] As for Italian patents and publications, the figure does not represent 3rd generation GMOs. A detailed table with the frequency for each theme is reported in Appendix 4. Here, I have also included the number of field trials I could not classify in any of my categories.

dramatically declined thereafter. Notably, Italian authorities did not approve any field trial requests after 2005.

*Scientific output*

There are three main points to take from the analysis of agricultural biotechnology output in Italy. First, the extremely small number of patents raises important questions about whether these are a valid indicator of Italian agricultural biotechnology output and, more generally, of science. This introduces further reflections about the very characteristics that scientific research takes in Italy and how these might be different when compared to other countries. It seems reasonable to assume that the limited number of patents contributes to define the Italian GM science culture. It will be interesting to see which other characteristics contribute to shape GM science culture. Second, this analysis points to a differentiation in terms of content across the three science output indicators, which suggests a relation between output indicators and the different 'themes' of agricultural biotechnology. Specifically, Italian scientists largely used publications as a means to address broad genetic and biology questions (50%), the majority of patents to protect GM applications such as 1$^{st}$ or 2$^{nd}$ generation GMOs and field trials to test GMOs developed for the benefit of the producers. Finally, and with regards to the temporal development of agricultural biotechnology, this analysis has contributed to open up new questions that this thesis will possibly answer through the next chapters, such as why do 'key moments', similar in their characteristics, occur in different time periods across the different scientific output indicators? As the analysis of Italy shows, the annual frequency of field trials begins to decline in 1998 while publications did not decline until 2004. Why this discrepancy? As discussed in the British context, there are multiple explanations. It might be that this is due to the fact that, chronologically speaking, field trials are likely to occur at different stages (i.e. beginning, middle, end) in an ideal research project on GMOs, while publications and patents represent the natural conclusion of such study. However, this discrepancy introduces further questions vis-à-vis lay people, i.e. are field trials more sensitive to negative public opinion than patents and publications? Or perhaps, is it more likely to assume that the decrease in field trials is entirely independent from public opinion? If this is the case, what else might be responsible for the early decrease?

It appears then that the answers to my questions might go beyond the analysis of scientific output and public opinion. This suggests that the question needs further elaboration. However, before concluding this chapter, there is a further step that I need to take. In the next section, analysing Italy and the UK side by side, I question whether these findings support the hypothesis that an association between public opinion on GMOs and agricultural biotechnology output is at all possible.

**4. Association between public opinion on GMOs and agricultural biotechnology scientific output**

In this section I bring together my analysis on Italy and the UK in order to discuss possible associations between public opinion on GMOs and science output in both countries.

The two charts below (Figures 15 and 16) are intended to summarise public opinion on GMOs and agricultural biotechnology scientific output in the UK and Italy respectively. It was decided that the best way to address this question was by creating four indexes[71], one to describe public opinion and the other three to represent publications, patents and field trials. For each of the three science output indicators, I set the maximum value that was reached during the observation timeframe as 1 and calculated all other values as proportions in relation to this maximum. Thus, I created three indices with values ranging from 0 to 1. On the other hand, for public opinion I summarised the figures for total support[72] of GM crops and GM food[73]. This was achieved by calculating the average between the two values. Because the figures are percentages (of respondents who support GMOs), they can just as well be given as fractions of 1, thus confining the index to the same range of 0 to 1.

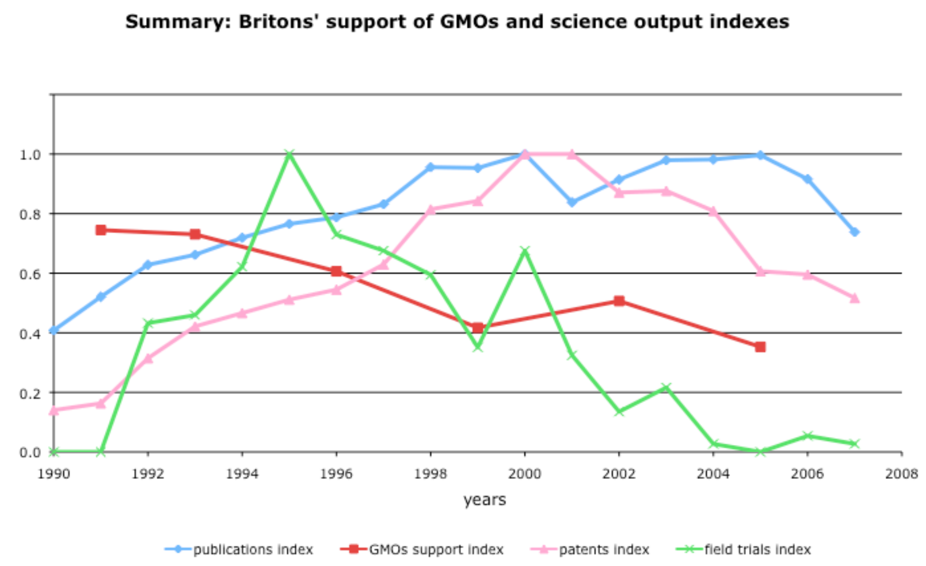


**Fig. 15: Summary: Britons' support of GMOs and science output indexes**

[71] In Figure 16 I decided against representing the patents index. The extremely small frequency of this variable in Italy meant it made sense to exclude it from the graph.

[72] In order to capture the evolution and content of public opinion, I focused on national levels of support towards GMOs. This choice was mostly motivated by the fact that public support, as opposed to risk perception, captures more layers of perceptions (see the Material and Methods section for more detail), it shows more fluctuations, and in both countries relevant changes in this variable were supported by the mass media analysis.

[73] The only exception is represented by 2005 when no data was available for GM crops, and therefore I only used the percentages related to GM food.

In Figure 15 we see that the *Eurobarometer*'s representation of Britons' perceptions indicates a steady decline in support towards GMOs throughout the 1990s that bottoms out in 1999. These findings, which are confirmed by the study of *The Independent*'s coverage of GMOs[74], point to the period around 1999 as being a 'key moment' in Britons' opinion of GMOs that stands out for the general lack of support towards agricultural biotechnology.

The figure also indicates that the frequency trends for publications and patents increase constantly during the 1990s, only to begin a decline around 2001 for publications and 2002 for patents. In this context, it emerges that even if the frequency of approved field trials does follow a similar pattern, its decline begins a few years before that of the other two scientific output indicators.

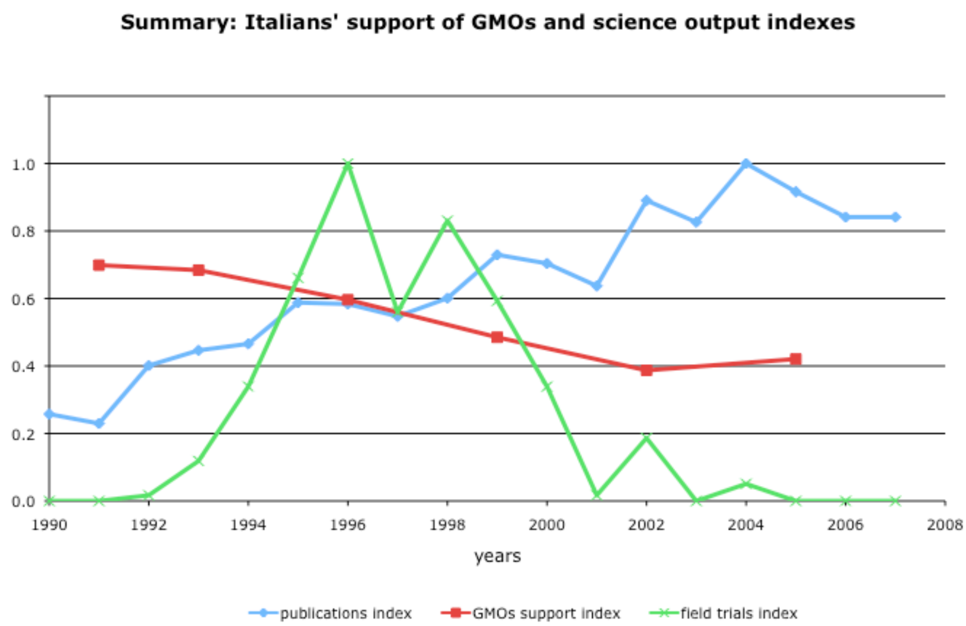


**Fig. 16: Summary: Italians' support of GMOs and science output indexes**

[74] See section 2.1.

Moving to Figure 16, which represents the Italian situation, it emerges that between 1991 and 1993 over two thirds of *Eurobarometer* respondents were supportive of GMOs. As the decade progressed, however, this initial support declines, with the lowest level of support occurring in 2002. As discussed earlier[75], throughout the period investigated, coverage by the Italian opinion-leading newspaper was characterised by a general lack of support and an increasing level of attention that peaked around 2003. Overall, these representations position the least favourable time period in public support of GMOs for Italy between 2002 and 2003.

Turning to the science output indicators, Figure 16 shows that Italian publications are characterised by a fluctuating upward trend, peaking in 2004, and it is also clear that the frequency of approved field trials rapidly increases in the first half of the 1990s but begins an equally sharp decline after 1998.

Looking at these figures together indicates a decline in the frequency of approved field trials, followed a few years later by similar declines in publications and patents' frequencies. When including in the discussion the representations of public opinion the *Eurobarometer* and mass media, the study shows that typically, Britons and Italians' peaks of negativity towards GMOs lie contemporaneously with, or immediately after, the decline in approved field trials begins and before publications and patents' downward trend starts. Given that there is likely to be a time lag between public opinion and scientific response, these graphs tentatively point to an association between public support for GMOs and publication and patent portfolios, while they remain unclear about field trials. The latter might be the most sensitive indicator of negative public opinion on GMOs, decreasing as soon as GMOs

[75] See section 3.1.

became an issue in both Italy and the UK. However, field trials could also be independent from public opinion and therefore their decline might have a different explanation. If this is the case, and what caused the decline in field trials also affected patents and publications, the possible association I argued above (between patents/publications and public support towards GMOs) turns out to be spurious.

**5. Discussion**

Comparing these results unveils interesting similarities and differences between the two countries. Clearly, both nations experienced a decrease in the positivity of public opinion on GMOs during the 1990s. This is characterised by a decline in public support, increased risk perceptions and an increase in critical mass media attention. Nonetheless, this decline ends at different moments in each of the two countries, around 1999 and 2002 for the UK and Italy respectively. These findings are consistent with Torgersen et al. (2002), who highlight that, in terms of the biotechnology debate, Italy is a *latecomer* and did not pay particular attention to this issue until it had become a problem at a European Union level. On the other hand, the UK, being a *forerunner* country, reacted very early to the challenges both within science as well as in the public arena. Therefore, even if the GM debate can be considered an international issue, it appears to have taken different trajectories and meanings within each country. This, ultimately, suggests that it is meaningful to talk about national climates of opinion on science, rather than generalise at international levels (i.e. European level).

Moving on to agricultural biotechnology, these results highlight that in both countries there has been a decrease in both publications and field trials. This indicates that something occurred within the agricultural biotechnology system.

However, as with public opinion, variations in scientific output seem to occur at different moments according to the country, suggesting that, as several STS scholars argue (see Wynne, Latour and Jasanoff's work), scientific activity must be understood as embedded in its local context. Reflecting on these issues, French sociologist Bruno Latour (1983) suggests that the very separation of science (inside) from its social environment (outside) has lost its meaning, and, discussing Pasteur's experience, in his famous essay *Give me a laboratory and I will raise the world* (1983) the scholar continues:

> We do not have a context influencing, or not influencing, a laboratory immune from social forces. This view, which is the dominant view among most sociologists, is exactly what is untenable. Of course, many good scholars like Geison could show why the fact that Pasteur is a Catholic, a conservative, a chemist, a Bonapartist, etc., do count (Farley and Geison, 1979). But this sort of analysis, no matter how careful and interesting, would entirely miss the main point. In his very scientific work, in the depth of his laboratory, Pasteur actively modifies the society of his time and he does so directly – not indirectly – by displacing some of its most important actors. (Latour, 1983: 156)

Furthermore, these results corroborate the findings of Philippe Vain (2005), whose work suggests that the amount of attention devoted to agriculture varies across the different regions of the world.

This chapter also helps refine our conceptualisation of scientific output. In both countries I found that declines in field trial approvals occur between four and six years before the beginning of downward trends in publications. In addition, I found relevant differences across the two nations in the frequencies and content of each output indicator. These findings support Tijssen and Van Leeuwen's (2003) idea that scientific indicators, such as publications count, only show part of the picture and need to be supported with information from other sources. Furthermore, looking at the great discrepancy in the frequency of patents on GMOs in Italy and the UK, this chapter has raised interesting questions about the different characteristics of science within different national boundaries. This discrepancy unveils different cultures of science across Italian and British GM scientists, which are worth analysing further in the following chapters.

To conclude, I return to the core question that informs this chapter: is there an association between public opinion on GMOs and agricultural biotechnology? In this respect, one of the most significant findings to emerge from this chapter is that the relation between public and science is extremely complex, and in fact too complex to be reduced to the analysis of the representations of public opinion on GMOs and science output only.

One clear example of the difficulties that researchers encounter when comparing these sets of data (i.e. representations of public opinion and GM research output) emerges when taking into account scientific output indicators. Let us take a step back and exclude from the picture, for just a moment, field trials with their clear time and space location, and concentrate on publications and patents only. Clearly, we can see that although it is possible to access, count, read and analyse all the documents published on one topic divided per year and country, the history behind each of these documents remains unknown. If it is true that sometimes researchers write their papers while conducting their projects, or right after they concluded these, it is also correct that on other occasions certain, and unspecified, amounts of time have to pass between the end of a project and the publication of the paper. Without entering into the numerous technicalities behind why this time gap occurs, or how long this might be, it becomes clear why drawing a map of the trajectory of these output indicators that is precise enough to be compared to public opinion, on a year-by-year basis, might still be insufficient to answer questions similar to mine.

Of course this does not mean that there is no relation between public opinion and science indicators. In my study, for example, I envision multiple scenarios that possibly explain this chapter's findings, either supporting or rejecting an association between opinions on GMOs and GM research output. I discuss below two possible, and in many ways contradictory, scenarios.

The first scenario, which is in favour of an association between public opinion and science output, focuses on the decrease of publications and patents on GMOs that begins a few years after both countries experienced a sensible decrease in public support towards GMOs. In this context, the discrepancy showed by field trial frequencies, which in both cases begins to decrease during, or immediately before, the period of peak of mass media attention on GMOs and lack of support according to the *Eurobarometer*, might be explained by a great level of sensitivity of this indicator to public opinion. Nonetheless, it appears slightly surprising how early in the GM debate this indicator began to decline and also how rapidly its frequency decreases. One would have to assume that scientists were extremely perceptive of public opinion. Realising in the early stages of the controversy that support was not likely to recover anytime soon, researchers adapted their studies to the perceived social desirability by immediately stopping GMO releases.

In the second scenario, field trials are a proxy of something that might be inside science, i.e. changes due to the knowledge itself, or even outside science, i.e. the government to which they are closely related (see the Material and methods section). In this context, the decline that characterises the annual frequency of field trials mirrors that of publications and patents a few years later. Here, if the decline is determined by something outside science like the government for example, the question to be asked is if and how this was affected by public uneasiness about GMOs in the first place. However, as the great outbursts of criticism of GMOs occurred only after field trials began their decline, hypothesising that the decline of field trials reflects public uneasiness might not leave enough time for the following events to occur: a) the adoption of this criticism by politicians b) the introduction of a new policy and finally, c) the development of some effects in GM scientific activity. A close relation between field trials and the government position about GMOs, however, remains quite likely and should be further investigated in the next chapters.

This however does not exclude the possibility of other scenarios that might also combine some of the aspects of the first scenario, i.e. an association between public opinion and publications and patents trajectory, with some of the aspects of the second scenario, i.e. a link between the government level of support towards GMOs and the decline in field trials, without a necessary association between the government and public opinion.

At this stage, it seems inappropriate to either support or exclude any of these scenarios; also because it might be that while one applies to the UK another applies to Italy. More exploration is then needed, which is why I will leave quantitative methods and turn to qualitative ones, i.e. narrative analysis of interviews with scientists and case study analysis of two GM projects, one per country.

Critical PUS scholars, such as Alan Irwin (2006), argue that public dialogue and engagement have become fashionable policies, particularly within the European

Union. Nonetheless, contemporary practices of public engagement have proven weak and unsatisfactory (Wynne, 2003; Kearnes et al, 2006). In this context, I contend that some of the limits that characterise public engagement might go beyond the mechanisms through which scientists 'talk' to the public and, in fact, might be linked to how they 'listen' to the public, or fail to do so.

**6. Conclusion**

I began this chapter by questioning whether an association between public opinion and science output is at all possible. The goal was to see if negative public opinion is associated with lower scientific outputs, which could indicate whether or not scientists listen and respond to the public.

The most important result of this chapter lies in the ambiguity of its findings, which suggest that the relation between science and society requires more exploration. Nonetheless, the chapter has shown how representations of public opinion on and scientific outputs of GMOs have developed and changed over time, as well as some of the similarities and differences between the two countries. These findings, which are interesting per se and important to anybody who is interested in the study of either public opinion or of science and knowledge production, are extremely informative to this thesis and help me draw a basic map of what happened when GMOs entered science and the public in Italy and the UK respectively. The next step in pursuing my question will be to meet with the people who actually request field trials, i.e. scientists, and are the main object of inquiry in this thesis. By listening to them and asking for their views on, and understanding of, public opinion and its effect on their work, the project gains an additional vantage point through which we can interpret the findings of this chapter and, more generally, better understand if and how science listens to lay people.

## Chapter Four

## GM Scientists' Narratives of Public Opinion in their Work

Over the past 20 years, a considerable amount of literature has been written on the relationship between science and the public, with particular attention to lay people's representations of science. This body of work has recently broadened to focus on how scientists perceive the public (Cook et al, 2005; Davies, 2008; Michael and Brike, 1994), their views on the practices of public dialogue and engagement (Burchell et al 2009), and finally their opinions, understandings and concerns on the ethical and social implications of biotechnological projects (Haddow et al, 2008). This study builds on the literature developed by this prominent group of sociologists, and focuses on scientists' perception of public opinion's influence on their work. More specifically, in this chapter I investigate how GM researchers make sense of public opinion on GMOs and such opinion's role both in their specific work and their field of research in general.

To address this set of questions, this chapter examines the stories constructed by a group of 21 GM scientists I interviewed in Italy and the UK. In light of Chapter 3's discussion, I pay close attention to the role of temporality in scientists' narratives, or the timeline of events that structures the stories scientists unfold during our meetings. In addition, through the analysis of scientists' accounts, I address some of the social, economic and political factors that scientists call upon when describing their relation with the public. These are discussed further in Chapter 5.

I begin by presenting the material and methods of this chapter. In the core sections of this chapter I describe and compare how British and Italian scientists discussed public opinion. These stories tell us about who GM scientists are, and how they conceptualise their relationship to the public within their country. We will see that Italy and the UK differ in two ways: a) governmental involvement with science and its relationships with the public, and b) how 'dialogue' is valued as a goal. Reflecting on the similarities and differences between these two countries, I begin to sketch out two phases of the listening process, which consist of hearing and responding to, public opinion. Further analysis and discussions on these two phases together with other findings in the listening process is carried on in Chapter 6.

**Material and Methods**

Qualitative research has been traditionally used to establish social facts. The effective use of social facts allowed social scientists to ask better questions or revise and improve hypotheses (Burchell et al, 2009: 20). On this basis, sociologists Sarah Franklin and Celia Roberts (2006) suggest that qualitative methods are particularly effective when looking at areas of uncertainty, allowing for an exploration of ambivalence. Furthermore, they argue that 'qualitative and quantitative methods thus complement each other, precisely because they are based on opposing principles' (Franklin and Roberts, 2006: 82). In light of these reflections, and taking into account the complexity of the science and public relation illustrated in Chapter 3, I felt it necessary to meet with GM scientists and find out their thoughts and opinions on their relations with the public.

I conducted 21 open-ended interviews with scientists who were fairly established in the GM field. The interviews were carried out following a ‘conversational style’ (Burchell et al, 2009: 20) to allow scientists to speak about public opinion in their own terms. All the interviews collected in Italy were conducted in Italian; all but one of the interviews in the UK were conducted in English[76]. All interviews were held in the researcher’s place of work, i.e. their laboratory or office, and I proceeded to transcribe all the interviews in the days that followed my meetings with the scientists. I structured the interviews around three main themes a) the interviewee’s experience with GM plants, b) the interviewee’s thoughts about public opinion on GMOs c) the interviewee’s thoughts about the relationship between GM science, the government and funding streams[77].

Taking into account the plethora of definitions of ‘public’ and ‘public opinion’ in the social sciences, I feel it is important to articulate my own understanding of these terms before proceeding further with my analysis. Similar to Martin Bauer’s (2002) hydra model, I understand the public to be all those people who are not engaged, in one way or another, in the presents and futures of this technology. Thus, for example, any researcher outside the GM community would be a member of the public, while an employee of Monsanto would fall outside the GM public. Following Neidhardt’s definition of public opinion that I proposed in Chapter 3, I understand public opinion as ‘fiction, which refers to some kind of volonté général, reminding us of the elementary semantics of democracy’ (Neidhardt, 1993: 339). This means that for me public opinion represents the opinion shared by the majority of members of a nation. Finally, as noted in Chapter 3, I consider the mass media and public perception surveys useful tools to learn about public opinion

[76] In one case, I met with a researcher who was working in the UK, but he is a native Italian speaker and we both felt more comfortable to frame the interview in Italian.
[77] See Appendix 6 for more detail.

At the time of the interviews, I was a 26-year-old woman, who had entered a PhD programme in Sociology after completing of a degree in agricultural biotechnology and two Master programmes that focused on the relation between science and society.  As such, most interviews took on the structure of a conversation between a professor and a student.

My familiarity with the field allowed me to establish a trusting relationship with the interviewees. Scientists interviewed generally assumed I could understand both scientific logic and terminology. In addition, respondents often see me as part of the GM community, which, as I will show later, is a field that they separated from the rest of society. Finally, interviewees generally seemed to believe that I would have experienced the negative opinion about GMOs in the same way as they did.

The analytic tool I use to interpret the interviews is narrative analysis. For the purpose of this study, I define narrative 'a discourse that consists of a sequence of temporally related events connected in a meaningful way for a particular audience in order to make sense of the world and/or people's experience in it' (Hinchman and Hinchman 1997:xvi). More detail on the selection of this method can be found in Chapter 2 section 3.  However, it is important to re-emphasise that my analysis concentrates on the 'told', or what is called the content of the stories that scientists and I co-constructed during the interviews.  In this context, I categorised the interviews by country.  I then read the transcripts of interviews and listened to the recordings several times, looking for primary stories.  While doing so, I coded the interviews for key themes and wrote both brief and extensive memos on the narrative arcs that structured scientists' stories. Interviews conducted in Italian were translated at this time. To conclude my analysis, I used my codes and memos to compare scientists' narratives by country.

**2. UK scientists**

**2.1 Main story**

The story of GMOs in the UK covers the period between the 1980s to the present. Most scientists I spoke with started their story in the 1980s, a time when the GM community and the government shared enthusiasm for GM technology in the agricultural context. However, scientists would rapidly move to the 1990s, a decade characterised by general uneasiness towards GMOs that was propelled by NGOs and mass media, which eventually spread to lay people. Their stories usually end in the present, which most scientists defined as a moment of relaxed public opinion. Accordingly, many of the respondents expressed sincere hope for the future of this field.

When talking about the early days of GMOs, scientists noted that this technology was been tested in the field and researched in laboratories without attracting much attention from the public or the mass media. Nevertheless, as the following excerpt shows, this situation did not last long. Paralleling Michael and Brown's (2000) respondents, the interviewee in the quote below demonised the role played by NGOs. In particular, the researcher described NGOs as initiating the general opposition against GMOs in the UK.

> So, I think you can say that initially the public were not against GMOs. NGOs and various environmental groups convinced the public that this was a product that we did not want. (University Researcher 1, 2008)

Besides NGOs, the mass media was also a key social actor in scientists' narratives regarding the changed opinions on the topic of GMOs. In parallel to the findings of other scholars (Burchell et al, 2009; Cook et al, 2004), respondents in my sample often blamed journalists for the controversy. In particular, study participants believed that the media exaggerated risks of using and consuming GMOs and thereby exacerbated people's fears and concerns about science.

> Valentina: And I was wondering then how, in your opinion, did the media frame the debate on GM? Were they important, in any way? Would you say they played a specific role?
> Interviewee: Well, I would think that the majority of media coverage was anti-GM… you see, what happened was that it got mixed up with several issues: the anti-globalization issue; […] the fact the people believe, or wanted to believe, that their food is grown the way your grandma would grow it; […] and on top of that, there was the Pusztai affair. (UR 1, 2008)

As this respondent emphasised, the GMO controversy entered British society in conjunction with several other events and issues that, at times, fall within science (e.g., the Pusztai affair). GMOs were frequently interlinked with other social movements as well, such as anti-globalization.

At this stage of the story, interviewees were likely to introduce actions of multinational companies, specifically Monsanto. As the company who made the first attempt to ship GM soya to the UK, Monsanto was described as arrogant and insensitive to the differences between the EU and the US markets (GR2, 2008). In other words, inline with the findings in the Scope project[78] (Burchell et al, 2009), the respondents in my sample often blamed multinational companies, which had involuntarily become an easy target for NGOs' anti-GM campaigns.

This combination of events resulted in a state of affairs that characterises the late 1990s and Britons' uneasiness towards GMOs. A governmental researcher suggested

[78] The Scope project is a three-year project conducted by Sarah Franklin, Kevin Burchell and Kerry Holden that explores, through qualitative analysis of 30 semi-structured interviews, British scientists' understandings, views, perspectives, judgments and experiences of public engagement and dialogue experiences. The project, published while I was working on this chapter, was inspirational to my analysis and reflections.

that 'at that time the idea that GMOs are bad was very much entrenched in public opinion' (GR3, 2008). Notably, the peak of resistance towards GMOs identified by scientists overlaps with *The Independent* and *Eurobarometer*'s representations of Britons' opinions on GMOs, pointing to the late 1990s as the height of public backlash against this technology.

Along with NGOs, mass media and multinational companies, in their stories of public opinion on GMOs, scientists frequently made reference to the government, which, as they argued was always supportive of GMOs, and, in light of public resistance to GMOs, implemented a series of interventions that put the question on hold. As we read below, this strategy is exemplified by the decision to set up the Agriculture and Environmental Biotechnology Council. The latter was appointed by the government to facilitate a discussion over GM issues between experts and non-experts.

> Right at the beginning of the decade, they [the UK government] set up an organisation called Agricultural and Environmental Biotechnology Council, where these various issues were supposed to be worked out… but nothing happened … half of the people were scientists, half came from Greenpeace and they just fought and didn't move anywhere… so this then stopped, but this was the government's way to say 'you think about it, so that we [the government] can postpone the problem'. (UR2, 2008)

Another governmental scientist similarly framed the Farm Scale Evaluation programme as another way for the government to delay a final decision on GMOs until, as he said, the climate of opinion became more relaxed.

> In the mid 1990s, opposition began to be intense and, to a certain extent, the Farm Scale Evaluation trials were an attempt, I think, by the government to delay the decision until such a time when they thought the controversy would have gone away. (Governmental Researcher 2, 2008)

That said, another governmental researcher noted that there was a re-allocation of funding during the late 1990s. While the BBSRC continued to fund GMO research, DEFRA moved its resources away from applied research. In practice, this change implied a decrease in state funding for applied GM research while funding for basic GM science continued with possible increase. Typically, funding changes were also occurring at the EU level, which was drastically decreasing its investments on GM science.

> I guess there is an extent to which public funding research changed…but not from the BBSRC. […] I mean they are perfectly happy to consider GM as a research tool. You could say that the funding stream for these kinds of research has nicely increased. But in terms of crops improvement, both DEFRA and the EU, I think, have moved away from it. Particularly the EU has moved in that sense. (UR3, 2008)

To further elaborate on the role of the EU, another respondent noted that the European regulatory framework delayed significantly the development of GMOs in response to public concerns.

> See, the problem is that the EU community has now created a regulatory framework which self-perpetuates opposition towards this technology, which is a very curious thing… (GR4, 2008)

The same respondent commented on the departure of multinational companies from the UK in the context of public discontents. This exodus, which exacerbated the funding situation for applied research, created financial difficulties for scientists engaged in applied research and crop improvement.

> I remember, there was this transgenetic company, which was doing transgenic plants with vaccines, particularly in bananas, and a lot of this activity just left; I think the main thing that happened is that people generally stopped focusing their research on crops and crop improvement. (GR4, 2008)

Up to this point, British scientists constructed a complicated story, characterised by public uneasiness and lack of support towards GMOs. Typically, scientists present public opinion as NGO-driven, or media generated. Such framing enables scientists to easily negate the validity of public concerns and their possible contribution to scientific progress. However, following this lack of public support towards GMOs, interviewees also note a decrease of funding available for applied research and crop improvement that they associate to a shift of governmental funding patterns and the exodus of corporations. This story usually ends with various examples of how this situation impacted the respondents and their field of research.

Most researchers believed that they have now entered happier days. A government researcher noted the recent change in attitudes towards GMOs in the British public sphere. As this respondent enthusiastically noted, similar to the analysis of *The Independent* and findings to the *Eurobarometer* (see Chapter 3), Britons have recently become less worried about GMOs.

> I think that the path is now changing, you can start to see now how all the political language is changing etcetera […] Some NGOs have started to change their position and only Friends of the Earth still hold a very extreme position. Broadly speaking, there is a general sense that the media have accepted that the rest of the world have done this (GMOs) and we have to have a look at it and see why it is that we are not adopting this technology seriously in the EU. I would say that also the public has recently become more open about GMOs, especially now that food prices are going up. (GR4, 2008)

Notably, while this excerpt links increased public support to the recent rise in food prices, another British researcher suggested a relationship between this shift of opinion and an increase of empirical evidence in favour of GM safety for human consumption. To verify the validity of these claimed associations would be a topic of interest for future investigations.

> V: So, are you suggesting that things are about to change now? Is this correct? But how do you think this is going to happen?
> I: Well, for a number of reasons, the media factor to begin with, and also that this [GMOs] is something that has been going on for 12 years or so, and nothing has happened – nobody has died, no animals have died, the environment is not collapsing – and some people are beginning to realise that the stories they heard are perhaps not true; and if that is correct, GM might be not so terrible. (UR2, 2008)

Overall, British GM scientists tell a story in which an internally exciting field of science was suddenly pushed into the limelight, creating a disruption from the public backlash that occurred in the late 1990s. This disruption is currently in a period of restoration. In telling this story, GM scientists introduce a series of actors (i.e. the government, NGOs, the mass media, multinationals) as the mediators in the relation between the public and scientists. These relations, which animated the key themes I explore in the next section, also shed light on the complexity of the relation between science and society.

**2.2 Key themes**

Analysing British scientists' main storyline, I noted it was characterised by a series of key themes that I unpack below. I begin by looking at how British scientists define public opinion, exploring respondents' discourses on the general public, mass media and NGOs. I then focus on how GM science developed and was re-organised in the context of negative public opinion. Specifically, I examine what happened in the GM field right after the public backlash, and what kinds of losses this field endured. Finally, I investigate how scientists understand communication *to* and *with* the public. The analysis of these key themes will enrich my understanding of the main British narrative, and help unveil how GM researchers make sense of the public, as well as the role of public opinion in their work and their field in general.

*Who does public opinion represent? The general public*

In the majority of the cases, researchers showed confidence with their grasp of what terms like the 'public' and 'public opinion' denote. Within my sample, scientists tended to understand public opinion as the opinions shared by the general UK public. Similar to the findings in Michael's (2009) research, scientists I met with described the general public as an 'undifferentiated whole distinguished by science that is itself characterised globally in terms of some key dimensions' (Michael, 2009: 620).

In line with findings in both the Scope report (Burchell et al, 2009) and Sarah Davies's (2008) study, interviewees recurrently referred to the general public as deficient of scientific knowledge. Notably, as shown in the three quotes below, this characteristic is often coupled with the idea that the public does not have an adequate sense of risk. Some also asserted that the public was lazy.

> Let's face it – the general public has not always had the most informed and balanced perspective on complicated issues. (UR3, 2008)
>
> The problem for them, and I mean the public, is that for the most part they are not educated with scientific information and even less with scientific thinking. (UR2, 2008)
>
> V: So would you say that the GM debate was in large part based on ignorance?
> I: Yes… well… I guess it is ignorance… a combination of ignorance and laziness… I think perhaps a lack of understanding of risk and what risk means. (GR3, 2008)

In contrast to evidences from previous PUS research on education and risk perception (Evans and Durant, 1995; Aldhous et al, 1999; Wynne, 2002; Davies, 2008), most of the scientists I interviewed used these arguments when making sense of the publics' lack of support for GMOs. They assumed that with more education and a better understanding of risk members of the public would become more supportive of science. In her study on scientists' understandings of publics, Davies (2008: 428) argues that her 'participants share the basic concept of an education process, with scientific information being given to a deficient public (Gregory & Miller, 1998)', and further suggests that '[t]his process is visualised as itself having further possible effects, for example creating […] a more positive outlook toward science' (Davies, 2008: 428). We see a similar pattern also in British scientists' stories.

Respondents also proposed some variations on this pattern. At times, interviewees described the public as knowledgeable, reasonable, and practical. For example one respondent argued: 'I think that a lot of people are actually pretty reasonable about this… I think that the opposition would have to be silent to the need of food and the cost of food' (GR2, 2008). However, as we read above, scientists were careful to associate these adjectives exclusively to the economic component of GMOs. As such, publics are rational actors in the economic arena, but not necessarily so in the context of science and risk assessment. We see this theme being reiterated below by another respondent who suggested that Britons are practical and thus will change their minds about GMOs for their potential significance to the food market.

> I believe that the public is very practical. This is not only with regards to GMOs, but it is certainly important when they have to deal with this technology. By now, they know that there are no health issues whatsoever, and they know that GMOs will be crucial for the future of our agriculture, and food market. (UR1, 2008)

Food, and food production were prominent themes in scientists' more general discussions on GMOs. For example, while some scientists held that the

British public are rational actors in relationship to their food consumption, another respondent suggested the urbanisation process in the UK meant that there was a lack of public awareness on agriculture and its practices.

> I think that there is also another thing to consider… you know, if you are in China, even if there are people who have lived their whole life in a city, they are likely to have relatives who actually lived in the countryside; in France it is pretty much the same thing; instead, in the UK most people probably have to go back up to six generations to have this, and, you know, the UK was the most urbanized country in the world in the last century… so I guess what I am saying is that here there is less awareness of the whole agricultural business. (GR4, 2008)

In addition, some respondents noted that GMOs are different from other technologies because of the emotional and physical relationship people have with food.

> Why do you think there was so much opposition and the campaigns were so successful? It is because food is different. I mean, it is possible that mobile phones are 'frying our brains', and also that there are only a few mobile phone companies, but people don't have the same emotional reaction to the fact that there are only a few mobile phone companies as to the fact there are only a few seed companies controlling our food, because food is visceral and emotional. (GR2, 2008)

Although in a general sense, GM scientists interviewed acknowledge that lay people can be knowledgeable, practical and reasonable, when it is in the specific context of GMOs, they perceive the public differently. As have also identified by several PUS studies (Davies, 2008; Burchell et al 2009), GM scientists' account on the public features a knowledge deficiency in GMOs, and a lack of understanding of scientific reasoning and risk assessment. According to scientists interviewed, these characteristics are of even more devastating effect on GMOs than in other sciences, because food is closely linked with people's deepest emotions. Notably, as Brian Wynne and Alan Irwin (Irwin and Wynne, 2003; Wynne; 2006) argue, images of emotional and irrational publics represent a cornerstone of the deficit model.

*Who does public opinion represent? Mass media and NGOs*

Stories of public opinion were also populated by the mass media and NGOs. As illustrated by the comment below, which describes the expected increase of support towards GMOs in the near future, it is quite difficult to distinguish the opinion of the public from mass media's representations. It can be argued that, as widely discussed by social scientists, GM researchers identify a complexity in the relationship between mass media and public opinion, which mutually influence one another.

> I think that the public will realise that although it has all been quiet over the last 5 years, a lot of research work has been going on [...] I think that over the next 2 years there will be a huge change in public opinion and the media... of course one leads the other... you know, it's a very complicated issue to figure out who influences who...(GR3, 2008)

Along these lines, a governmental researcher argued that 'it is very difficult to judge public opinion, but if you are interested in this you can certainly refer to journalists' opinions' (GR2, 2008). This comment points to the mass media as a useful tool to hear public opinion.

In light of the material and methods I use in Chapter 3, I identify some overlap between my analysis of public opinion and that of British scientists. In addition, with regards to the main guiding question of this thesis, which focuses on the listening capacity of science, it seems that the mass media are understood by the scientists as a tool to hear from the public.

While many saw the connotation of 'public opinion' as relatively straightforward, a few researchers would open up the very idea of the public and discuss the complexity of this concept.

> I: Well, no, I don't think the public has a direct influence, although if you… do you consider the Royal Society for Protection of Birds to be the public? They are an NGO with millions of members – they are the largest charity in UK.
> V: So, you are saying that your answer depends from what kind of public I consider?
> I: Yes, I would say so… take Greenpeace, for example – they can put pressure on the government to change … well, I don't know to what extent you can say they are members of the public. (GR2, 2008)

Michael and Birke's (1994a: 84) work on animal experiments argues that in the process of maintaining dialogue with their opponents 'scientists define the character of the public – they disaggregate it into component, more or less amenable, fractions'. In this context, the scholars talk about 'appropriate opponents' and 'critical publics'. We see a similar idea here, with the notion that there may be multiple kinds of publics that co-exist in the UK landscape.

Through this section, further layers of complexity are added to the conceptualisation of public opinion that opened the section above. In particular, GM researchers include mass media and NGOs in the discussion of public opinion. In addition, on occasion respondents perceive the British landscape as constituting more than one kind of public. The latter discourses foreground a more local image of the public, which shares some similarities with critical PUS discourses (Wynne and Irwin, 2003).

*GM science developments and re-organisation*

> So, although a lot of people would say that in order to get acceptance of GM crops you have got to produce something that consumers want… I personally think it is absolutely wrong, and I think that it is our job as people who understand this whole business to advise the general public. (UR3, 2008)

The quote above demonstrates a typical feature of UK science policy. That is scientific knowledge is championed in state level decision-making (Rayner, 2003).

Like this respondent, many of the researchers I met described themselves as the repository of truthful knowledge and consequently believed themselves to be best positioned in both advising and mediating between the British public, and government, on the topic of GMOs. This is consistent with the notion that science is separated from society, and the corresponding diffusion model (Lewenstein, 1994).

Interestingly, in the concluding part of his interview this respondent talked about the changes that characterised the field of GM science, and included a shift of focus from inserting bacteria or virus DNA fragments into plants to working directly on plants' genes. We read about this in quote below, which highlights the scientific value of this shift.

> From a technological point of view, there has been a transition during the time period that you are interested in […] At the beginning of the 1990s, we had the capacity to transfer genes into plants, but most of the genes were fragments of DNA from bacteria and virus. […] Since then, research and technology have moved on and now we have a new generation of genetically modified plants where genes are transferred between plants. This gives us a much bigger and more flexible toolbox than the one we had before. (UR3, 2008)

Making it more difficult for the public to 'resist' GMOs on the basis of their previous concerns[79], this respondent admitted that this new technological advancement might also ease some public concerns about GMOs. This discourse, which contradicts the idealised image of science being independent from society presented earlier by this same respondent, suggests some grey areas in the relationship between science and society, and indicates that contradictory ideas about science and the public may coexist in the space of one interview.

[79] Common reason of concern for the public was the idea that GM technology might combine genes across genetically distant species, ending up producing products such as the popular strawberry fish, a strawberry with the flavour of fish. (http://www.senseaboutscience.org.uk/PDF/MakingSenseofGM.pdf).

Whereas this particular respondent had certain difficulties envisioning the relation between this shift in science and the negative public opinion on GMOs, numerous British scientists I spoke to commented extensively on the relation between the recent re-organisation of GM research around risks and environmental issues and Britons' resistance to GMOs. In these stories, private and public funding are commonly portrayed as mediators for public opinion on the GM research field.

> In some ways, I haven't been too directly disrupted by the negative view that the public had of GM… we probably would have received more resources [from the government], because a lot of money has been diverted into safety issues, and I think this was very frustrating because these projects use certain kinds of crops that weren't yet being commercialised and nor will they be… so, it would have been better to spend the money on research to develop viable GM crops and then invest in safety programs only on those crops that within this range were expected to be used. (GR1, 2008)

Notably, stories of the influences of public opinion on the GM field were accompanied by scientists' frustration with the logic that drives this decision. Scientists usually considered the latter to be not scientifically rational and emotionally driven. Despite respondents' frustration, and idealised ideas of science, it appears that GM scientists' stories of public opinion situate the GM field in close relation with the rest of society. Here, through the mediation of the government, science is asked to respond to public opinion.

Furthermore, another researcher discussed public opinion in a way that allows the public to enter and impact directly on the actual design of one of her research projects.

> For example, I set up a company with another researcher and tried to modify potato by inserting a very important resistance gene. As you know, at the moment there already are GM potatoes, but their colour is different from that of the normal ones. This, I think, is not very nice and attracts consumers' concerns and scepticism. Thus, we thought to

> combine the resistance gene with a transformation that would not alter the colour… So if you manage to have both transformations together, then you have a way of persuading consumers and also facilitate the production of this potato variety. (GR5, 2008)

Quotes like this one nicely exemplifies the blurring boundaries between science and society, popularised by Helga Nowotny and Michael Gibbons in *Re-thinking Science: Knowledge in an Age of Uncertainty* (2001). In this influential book, the authors argue that '[t]oday, at any rate in developing countries, society 'speaks back' to science' (Nowotny and Gibbons, 2001: 52), and continue 'society is now 'listening', in part because the boundaries between science and society are becoming more spurious' (Nowotny and Gibbons, 2001: 53).

Looking at this section, it is possible to identify a mixture of voices. Images of separations between science and society still exist but are blended with ideas of science in society. Amongst those who situate science in society, some talk about a direct impact public opinion had on science, but the majority introduce private and public funding as the mediators of public opinion and stimulus for science's response.

*The losses of science*

In addition to a re-organisation of the GM research field in the UK, many of the scientists I spoke to also noted a series of losses. For example, one interviewee pointed out that the UK has lost its scientific competitiveness in plant science. Interestingly, according to him, this is linked with a lost opportunity to be competitive in the global market level.

> You know, we used to be world leaders in genetically modified crops and through a very misguided anti-GMO debate, this field has collapsed and now the world still grows them… and Britain, instead of being part of a multi-billion industry, stepped away from it. (UR2, 2008)

On discussing similar issues with another researcher, a different kind of loss emerged. This researcher noted that the UK owns a technology that has been extensively used in laboratories, and yet failed to properly move into the fields.

> At the moment, we could genetically engineer a plant and make it resistant to almost any virus disease that you can name. It would not be an extreme effort to do that. However, in my view unfortunately, the number of examples where this technology has been applied is rather limited. And there are some very serious virus diseases in both developing and developed countries that are problematic and it would be quite nice to address them with our knowledge. So the technology is there, but it hasn't been transferred into the field. And I think that, lastly, it has not been transferred into the field because industries, I mean people who pay for these things, are reluctant to take on board a technology that is not accepted by the public. (GR2, 2008)

Notably, in order to explain this delay, the researcher drew an indirect link with public opinion. The latter acted on industries and corporations, which decreased their interest in the GM field and thus their investments for applied studies on GMOs.

Finally, an additional loss emerges when looking at the story of a university researcher, who was unable to secure funding for his GM project on the long terms effects of GMOs on the environment.

> I: We developed this project to create a model and study what happens in the long round when using certain genetically modified crops and we finished… well we got no funding to go on… about 5 years ago… 5 years ago we failed to get funding 3 times on the trot and the staff all left and the project failed…
> V: And would you say this was related with public resistance to GMOs?
> I: Of course it was… (UR1, 2008)

Here we see a loss that touched the respondent personally. Notably, in answering this question, the respondent directly linked this episode with the lack of public support.

When trying to make sense of science's losses, localising science in society represents a common theme across GM researchers, one that specifically allows them to place the blame outside the science community. Furthermore, this section points to the complexity of the relation between public opinion and science, as it includes numerous other actors, such as the government and private companies.

*Communicating to the public*

Having presented the actors, I will now explore the communication process they participated in. I will focus on a) how scientists communicate *to* the public, a common feature amongst PUS scholars, and b) how they communicate *with* the public, an idea that has been introduced by the more recent dialogue mode.

Typically, the mass media featured in the interviews as the most prominent mediator in communicating science to the public. For example, one government researcher I interviewed had just concluded a study on a new GM product with improved quality for consumers. I was struck by the amount of details and time she spent on describing how this research had been represented in newspapers, radios and TVs.

> So one press release broke the embargo, which was the Sunday Times and they had a couple of quotes, one from this member of Greenpeace and of course he was negative... and the only other negative piece I think was from a radio programme. But I called and the journalist said that he was not really that critical, they just captured the negative bits. Anyway, all the rest of the media have been very supportive, so I think it is really great. (GR5, 2008)

Similarly, a government researcher discussed a common practice of how scientists arrange their meetings with mass media.

> Well, I have been very much involved in talking with the media and the public… and often, when there is a GM story in the media, they want to know in general how GM works, so quite frequently I have had to explain

> how it is possible to make a GM crop or plant... you know, showing a TV camera around the lab and explaining how to make a GM plant (GR6, 2008)

Here we see interactions with the media as a rather routine event, one that he considered under his control. This interaction is presented as one-directional, where information is brought from science to the public through mass media. It can be argued that the media closes the gap between science and the public. The mass media – and indirectly the public – is allowed to enter the laboratory that had, for quite some time, not welcomed society (Gregory and Miller, 1995).

To visualise the relation of science with society, a university researcher drew a picture. Science occupies the top one side, while the public occupies the other side of the picture, at the bottom. In the middle, he drew a series of mediators, which he called opinion formers. These opinion formers include the mass media, NGOs, politicians and other public figures.

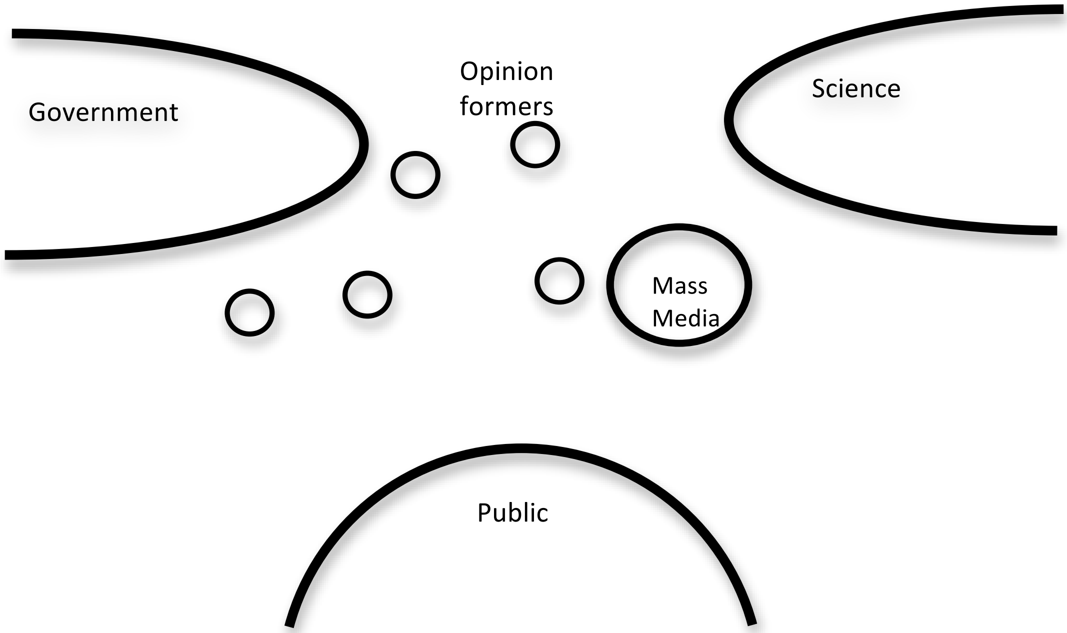


**Figure 17: Respondent's picture on the relation of science with society**

*Communicating with the public*

Following this discussion, the above respondent suggested another way to get in touch with the public. That is public meetings. This format of communication allows public to respond, thereby facilitating two-way communication as opposed to one-way education.

> I suppose, as a lot of people do, I get a view of what the public thinks when I have to stand up in front of a lot of people … I mean, I have been to meetings … there was one for which I went to this small village in Norfolk, where a trial of GM crops had been proposed … and I found myself in this completely full room … I mean there was not room for everyone and it was an unusually warm day – 25°C at 9 a.m. – and you sensed that nobody in that room had any sympathy for me at all … it's a sort of threatening experience … you certainly know what a subsection of the public thinks when you go to those kinds of meetings… (UR3, 2008)

This comment shows that (some) GM researchers use meetings with the public as a means to learn/hear about public opinion. This particular respondent heard members of the public by observing their body language. These meetings, as the respondent noted, were difficult, almost threatening, experiences. This finding aligns with Sarah Davies's (2008: 427) work on scientists' understanding of the public in which she argues that 'public communication was generally framed in very negative ways: it is seen as a difficult, perhaps impossible, task, as well as a dangerous one that requires extreme caution to prevent audiences from misunderstanding or misusing scientific information'.

As the conversation with the researcher continued, he started referring to the relationship between the public and science as a two-way communication process, one that can be informative for the public as well as scientists.

> I think the general public needs to listen to experts… and not always look at their own interests… but look at the situation as a whole; it works the other way around too – scientists need to learn from the discussion they are having with the public … I would say that I have been educated by the participation in the discussion on GM foods. Like many scientists, I came to this research field with a very naïve perspective about how to produce crops. However, I think that, as a result of having participated in the discussion, my perspective has now become a little less naïve than what it was. What I appreciate now is that there is a lot of information out there about food production, and agricultural practices. These do not necessarily involve molecular biology. So, as a result of this, I think that the whole process of communication with the public is a two-way process, and scientists and technologists have things to learn from this discussion with the public as well. (UR3, 2008)

In common with the Scope report (Burchell et al, 2009), this scientist's narrative shows that the deficit model[80] can and often did coexist with public engagement

[80] This thesis frequently refers to the 'deficit model'. I am aware that this term is problematic, and requires careful definition and precise use. The deficit model is a complex set of ideas, discourses, and attitudes. It encompasses different ideas (e.g., ignorant and deficient public, the separation between science and society, and finally the idea that members of the public are concerned about science). To contend with the heterogeneity of this term, I try to use it with precision and therefore do not refer to all these elements at once. Throughout the thesis, I specify which aspect of the deficit model I am referring to. I am also careful to put the term in context. Nonetheless, I do believe that it is important to use this term for the purposes of

discourses in the UK. We see this again in the following statement, made by another UK scientist.

> Indeed, I am pretty happy to follow what the public want, except that I know that, with the population levels rising and the consequent food shortage, this will have an impact on the availability of food, even in the EU […] and maybe we also failed in not explaining to people what was going on; I mean, my colleagues used to say that 'people are stupid and it is ridiculous to be afraid of GM, they don't understand'… but I mean I disagree… but the public doesn't understand, they don't understand risk assessments even if they make them every day… every day people take a level of risk… even pretty high ones with alcohol or smoking… and people do even crazier things… and the risk of GM is very, very low because we have run a lot of tests and benefits could be very high. (GR1, 2008)

Here, we see all the tensions between the two models of communication that have been at the source of debate within PUS scholarship disappear. The researcher jumped from the idea of a two-way communication process to the idea that the public is ignorant in the space of one sentence. As Wynne and Irwin (Wynne and Irwin, 2003; Irwin, 2001) note, public engagement is not yet a practice in the UK. However, as Burchell et al (2009) suggest, engagement is an important discourse that is beginning to shape scientists' understandings of their relationships to the public. The lack of public engagement experiences amongst many of the scientists I interviewed may have led to an increasingly blurred boundary between the deficit and public engagement models.

To sum up, in their stories on public opinion, GM scientists express a fairly complex conceptualisation of the subject of their stories. For the majority, the public includes the general public, mass media and NGOs. A few interviewees further acknowledge the possibility that there may be multiple publics in the UK. Aligning with the findings in the Scope report, scientists often move between the

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this study. The deficit model was frequently present in my conversations with scientists, and informed how GMO scientists heard public opinion.

deficit and public engagement models in narrating their relations with publics. Reflecting on the content of public opinion, UK respondents indicate the mass media and meetings with the public as two main ways to hear, communicate to, and communicate with the public. The conversations highlight a period of lack of support towards GMOs that peaked in the late 1990s early 2000s, and was followed by two main changes. These are a re-organisation of GM research around risk and environmental issues and a decrease in international competitiveness. Notably, respondents hardly see public opinion as directly responsible of these changes, and use other social actors, such as the government and corporations, to explain the impact as mediators of public opinion. In other words, public opinion affected the government and corporations, which in turn stimulated some changes in the GM field. This final point will be further expanded upon in subsequent chapters, when elaborating upon the listening process and the factors that influence it. At this stage, however, it appears that the listening process has at least two phases, one during which scientists hear public opinion, and the other in which they respond to it.

## 3. Italian scientists

### 3.1 The main story

I now turn my attention to the ways in which scientists in Italy narrated the trajectory of GMOs in their country, a story that similarly began in the late 1980s and continued into the present day. Overall, this story can be divided into two parts. The first part of the story is characterised by support for GMOs from both the scientific community and the government. During this time, Italy was keeping up with the rest of the EU, and hosted a sizeable portion of research on plant biotechnology.

> The Italian adventure in agricultural biotechnology began with certain timing; we are talking about 1987 to '89. Considering that Europe as a whole represented an avant-garde in this field, well you could say that we [Italian researchers] were not late, not late at all. (UR3, 2008)

In this context, the following quote, which is taken from another university researcher, adds more detail to the atmosphere that characterised the good early days of GMOs. It shows that at that time, the government was mostly supportive, while the mass media was not particularly interested in the issue. In addition, it was noted elsewhere during the interview that on the rare occasions when the mass media did report on GMOs, positive language was used. For example, GMOs were called the 'food of the future'.

> At that time, you can say the mass media were not interested in the GM issue. Meanwhile, the government was giving great support to agricultural biotechnology, not just in the universities, to whom the Ministries were giving funding, but also within the National Centre of Research[81] (CNR), which was hosting great programmes on GM research. (UR4, 2008)

Until the late 1990s, GM researchers believed that they had great prospect in Italy. Early anti-GM campaigns were understood as US phenomena and were not to be of concern.

At the turn of the century, however, a series of rapid events completely overturned this situation. These events open the second phase of Italian scientists' stories, which is characterised by great public uneasiness and the lack of government's support.

[81] The National Council of Research 'is a public organisation; its duty is to carry out, promote, spread, transfer and improve research activities in the main sectors of knowledge growth and of its applications for the scientific, technological, economic and social development of the country.' (http://www.cnr.it/sitocnr/Englishversion/Englishversion.html) (last visit 24/07/2010).

As noted in the excerpt below, scientists emphasised the government's role in the reversed decision regarding GM research. Specifically, scientists highlighted government's decision to stop funding GM research in two instances.

> Well, you know, the former Minister of Agriculture Pecoraro Scanio is a member of the Green party, and he was clearly against GMOs. During his mandate he stopped all the findings from pubic institutions towards research on GMOs. (UR5, 2008)

Two years later, Giovanni Alemanno, the new Minister of Agriculture, had all GMO-trials receiving public funds terminated. In addition, he prohibited all public institutions to use inventions that involved GMOs and were protected by patent rights, or sell these rights to other institutions, within or outside the country.

> Well, our 'story' begins with this fax… Can you see this here? This is Giuseppe Ambrosio's signature … at the time, he was Director of Agricultural Policy under Pecoraro Scanio… 2 years later, the same director, but in the 'Alemanno era', sent a fax prohibiting experimentations with GMOs to all the institutes somewhat affiliated with the government… this was the lowest point for us, also because in these letters they asked us not to use, and not sell, the rights over a couple of inventions we recently patented. (GR2, 2008)

Meanwhile, scientists noted that anti-GM campaigns reached Italy. But Italian scientists argued that a very peculiar combination of interests emerged in this context. Opponents not only received support from the Green party as would have been expected, but also from Coldiretti, the Italian union of small farmers. As the quote below highlights, scientists saw this opposition as merely financially driven.

> When these campaigns reached Italy, they were immediately welcomed by the Green Party, and, quite surprisingly, also by Coldiretti. Clearly, an interesting union of interests was generated between these environmentalist groups and Coldiretti, which for financial reasons thought that Italian agriculture would have suffered from the spread of GMOs. (UR2, 2007)

Opposition groups were in turn fuelled by a series of mistakes made by multinational companies. As the respondent quoted below suggested, companies like Monsanto were arrogant in the way they introduced products into the EU market. Similar to the respondents in the Scope project (Burchell et al, 2009) and the British scientists I interviewed, Italian researchers do not support these corporations either. Scientists hold their reservations towards these companies.

> To tell you the truth, I think that multinational companies, like Monsanto, for example, made a great mistake. In fact, they were quite arrogant in imposing their products on Europe, and with such a hurry. (UR3, 2008)

What followed was a strong anti-GM campaign run by the majority of the Italian mass media. Through exaggeration of fears and concerns towards GMOs, mass media reporting led to high levels of public uneasiness towards these products, a sentiment that characterised scientists' discussions of the late 1990s. As a government researcher suggested, 'suddenly GMOs turned into demons' (GR3, 2008). To summarise, Italian researchers localise an increase of media attention over the 1990s, coupled with a decrease in public support.

In the next decade, respondents recalled a period of relaxation followed by a recent exacerbation of the debate, which they link with Mario Capanna[82]'s anti-GM campaign. The latter, which was supported by a group of 32 small organisations, collected 3 million signatures against the commercialisation of GMOs in Italy. This atmosphere is in striking contrast with the scenario portrayed by the British respondents, who express confidence for the future of public opinion on GMOs.

[82] Mario Capanna is known as one of the leaders of the Italian student movement during the 1960s.

Significantly for the purpose of this chapter, which investigates scientists' perception of public opinion's influence on their work, the majority of researchers did not describe any particular change in their research. Somehow, all interviewees managed to continue their projects, although many lamented difficulties in getting funded. Most stated that they turned to the EU for funding, or, as we read in the quote below, named their research with biosecurity labels to receive governmental funds.

> At one point, many research groups in Italy shifted and focused on… you know, screening techniques… in order to screen the presence of foreign DNA in food or plants … but there is nothing new in this kind of research… it is just an easier and more fashionable way to receive funding… (UR1, 2008)

It then appears that where changes took place, they were focused on the form rather than the content of the research project.

Italian scientists tell a story of GMOs that highlights the independence of the GM scientific community. Despite obstacles, researchers have continued to do their work. In light of this narrative, the following section explores key themes that emerged during the interviews, aiming to further clarify how GM scientists make sense of public opinion and its impact on their work and their field more broadly.

**3.2 Key themes**

Just like in the British context, there were key themes that characterised Italian scientists' main story. This section is meant to explore these themes. I begin with the analysis of how Italian scientists understand public opinion and its relationship to the mass media. I then move on to examine how respondents position themselves in society. I conclude by reflecting on how these themes inform the communication process between GM science and the public in Italy. The respondents, as I will show, largely rely on a one-way communication model, in which science (should) inform the public.

*What does public opinion represent? Who is the general public?*

The idea of the general public was a central topic during interviews and the way scientists used it overlaps with the notion of general public proposed by Michael (2009) (see section 2.2). Here, public opinion was assumed to indicate the most popular opinions expressed by the general public. Thus, it can be argued that Italian interviewees' understanding of this term is similar to mine (see section 1). Notably, in all but one occasion, respondents did not question this term, which they employed with confidence.

In my conversation with one person, discourses about public opinion were a particular recurring theme. In this context, I asked the respondent directly how he learned about public opinion.

> I: Well, I actually don't have any direct contact with the public; I mainly operate in the scientific and mass media communities, through mailing lists.
> V: Right… but we were saying Italians are not confident about GMOs… how do you know they are not confident?
> I: Oh … I see what you mean… definitely from public perception surveys. (GR2, 2008)

Interestingly, other scientists often described this person as *the* GM scientist who is responsible for GM-related communication with the public. In this context, it is important to note that he defined meeting with the public as working with the popular press. This respondent also noted that he relied upon public perception surveys to learn about public opinion. Taken together, this suggests that a) the Italian GM community shares assumptions with classical approaches to representing public opinion in the field of PUS, which merge public perception surveys with mass media analysis; b) public perception surveys are a primary tool that these GM scientists use to hear from the public.

Exploring this topic further, I found that, like other PUS studies (Burchell et al, 2009; Davies, 2008), Italian scientists assumed the general public has a deficit of knowledge. Respondents implied that if the public knew more about this technology, they would rapidly change their minds about it and agree with the scientists.

> The problem is not really that they are not supporting GMOs, the problem is that they don't know what we are talking about. (UR2, 2007)

Notably, this characteristic was followed by other images of irrational, emotional and self-centred publics. These, which frequently feature in other PUS studies on scientists' understandings of the public (Burchell et al, 2009; Michael and Brike, 1994), are strongly questioned by critical PUS scholars (Irwin, 2003; Wynne and Irwin, 2003; Jasanoff, 2005). Focusing on environmental threats such as pollution and hazards in the context of local communities, sociology scholar Alan Irwin and his colleagues argue that what scientists might see as 'local ignorance (or local resistance) to technical innovations is an actively constructed social process rather than 'apathy' or 'irrationality" (Irwin et al, 2003: 61). Local communities use these processes to make sense of environmental threats, in ways that might be different, but are not necessarily inferior to the ways scientists understand these events.

Finally, similar to the UK, occasionally respondents reflected on the peculiar character of GMOs as a scientific controversy. As food, GMOs are entranced in everyday cultural practices and emotions.

> I think that in the US people are concerned about other things. Maybe for them food is not as important as it is for us. I guess you can say they are used to eat unhealthy food, and they don't seem to be concerned. Why they would be concerned about GMOs? After all, these are

> considered safe by the FDA. But here things are different – food is part of our culture and traditions. (UR6, 2008)

Limited scientific knowledge, self-centred attitudes, along with the baggage of history and emotional relations to food are all used by respondents to explain the distance between themselves and the public. Importantly, this characterisation contrasts with the notion that the public might contribute valuable inputs to the progress of science (Wynne and Irwin, 2003; Jasanoff, 2005), and allows scientists to dismiss lay people's concerns outright. Finally, it is important to note that GM researchers recognise public perception surveys as a tool to hear about the public.

*Who does public opinion represent? The mass media*

As I was working with my transcription I noted that Italian scientists often talked about the mass media.

> V: So we have been talking about public opinion for a while… I was just wondering, how do you actually get to know public opinion?
> I: Well… mostly through the mass media… in the end, they are the mirror of the public, aren't they? (GR2, 2007)

I already mentioned above that Italian scientists often discussed the mass media in conjunction with the general public and ideas of public opinion. The above quotation, for example, reiterates this discourse, and suggests that the mass media mirrors the public. In other words some Italian scientists consider the mass media a valuable tool to hear the public on GMOs.

However, not all Italian scientists I spoke with held this idea that the mass media mirrors public opinion.

> If you look at the mass media, it would seem everybody in Italy is against GMOs. But that is it not the case because recently the trends of Italians' opinions are much more positive. I was telling you about this journalist who came here, and asked about this plant that is more resistant to environmental stress… he could not believe it was GM, because, you

> know, in part is ignorance and in part they have created this image of GMOs as demons. (UR5, 2008)

The above quote asserts that there is a mismatch between what ‘true public opinion’ is and the opinion reported in the mass media. The respondent noted that the mass media have demonised GMOs, partly due to reporters’ ignorance. In other words, this section underlines that opposing statements on the relationship between the mass media and public perception co-exist in scientists’ stories of public opinion. These, furthermore, summarise long-standing debates among sociologists and social scientists on the relation between the mass media and public opinion (Gutteling, 2002).

Numerous respondents framed their stories about mass media in terms of ‘battle’. Terms like these are also prominent in Guy Cook’s (2004: 109) work on ‘genetically modified languages’, in which the professor of linguistics argues that ‘metaphors of battle are frequent in the discourse of both opponents and proponents’ of GMOs. In addition, in line with Bucchi (1996) and Hilgartner’s (1990) works, Italian GM researchers suggested that, through the process of popularisation of science, the mass media misrepresented GMOs into the public arena. Furthermore, scientists claimed that the mass media is manipulative in Italy, which is especially worrying given its pivotal role in mediating the relation between science and the public (see section below).

> In our country, the levels of persuasion that you can get from mass media are enormous. I always make this example. Let’s assume for a moment that the Prime Minister[83] owned a GMO manufacturing company. He would immediately organise a public campaign to persuade

[83] Silvio Berlusconi is the current Italian Prime Ministry and, surprising as it might be for a democratic country, he owns a consistent percentage of the mass media in Italy.

> Italians […] In maybe 4 months, the 80% of the populations would become pro-GM. (UR4, 2008)

According to these findings, it can be argued that Italian researchers do not trace clear boundaries between the mass media and public opinion. In addition, GM researchers are especially critical of this social actor, which they define as ignorant and manipulative. Overall, this shows that, while the mass media can be a tool scientists use to hear about the public, the popular press is simultaneously understood as manipulating the public.

*Who are GM scientists?*

> Thinking about the science community nowadays, you can see it is a quite uniform reality, with common intentions and beliefs and universal methods, something you cannot find in the public, for example. This is one of the reasons why I believe you cannot talk about public opinion – ultimately it does not exist. (UR2, 2007)

In common with previous research (Cook et al, 2004; Burchell, 2007; 2007a), the quote above describes the scientific community as a uniform group of people who share similar beliefs, intentions and methods. These characteristics distinguish scientists from the public and public opinion, which are two concepts the respondent questioned. The separation between the GM community and those outside is apparent in the quote below, which was taken from an interview with a university researcher who works in Milan.

> I believe there is a group of people who are experts in molecular biology, not necessary genetics though… and then there are the masses that do not know about these things. (UR1, 2007)

Notably, this respondent saw knowledge as the critical element that separates the GM community from 'the masses'.

Knowledge was also important in excluding a number of scientists whose understanding of plant biology was considered 'inadequate' to be part of the GM community.

The notion of separation was particularly prominent when the respondents discussed the mass media, which, as we already saw, are a recurrent theme in the interviews with Italian GM researchers. As we read in the following excerpt, one interviewee suggested that it had become a common practice for the news to frame GM issues in terms of pros and cons. She lamented how this and other media strategies undermine scientists, who were often attacked by non-experts. In a way, it could be argued that mass media have to some extent shaped science and further contributed to shaping respondents' image of the public, as well as their self-representation in society.

> You can see that they [mass media] are manipulating us [scientists]. In the debate, they always give the scientist less time, or they interrupt him while talking or possibly try and leave those against GMOs at the end of the debate, assuming there actually is one… it is a very cheap technique … also, if you look at the opponents, they are usually actors or writers, like Dario Fo[84], for example, and they have no clue about GMOs, but the public know them so they believe they are right. (GR1, 2007)

In the quote above, the respondent questions who the experts are in Italy. Similarly, another researcher stated that 'as bizarre as this can sound, in Italy it is supermarket chains like Coop[85] that tell mums what is good and not good, not doctors for example' (UR4, 2008). Together with the above quote, these statements highlight

[84] Dario Fo is a popular Italian writer and satirist. He received the Nobel Prize for Literature in 1997. In 2006, Dario Fo made a failed attempt to run for mayor of Milan.
[85] Coop is an Italian cooperative of farmers and small family businesses. In 1854, Coop opened its first shop in Turin. Today Coop operates in the entire nation and has become one of the largest Italian supermarket chains.

that, in Italy, scientists perceive a lack of respect towards science and scientific expertise, which leads to them feeling being marginalised in Italian society.

Discourses of marginalisation became particularly acute when researchers discussed their position in relation to the government. One interviewee stated 'science has never been important at the government level. I mean, everybody says research matters, but scientists are always at the bottom of politicians' agendas, regardless of the government' (UR5, 2008). Another interviewee suggested that, in Italy, the scientific community is too small to attract the attention of politicians, who in fact are only interested to votes (UR2, 2008). Finally, and even more surprisingly, the scientist quoted below noted that the Italian government had never really taken an interest in science in general, and care about GMOs even less.  This refers to Italy's lacks of specific scientific policy.

> So you are asking me about the government's GM policy? I have to say this is a naïve question, you see… there is no government policy of science, there has never been one in the past, and it does not seem there will be one anytime soon. (UR2, 2008)

GM scientists set clear boundaries between the inside and outside of the GM community. The latter, made up by scientists with specific knowledge in plant biotechnology, is typically identified by the respondents at the margin of society, outside the government's agenda. As a final note, it could be argued that this strong emphasis on discourses of inclusion and exclusion in the Italian landscape is a consequence of the controversial tones that characterise this topic within the Italian landscape. As Burchell (2007:161) notes, conditions of controversy, like the one that characterise the GM debate, 'would appear to increase the extent to which scientists construct contingent 'others".

*How to communicate to the public*

Having described the main characteristics of science and public opinion, I will now reflect on the relation between scientists and the public in Italy and in the context of PUS scholarship. During the interviews, I alternatively used terms like 'communicazione pubblica della scienza' (public communication of science) or 'dialogo della scienza con il pubblico' (public dialogue). However, I preferred to not use words like 'public engagement' because this terminology does not circulate among Italian scientists. Indeed, no reference was made to any experience with public engagement during the interviews.

However, several people I interviewed used the term 'divulgazione' of science.

> Personally, I have been a little bit involved in the communication of science… I wrote a few articles on that… we also wrote a few publications on how to 'divulgare' science to the public… Well, it was certainly very time-consuming and not quite efficient, I have to say. (GR3, 2008)

In its English translation, the term 'divulgazione' merges the verbs 'to popularise' with 'to disseminate'. As Bucchi (1998: 3) argues, terms like popularise and disseminate involve 'some deeper assumptions about the nature of scientific discourse and about the nature of scientific work at large. According to such views, the public discourse of science starts where scientific discourse ends'. As the scholar explains this means that simplified forms of scientific knowledge can be transferred to non-experts only when 'the task of producing 'pure', reliable knowledge has been accomplished' (Bucchi, 1998: 4). As such, 'divulgazione' carries derogatory ideas about the mass that are typical of the deficit model.

Here, researchers seemed to construct an image of communication that corresponds to the model of communication proposed by the two mathematicians Claude

Shannon and Warren Weaver (1949 in Gregory and Miller, 1998), in which a packet of information is transferred from the sender (actor 1) to the receiver (actor 2). In this context, the mass media were understood as necessary mediators. Typically, respondents were critical of these mediators, who, as one respondent commented 'had done an awful job with GMOs' (UR2, 2008).

Ultimately, it was striking that all but one researcher who had been involved in communicating science (which necessarily used the mass media) chose to give this activity up. Respondents often noted that speaking to the media was time-consuming, frustrating and at times even meaningless, considering the rather low level of public understanding of science. Meanwhile, I found that several science universities have launched Masters programmes that train people in how to communicate science with the public.

Taken together, these findings point to a divide between the public, whom scientists define as ignorant, and the GM scientific community. In this context, scientists rely on the mass media, which they also loudly criticised, as the main (and possibly only) mediator of communication to the public. Noticeably, no reference was made to the other side of the communication process, from which the public is supposed to reach science and is strongly linked to the listening process that is of particular interest to this thesis.

On the other hand, a new cadre of science communicators is been trained to speak to the public.

**4. GM scientists in the UK and Italy**

This section compares Italian and British scientists' stories about GMOs. I address the stories and themes that emerged across these two countries, paying close attention to similarities and differences.

The first relevant finding of this chapter suggests that scientists' stories on GMOs and public opinion parallel Chapter 3's analysis of mass media and public perception surveys. This is especially interesting taking into account that Italian and British respondents described learning about the public in different ways. Thus, while Italian scientists rely on both public perception surveys and the mass media to hear about public opinion, British interviewees hear the lay people through public meetings in addition to mass media. In other words, this suggests that the tools I used to analyse public opinion in the previous chapter do not necessary constrain the content of this analysis. As emerged through the analysis of mass media and public perception surveys (Chapter 3), study participants described an evolution of negative opinion that peaked in the late 1990s and early 2000s. Negative public opinion has been sustained in Italy, but has been followed by increasing support in the British context. It is worth pointing out that respondents' talks about public opinion, which they described as the opinions shared by the majority of the public within their own country, parallel my own understanding of this concept.

In both countries, scientists acknowledged that the relationship between the mass media and the public is a complex one. However, Italian respondents emphasised a mismatch between mass media representations of public opinion and what the real public opinion on GMOs is. In the UK, scientists talked about the mutual influences between mass media and public perception. This suggests that Italian researchers question the representativeness of the mass media.

In addition, in the case of the UK, a more contextual and local idea of public emerges.

The mass media, NGOs and multinational companies were typically represented by scientists as malign actors, who mediate the relation between science and society in ways that disrupt and misrepresent science. In the case of Italy, special emphasis was placed on the mass media. In the UK, scientists identified NGOs as the initiators of public resistance to this technology. In both countries, scientists shared a negative perception of multinational companies, whose actions ultimately damaged GMOs, albeit non-intentionally. In addition, as other PUS scholars note (Davies, 2008), study participants frequently referred to the deficit model and assumed an ignorant and uneducated public. All together, these discourses enable the scientists to easily invalidate the notion that publics' concerns are instrumental to the future of life sciences.

Having said that, in the case of the UK, scientists also talked about a knowledgeable, reasonable and practical public, one that is likely to accept GMOs in the near future. In regards to this topic, Michael's (2004) work suggests that scientists are more interested to engage in dialogue experiences with particular kinds of public, i.e. knowledgeable and rational, than others (i.e. irrational and extreme). In light of this argument I suggest that, if dialogue is key for listening, a space for listening is emerging in the British GM community. This however, does not seem to feature in the Italian landscape.

Like other PUS studies (Burchell, 2007; Cook et al, 2004), my findings indicate that scientists distinguish between insiders and outsiders when talking about science and society. However, national differences emerge in the ways Italian and British researchers talked about those who are actually inside and outside the GM community. UK researchers described themselves as experts within a society in which expertise is championed at the state level. In the case of Italy, researchers positioned themselves against the rest of society, including the government. In addition, Italian scientists were extremely specific in the kinds of knowledge necessary in order to be part of the GM community. This translated in an even stronger emphasis on exclusionary practices.

I have drawn a picture of science in society based on Italian respondents, as a device to compare the ways British and Italian GM scientists envision their place in social life. In this picture, the government is at the top, distant from science. The mass media is in the middle, mediating the relations between a very marginalised science community that typically lies on the bottom of society and the public.

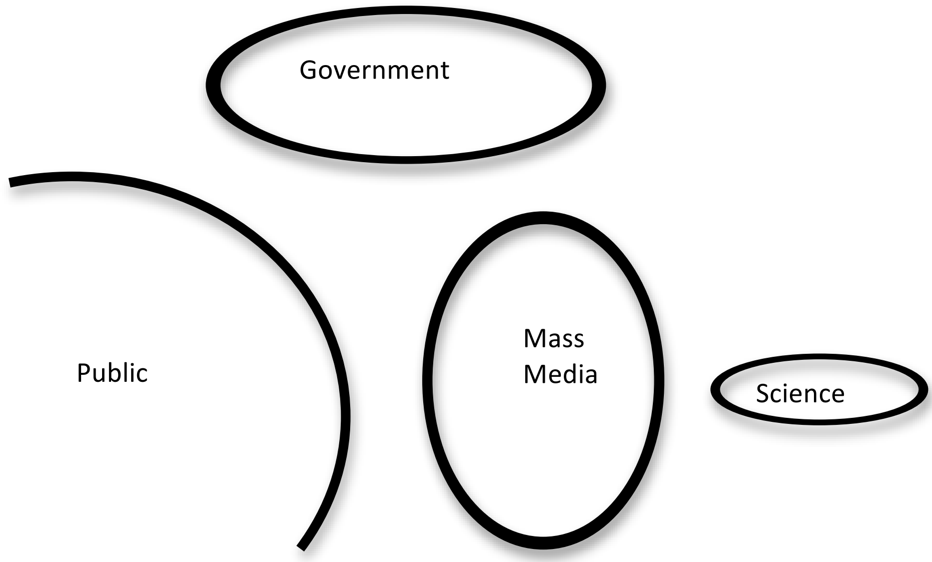


**Figure 18: Imaginary representation of science in society according to Italian respondents**

The British government was often described as generally supportive of GMOs by UK scientists, although at times somewhat restrictive in order to address public uneasiness.  Meanwhile, Italian scientists portrayed the government as GMOs' greatest opponent.  Importantly, all Italian researchers mentioned the actions taken by two consecutive Ministries of Agriculture to cut public funding and research on GMOs.  In regards to the government's position in relation to science, my findings show that Italian scientists lamented the lack of a clear science policy in Italy and substantial interest in science on the part of the government. In contrast, in the UK, the government has always championed science.  Science is governed through clear and programmatic policies. Finally, while British scientists emphasised the influence of public opinion on the government's management of GMOs, Italian scientists rarely linked public opinion and the government.

Overall, this suggests that, while British researchers see the government as a mediator of public discontent and indirectly responsible for changing GM science, Italian scientists blame the government.

Furthermore, it is interesting to note British respondents' emphasis on the losses of science that characterised the GM field. Discourses about losses were less prominent in Italy. It can be argued that this difference is just another example of the different cultures of science that characterise Italy and the UK and first began to emerge when comparing British and Italian attitudes towards patenting GM inventions in Chapter 3.

These discourses bring me closer to the question driving this chapter, which is what influence, if any, does public opinion have on the respondents' work and their field in general. According to my findings, British respondents envision a multiplicity of possibilities that includes a full gamut of answers. Nevertheless, there is a widespread consensus across researchers on one particular narrative. This is to say, albeit indirectly, public opinion did affect respondents' work and the broader field. In this context, the government and agrochemical industries function as main mediators. In comparison, opinions are more unified in the Italian case in which GM researchers see the government as hampering their work and the field in general. This narrative leaves little room for public opinion.

It should be noted that I remain open to the possibility that some influence of public opinion was exerted on science in Italy. For example, it could be argued that the government's opposition to GMOs was in response to the negative public opinion that characterises the country. However, Italian scientists did not, or perhaps did not want to, emphasise this aspect of the story. Therefore, although this hypothesis is not ruled out, it is not prominent in scientists' narratives.

Finally, in relation to the discussion of public communication to/with science, I found that in the UK, scientists' descriptions of the public introduce discourses of dialogue as well as the deficit model's assumptions. In addition, researchers employed the language of these models alternatively and without tension. Notably, in Italy, no reference was made to public dialogue experiences and related language was not used. Although British scientists made some references to public engagement, in both countries the respondents never used the term public engagement. In Italy, scientists frequently talked about 'divulgazione della scienza', which stresses the idea of a one-way communication process that goes from science to the public. Italy and the UK seem to approach problems between science-public communication in different ways. The British government has been mediating the relationship between science and the public and is in the lead in developing dialogue and engagement models. Meanwhile, in Italy, a new cadre of professionals responsible for translating science into everyday language is being trained.

In this context, it is interesting to reflect on Sarah Davies's work on scientists' understanding of public communication experiences, where she argues that images of the publics are usually tied up with fuller narratives of communication between science and the public, and notes that more complex discourses of communication emerged in those cases in which scientists provided similarly more complex models of publics. Overall, it can be argued that the differences between national understandings of science communication reflect the different images of the public provided by Italian scientists, who exclusively focused on images of deficient and ignorant public, and British respondents, who admitted more complex and local ideas of the public.

Although not conclusive, these findings clarify the picture I started to sketch in Chapter 3. As I sensed in that context, understanding the relation between science and society might require something different from the pure and basic analysis of public opinion and science output. Looking at this chapter's findings, I suggest that this relation is complex and includes different kinds of mediators (i.e. mass media, NGOs, corporations and the government), which failed to emerge clearly in Chapter 3. Each of these mediators plays very specific roles in the process of listening. Starting with the mass media, my findings show that, in both countries, respondents use it as a way to speak to, as well as hearing from, the public. Noticeably, hearing appears to be only the first step for listening, which would be incomplete without a response. As noted throughout the chapter, the government and corporations can be considered the mediators of public opinion in the relationship between members of the public and science. At this stage, I wonder what happens after scientists hear public opinion and before they develop their responses.

In the next chapter, in which I analyse two case studies of research programmes on GMOs, I will try to further explore these tentative conclusions.

**5. Conclusions**

The main question of this chapter asks how GM scientists tell the story of the effects of public opinion on their work and their field in general. By comparing the experiences in Italy and the UK, I found two different answers to this question. In Italy, scientists describe the GM community as an independent field that is marginalised from society and hampered by the government's anti-GM policy. Public opinion plays little role in such a story. On the other hand, British respondents suggest public opinion had an indirect impact on their field and their work is mediated by the government and corporations. I argued that these different answers could be explained by looking at some crucial differences between Italy and the UK. These include science's position in society (or outside it), and in relation with the government, and the extent to which dialogue and engagement discourses circulated – as happened in the UK – or did not circulate – as happened in Italy. Finally, this chapter helped me begin to sketch out the process of listening, which so far includes two moments, which are hearing and responding to public opinion. In each country these moments are mediated, or not mediated, by different social actors that include the mass media, the government and corporations.

Several questions remain open for investigation, i.e. what do scientists do after hearing about public opinion? How do they deal with this information? Are there different kinds of listening? In what ways, and under which conditions, might other social actors facilitate science's response?

Before I can try to address these questions, I need to do one last step and put this project into its social context to explore the political, social and economic factors that are of importance to Italy and the UK in the process of listening. This will be the object of my next chapter.

## Chapter Five

## Comparative Analysis of Two Case Studies on GMOs Research in Italy and the UK

The central question of this thesis is how, and under what conditions, scientists listen to lay people's concerns about GMOs in Italy and the UK. In Chapter 3, I explored the evolution of Italian and British opinions on GMOs, and mapped each nation's scientific output associated with GMOs. In Chapter 4, I looked at how GM scientists' narrate the effects of public opinion on their work and their field more broadly. These findings suggest the relationship between science and society is complex and cannot be explained by only looking at public opinion and scientific output. This complexity in part results from the involvement of different actors, such as the government, corporations and mass media, that mediate (or fail to mediate) the ways scientists communicate with the public.

To further explore how the relationships between scientists and the public are mediated, this chapter asks what social, economical, political or other factors impact in the way GM scientists came to understand public opinion, and how? In order to address this question, I take a case study approach and focus on two GMO projects carried out in Italy and the UK. These projects reflect the similarities and differences between the two countries. Both projects were government-funded, with a comparable amount of money. Both took place right after public backlash against GMOs, and are by now concluded. Both were publicised as a way to address public concerns about GMOs. The British project, *Farm Scale Evaluation,* focused on the environmental impacts of GM cropping, whilst the Italian one, *OGM in Agricoltura,* took a multidisciplinary approach.

I begin this chapter with a description of my data collection and methods. Then

I move on to analyse the two projects, recounting how the projects were developed and carried out. Ultimately, this chapter tells us about the relationship between science and society and the actors implicated in this relationship. It provides a snapshot of the interactions between these different actors and how these impact the communication process between science and society. In the last section of the chapter, I reflect on the similarities and differences between the projects. This analytic exercise allows me to identify six factors that impact the ways GM scientists get to know public opinion: government, position and culture of science, private companies, types of publics, mass media and PUS academic debate. Ultimately, my findings are continuous with Wynne's (2006) argument that communication between science and society occurs within the local cultures of science and politics.

**1. Data collection**

To do a case study of the two research projects, I used multiple data sources, including both co-produced and extant materials. The co-produced materials consist of the transcriptions of the interviews I conducted with individuals who were involved in or implicated by the projects. In Italy I met with one of the project organisers. I also interviewed two researchers who felt they had been intentionally excluded from the research. In addition, I met with two journalists and scholars, who reported on the project. In the UK, I spoke with a researcher who participated to the project and two other scientists who were more broadly involved in the FSE. The general interview guide includes a discussion of the project as well as a broader reflection on the nation's approach to GMOs. In preparation for each of the meetings, I also listed a series of topics that I meant to discuss with each interviewee according to their specific relation to the project. Overall, I conducted eight semi-structured interviews, three in the UK and five in Italy.

In addition to this, I analysed different kinds of extant data. For the UK, this included popular press reports, scientific papers, government and policy documents, transcriptions of meetings of different kinds held by and with the numerous actors involved in the project, and recorded broadcast interviews with scientists, NGO spokesmen and MPs. The sample of public press reporting includes a collection of national newspaper coverage regarding the launch that publicised the field trial results in October 2003 that one interviewee gave me. I also searched for articles published in *The Independent*, the *Daily Mail* and the *Guardian* that contained the phrase 'Farm Scale Evaluation' and are listed in the Lexis Nexis database. This search provided a total of 61 articles, 8 in the *Daily Mail*, 24 in the *Guardian* and 29 in *The Independent*. As noted before in this thesis, over the period investigated, I consider *The Independent* to be the UK's opinion leading newspaper. The *Daily Mail*, which coined the term 'Frankenfood' and initiated a campaign against this technology, is the second British newspaper for readership. I decided to include the *Guardian*'s articles on the FSE, as this newspaper tends to be associated with environmental groups and NGOs largely involved in the FSE. The scientific papers on the methods and results of the FSE were published in *Philosophical Transactions of the Royal Society* journal. I scrupulously analysed the websites that followed the project, which includes a website run by one of the scientists who participated to the project[86], and

[86] http://www.rothamsted.ac.uk/pie/sadie/joe_general_work_GM_page_3.php (last visit 15/07/2010)

various websites of government departments and Committees[87] that were involved in FSE. This strategy allowed me to access a variety of reports, transcriptions[88] and broadcast interview records[89] covering the FSE.

Material proved harder to find regarding the Italian programme. I checked the archives of *La Repubblica* and *Il Corriere della Sera*[90], but was unable to find any article containing the phrase 'OGM in Agricoltura'. *Il Sole 24 Ore*[91] published the only two articles in the popular press featuring the project (July 8th, 2007; July 22nd, 2007). I also analysed the press release of the second work-in-progress conference launched by INRAN (7th March 2006). In addition, through an on line search, I collected three more on line articles that made some reference to the project[92]. Noticeably, the scientific press covered the project with two articles in *Nature Biotechnology* (2007; 2008). Furthermore, I read the book that was published as a result of the project, an edited collection written by the scientists involved (Carboni

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[87] http://webarchive.nationalarchives.gov.uk/20080306073937/http://www.defra.gov.uk/environment/gm/fse/, http://www.defra.gov.uk/acre/index.htm, http://www.gmsciencedebate.org.uk/report/default.htm, http://www.aebc.gov.uk/, http://www.parliament.uk/eacom/ (last visit 15/07/2010)

[88] Advisory Committee on Releases to the Environment meetings transcripts, Science Review Panel reports, Agricultural and Environment Biotechnology Committee report on the FSE, EAC report on the FSE.

[89] Examples include BBC broadcast Measuring GM crops in *More or Less* series, BBC Radio 5Live programme broadcasted in July 2001 and the March 5th, 2003 respectively. In both shows, Joe Perry (Rothamsted Institute) discusses the FSE. Recorder interview at *Up All Night* recorded on March 5th, 2003 with Peter Ainsworth MP (Chair of the EAC), Joe Perry (Rothamsted Institute), Claire Oxborrow (Friends of the Earth) and Professor John Pidgeon (Brooms Barn Research Station). Recorded interview with Joe Perry (Rothamsted Institute) on Radio Saturday *Eureka!* This is a New Zealand science magazine program hosted by Veronika Meduna. (April, 2004).

[90] Over the period investigated they are the first and second most popular Italian newspapers (Dati Ads Accertamento diffusione stampa - media mobile gennaio-dicembre 2008).

[91] *Il Sole 24 Ore* is Italy's most important financial newspaper.

[92] The on line version of the magazine *Galieo* on science and global issues published an article on *OGM in Agricoltura* http://www.galileonet.it/dossier/8224/il-programma-ogm-in-agricoltura (last visit Feb 1st, 2010). Another article was published in the magazine *Agricoltura Nuova* (March 30th, 2006), a magazine that circulated mostly amongst farmers. Last article was published in the Minister of Agriculture's on line magazine *Agricoltura Italiana* (http://www.aiol.it/contenuti/attualità/attualità-ministero/ogm-agricoltura (last visit 15/07/2010)

et al, 2006). Through an online search of the parliament website, I accessed three documents of correspondence between MPs and the Minister of Agriculture that either questioned or defended the project[93]. Finally, I carefully monitored the Institute of National Research on Agriculture and Nutrition (INRAN)[94] and SAgRI[95] websites, the only two that followed the project consistently.

**2. Method**

This chapter is a multiple-case study that compares two projects on GMOs, one located in Italy and one in the UK. The similarities and differences across the countries, listed in Table 4, have proven crucial to the selection of these cases as well as the analysis and final discussion.

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[93] http://www.salmone.org/chi-e-sagri/ (June, 6th 2006 and November 18th, 2007) (last visit 15/07/2010)

[94] http://www.inran.it/ (last visit 15/07/2010).

[95] SAgRI stands for SAlute, RIcerca e Agricoltura (Health, Research and agriculture). It is an NGO made up by Italian researchers and scientists http://www.salmone.org/chi-e-sagri/ (last visit 15/07/2010).

**Table 4 Similarities and differences between Italy and the UK, and the FSE and *OGM in Agricoltura***

| | Italy and the UK | FSE and *OGM in Agricoltura* |
|---|---|---|
| *Similarities* | • Italy and the UK are both members of the European Union, which means that they have similar regulations of new technologies<br>• In both Italy and the UK, public opinion was unsupportive of GMOs. | • The FSE and the *OGM in Agricoltura* are two government funded projects that cost the a similar amount of money, £6 million in the UK and €6 million in Italy<br>• Both these projects were proposed by the governments as a way to respond to public uneasiness towards GMOs and increase scientific knowledge. |
| *Differences* | • The UK initiated the modern debate on the Public Understanding of Science, while in Italy this discourse came later on from the EU<br>• Italy and the UK do not share the same 'cultures of science[96]' (Franklin, 1995)<br>• Italy and the UK have different traditions in terms of regulation/policy of science and new technologies. | • The UK published online all the steps and documents related to the FSE. The *OGM in Agricoltura* study did not, in any way, plan to communicate the results to the public<br>• The British project is expert-based and focuses on one topic only, while the *OGM in Agricoltura* study is a 360° project that covers GMOs broadly<br>• The British government supported the FSE with a series of Committees and controls to guarantee the greatest level of transparency. The Italian government lacked any instrument to control/support the project on GMOs. |

After collecting the majority of the data, I listed each and began reading the documents closely. The questions I asked included: what is the purpose of this document? Who wrote/co-produced it? What is the story this document is telling me? And, finally, who are the actors included in, or excluded by, this document?

96 Anthropologists of science introduced the idea that science is a culture and culture consists of 'the local practices of making sense' (Traweek in Franklin, 1995:174).

Methodologically, I conceptualised both research programmes as 'situations' following Adele Clarke's (2005) situational analysis approach. Quite early in this process, I began developing situational maps and social words/arenas maps. These are two analytical tools included in Clarke's situational analysis method. Responding to one of the main critiques to grounded theory, which argues this analytical process results in theories that tend to remain suspended in time and space (Burawoy, 2003), Clarke develops situational analysis as a means to resituate the process in question (Clarke, 2005). Accordingly, the situation, rather than the process, becomes the object of analysis (Friese, 2007). Clarke (2005) points out that situational analysis, as a method, allows scholars to open up the data and interrogate these materials in fresh ways. In addition, Friese's (2007) study on endangered animal cloning demonstrates the value of this methodological tool when comparing different situations.

Clarke defines *situational* those maps that 'lay out the major human, nonhuman, discursive, and other elements in the research situation of inquiry and provoke the analysis of the relations amongst them' (Clarke, 2004: xxii). I used those maps to lay out all the actors involved in and implicated by each of the projects. *Social worlds/arenas* maps are the ones that 'lay out the collective actors, key nonhuman actors and the arena(s) of commitment and discourse within which they are engaged in on-going negotiations – meso-level interpretation of the situation' (Clarke, 2004: xxii). Accordingly, I used social worlds/arenas maps to make sense of these situations in terms of which actors were representing social groups.

My next analytical step consisted of writing memos. Each of these memos referred to only one project at a time, either the FSE or the *OGM in Agricoltura*. The goal of the first 'wave' of memos was to put together all the pieces of the situation-puzzle in order and develop a detailed story of how the project developed over time. At this stage, I continually went back to my maps to see if there were possible gaps in my data collection, indicating where to search for missing information. Continuing to focus on one project at a time, in the second 'wave' of memos, I asked: which kinds of social, political, economical or other factors were entrenched in the situation? And also, in what ways did these contribute to, or limit, scientists' ability to listen to public opinion?

Finally, and in order to understand which social, economical, political or other factors shape the way GM scientists get to know public opinion, and how, I systematically compared and contrasted my maps and memos. This time, however, I abandoned the national boundaries and looked at Italy and the UK in parallel.

**3. Case Study One: the *Farm Scale Evaluation* in the UK**

As part of the data collection for this thesis, in February 2008 I met with a British researcher, who worked with GMOs for several years. This was the first time one of my interviewees referred to the *Farm Scale Evaluation* project. The researcher, who is one of the statisticians who contributed to planning the trials and analysing the results, characterised this project as 'the largest experience of release of GMOs in the UK' (GR2, 2008). Following that interview, I met with two researchers implicated in the project and checked the online material on the FSE. The latter proved to be extremely detailed and publicly accessible. It includes broadcast interview programmes with scientists who worked on the trials, interviews with NGOs and MPs, scientific publications, popular press articles covering the FSE, NGOs and policy documents, government bodies' reports, and transcriptions of public meetings arranged by the Advisory Committee of Releases into the Environment (ACRE) [97]. I believe that my interviews, along with this database provide adequate information to recount the evolution of the FSE.

> [T]he Environment minister, Michael Meacher, confirmed to Parliament that much tougher checks would be carried out on GM products under a voluntary agreement with the industry […] Mr Meacher told a Lords select committee that no insect-resistant crops will be introduced to the UK for three years and pledged to provide much more information about the fast-developing business […] Mr Meacher said the Government's aim was to strike the right balance between protecting the environment and human health on one hand, and on the other maintaining the proper degree of certainty needed by business for the development of new products. […] The process will be underpinned by strict guidelines for best practice in using GM crops, he added. 'The results of these farm-scale evaluations will be carefully assessed before moving further.' Tony Juniper, of Friends of the Earth, claimed the new arrangements did not go far enough and the voluntary framework proved that the Government had buckled under pressure from the GM foods industry. (Waugh, 1998)

This is the first time that members of the public heard about the *Farm Scale Evaluation*. As we read in this article, taken from *The Independent*, the government launched the FSE in an effort to strike the right balance between the environmental and health concerns related to GMOs, on the one hand, and corporations' needs to develop new products on the other.

From the early staging of the project it was clear that, as a situation, the FSE touched numerous social worlds. Figure 19, which at first glance might seem difficult to understand, will provide the reader a map to orient himself or herself as I proceed to unfold the FSE story.

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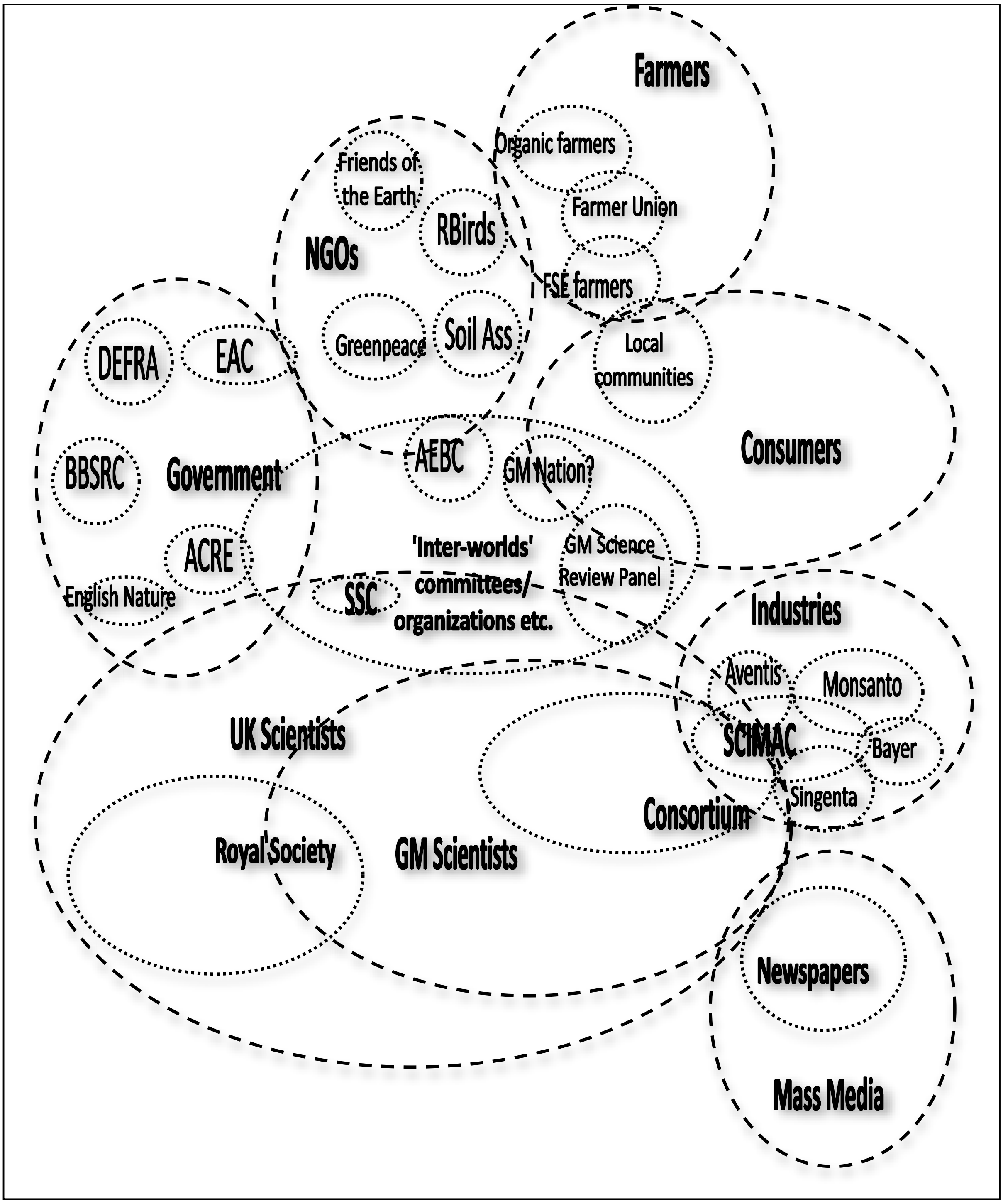
[97] 'ACRE is a statutory advisory committee appointed under section 124 of the Environmental Protection Act 1990 (the EPA) to provide advice to government regarding the release and marketing of genetically modified organisms' (http://webarchive.nationalarchives.gov.uk/20080306073937/http://www.defra.gov.uk/environment/acre/about/index.htm) (Last visit 15/07/2010).

**Fig. 19: Social Worlds Map Farm Scale Evaluation (1998-2003)**




The historical sequence of events that ultimately resulted in the FSE began two years before *The Independent* article was published. In 1996, early signs of public uneasiness towards GMOs were emerging within the British landscape. At that time, NGOs including Friends of the Earth (FoE) and Greenpeace were launching national campaigns against this technology, while the ACRE and the Pesticides Safety Directorate (PSD) opened a discussion on the impacts of GM crops on the British environment.

The Department of Environment Food and Rural Affairs' (DEFRA[98]) historical account of the events that lead to the FSE argues that, by 1998, different Genetically Modified Herbicide Tolerant (GMHT) varieties of maize, oilseed rape and beet were on the verge of entering the UK market (DEFRA, 2000: 1). The report continues by describing what happened early that year.

> The British Department of Environment and Transport (DETR) had started in depth discussions with English Nature to lay the ground for development of policy to address wider biodiversity issues related to GM crops. English Nature (EN), with other statutory nature conservation bodies, called publicly for a moratorium on the commercial use of genetically modified herbicide tolerant (GMHT) and genetically modified insect resistant (GMIR) crops until further research was carried out. They were specifically concerned about the continuing impact of farming practices on farmland wildlife. GM crops could exacerbate wildlife declines if they encouraged higher levels of weed control than necessary, which in turn would reduce invertebrate and bird numbers' (DEFRA, 2000: 2).

The following summer was characterised by intense discussions across the numerous governmental bodies touched by GMOs. By October 1998, the DETR called for a moratorium on the commercialization of GMOs. This possibility was rejected by the government, which in turn announced an agreement with GM corporations. The latter were going to postpone the introduction of GM varieties into the British

[98] The DEFRA was founded in 2001, when the Ministry of Agriculture, Fisheries and Food (MAFF) was merged with part of the Department of Environment, Transport and the Regions (DETR) and with a small part of the Home Office.

market until the completion of a four-year research programme that would study the impacts on the environment of specific GMHT varieties, i.e. spring oil-seed rape, fodder maize, sugar and fodder beet. This moment signals the beginning of the FSE.

After the decision to run the trials was taken, the government invited 15 organisations to tender for research contracts and test the null hypothesis that 'no significant differences between the biodiversity associated with the management of GM winter oilseed rape/spring oil seed rape/maize crops that are tolerant to herbicides and comparable non-GM crops at the farm scale' exist. (DEFRA, 1999: 245).

Following close consultation with NGOs and EN, on April 15th 1999 the government appointed the successful Consortium, which includes three publicly funded research institutes, led by the Centre for Ecology & Hydrology (CEH), alongside Rothamsted Research and the Scottish Crop Research Institute (SCRI). Meanwhile, the DETR finalized the practical agreements with the Supply Chain Initiative on Modified Agricultural Crop (SCIMAC), which represented the group of industries implicated in the FSE[99]. It was decided that SCIMAC was going to provide the locations and the GMHT seeds necessary for the trials.

The representations of, and reactions to the FSEs were different according to the position occupied in the project by each of the actors. For example, one of the researchers who took part to the FSE argued that this project 'had nothing to do with food safety or gene flow, it was purely in terms of the environment' (GR2, 2008). Les Firbank, coordinator of the Consortium, highlighted that the FSEs were not meant to study GMOs as such, but rather 'the effects of crop management

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99 SCIMAC includes Monsanto, Aventis, Bayer and Singenta.

systems on biodiversity and the other management systems associated with herbicide-tolerant crops' (Les Firbank, 2003:3). Nonetheless, the government sponsored this project as the British strategy to answer public concerns about GMOs in balance with the potential benefits of GMOs (DEFRA, 2001). Meanwhile, NGOs such as Friends of the Earth portrayed the FSEs as the government and industries' way to *show* Conservation Agencies and members of the public that *something* was being done with regards to GMOs. They claimed the government used taxpayers' money to fund a project needed by agricultural corporations in order to finalize the ongoing introduction of specific GMHT products into the British market (Diamand, 2003: 2).

The contrast between the official interpretation of the project given by the government and the interpretations provided by other actors implicated in the FSE elicits questions about the relation between the FSE and public opinion. Specifically, what kinds of public concerns, if any, did the FSE address? And how did the choice of research question reflect the priorities of some groups over others? On the other hand, the reconstruction of the early stages of this project suggests an attempt to reconcile the needs of science and industry with the concerns both the government and conservation bodies had with GMOs.

Two important actions were taken in the early stages of the project. These choices influenced the way the project was carried out. First, to foster transparency and facilitate public engagement with science, the Research Councils encouraged scientists to discuss their work with the public. In response to this suggestion, the FSE team decided to make all the material regarding the trials available on-line for public consultation. In addition, in May 1999, the government decided to appoint a

Science Steering Committee (SSC). The committee, which included scientists and ecologists, was meant to advise both the government and the Consortium throughout the entire trial period.

The first outcome of the collaboration between the Consortium and the SSC consisted of the decision to write the results of the project in the format of scientific papers (SSC, 1999)[100]. The underlying logic was that peer review by scientific journals would strengthen the validity of the trials. To some extent this requirement conflicted with the desire for transparency to foster public engagement. In order to strike a balance, members of the FSE program combined openness with regards to the methodology and the ongoing discussions of the project with confidentiality of results. This strategy embodies the ways in which British science culture and institutions champion expertise, while addressing and fostering public dialogue and engagement.

The main objective of the pilot year (1999) was to define a methodology that would fit the requirement of the project. Overall, a total of four trials with maize and three with oilseed rape were undertaken in that time frame. Of these, protesters damaged two and one was taken out by the farmer. Scientists immediately blamed the mass media and NGOs for this. Specifically, scientists claimed the FSEs were misrepresented in the public sphere.  Here, the FSE became connected with a range of questions that includes environmental safety, food quality, and the relationships between consumers, corporations, science policy and democracy (DEFRA, 1999). The Consortium felt these issues went far beyond the FSE's area of competence.

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[100] Overall the Consortium wrote a total of seven reports to the SSC, approximately one every six months.

Responding to this situation, scientists involved in the trials increased their engagement with the mass media. Essentially, they decided to use this strategy to communicate to the British public their views of the FSE. In addition, the government encouraged the Consortium to regularly meet with members of the local communities involved in the trials. These meetings gathered scientists, NGOs and members of the local communities, and were usually described by scientists as 'talks to' the public (GR2, 2008). Notably, both these strategies and also the vocabulary used to describe them are entrenched in the deficit model and corresponding assumptions regarding an ignorant public. Furthermore, the communication process with the public is framed as a top-down process that reiterates the deficit model assumptions, while opposing dialogue and public engagement discourses. Wynne et al (2007) argue that projects like the FSE gather *invited* publics, like local community members and NGO representatives participating in the Consortium public meetings, but also *uninvited* publics. The FSE chose to uninvite NGO members and other protesters who destroyed field trials.

In November 1999, the Consortium agreed to introduce a fourth variety, namely winter oilseed rape, and add a further 60 trials to the original plan. The negotiation happened between SCIMAC and the government. Noticeably, the latter offered to cover the extra costs related with the tests for winter oilseed rape in full. As with the other three GHMT varieties, SCIMAC committed to provide the locations and the seeds for the trials. In March 2003, the Environmental and Audit Committee (EAC), which was first established in 1997 to oversee environmental protection and sustainable development of the UK by the Labour Government, published a document commenting on this decision.

> What passed in the months between this agreement by the SSC in June 1999, and November 1999, when the new agreement was reached between the Government and SCIMAC on GM crops, is unclear […] It is regrettable that the Government failed to be transparent about the nature of any deal made with the industry over the inclusion of beet. Given the public's concern and suspicion on matters relating to the GM industry we would expect greater openness (EAC, 2004: 11).

Similar comments came from NGOs like FoE and Greenpeace. In addition to issues of transparency, these discourses elicit questions about science policy and democracy, i.e. which actors are invited to the table to make decisions? And also, which of the invited actors is listened to, and who is silenced?

Following the pilot year, as the programme entered full force, intentional damages to the trials decreased. In the third Consortium interim report to SSC, researchers reported being satisfied with the site selection for that year, which provided 'representative samples of the geography and style of management for the crops' (2000b: 1). This relaxed atmosphere suddenly changed during the summer of 2000.

In June 2000, scientists announced that conventional beet seeds, whose offspring were supposed to be used as a control group against the GMHT variety, were GM-contaminated. The *Daily Mail* covered this episode with a detailed feature where members of both NGOs and the Green Party were interviewed. Whilst these groups called for the government to intervene and halt the trial, scientists argued the incident did not compromise the validity of the project (Smith, *Daily Mail,* 2000). Ultimately, a few days later, the Scottish Executive decided to allow the Consortium to carry on with the study.

However, three months later, the field trials were back into the media. This time it was a jury in Norfolk's decision to clear 28 Greenpeace activists who, a year earlier, had raided William Brigham's GM maize field, which captured the media's attention. This episode generated opposing reactions. Particularly interesting was Mr. Brigham's comment on the episode in *The Independent*. 'Greenpeace is a massive environmental pressure group [...] We are a small family farm. It used bully-boy tactics to get its own way and today the bullies have won' (McCarthy, *The Independent*, 2000). In this excerpt, NGOs, which are normally framed as small organisations fighting against big corporations, are turned into bullies fighting small family farms. Furthermore, these few lines highlight that FSE farmers did not necessarily agree with NGOs' actions. But does this mean that some members of the general public may have felt supportive of the trials? Unfortunately, the large pile of data available ignores the general public's views of the project.

This gap in the material forces further reflection on the interventions carried out by FSE actors to engage members of the public. The gap supports the idea, proposed by other scholars (Wynne, 2006; Ellis et al, 2009), that scientific and political institutions construct images of the public that are not necessarily reflective of people's views on one particular issue. As we read below, sociologist Rebecca Ellis and her colleagues (2009) note that when imagined publics are the object of institutionalized forms of public engagement, these imagined figures might be detrimental to the process of democratization of science that they are inspired by.

> We suggest that the objectification of imagined publics in this way might be insensitive to the dynamics that Laclau describes as essential to democracy[101], in that they objectify certain assumptions about the

[101] A few paragraphs below Ellis et al explain better these dynamics as follows: 'One of Laclau's central ideas, which has helped us in understanding the relationship between barcoding's publics and its possible democratization, is the inability of the category of the 'people' to accommodate society's essential heterogeneity, an inability that, as Laclau reminds us, Rancière (1999) has called the 'paradoxical magnitude.' Both Rancière and Laclau are exploring the tensions inherent in doing democracy and the implications of recognizing that society is composed of more pluralities than reference to its totality can ever

> 'general public' without considering how these compromise the essential role of diversity in democracy. They could thus ironically undermine the very idea of the democratization of taxonomy, as an internal self-contradiction. (Ellis et al, 2009: 11)

On May 22nd 2001, the attention shifted to SCIMAC's decision to include the Warwickshire village of Wolston under the trials' umbrella. It was argued that, since this location was close to the Henry Doubleday Research Association's (HDRA) organic gardens at Ryton, organic crop varieties were going to be put at serious risk of contamination. Following conservation bodies and NGOs' protests, SCIMAC removed this location from the trials (McCarthy, *The Independent*, 2001). Commenting on this episode, the former Minister of Agriculture, Michael Meacher, expressed his support for SCIMAC's decision, which he argued 'is very sensible, because of the work and indeed the uniqueness of the HDRA' (McCarthy, *The Independent*, 2001). This event exemplifies the striking contrast between the positions occupied by corporations and scientists, invited guests at the table of the debate hosted by the government, and members of the public, who have to impose their voices to get heard as implicated actors in the FSE.

By September 2001, the Agriculture and Environment Biotechnology Committee (AEBC) published a report on the FSE. The committee, which was set up in June 2000 and includes experts and non-experts on GMOs, was meant to advise the government on the social, ethical and scientific issues related to these biotechnological products. In order to familiarize themselves with the topic, AEBC members decided to focus their first report on the FSEs, 'evaluate the role of the trials in the regulatory process, […] the data they [the FSEs] were expected to

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accommodate. For Rancière and Laclau this essential tension is what creates the very space needed by the 'political." (Ellis et al. 2009: 12) produce and the gaps which might still remain – and, in particular, try to understand and explain the evident public concern' (AEBC, 2001: 7).

The report written by AEBC members is significant for two main reasons. First, the AEBC suggested the British government to organise a broad public debate that investigates Britons' opinions with regards to the commercialization of GMOs. This called institutions' attention to the weaknesses that characterise the programmatic interventions of public engagement realised vis-à-vis the FSE. In addition, by recommending the government develop an independent body[102] that complements the FSE, the AEBC exposed the scientific limits of this project (AEBC, 2001). Members of the Consortium had always argued the FSEs were not the final piece of evidence before a decision on the commercialization of GMOs was to be taken (GR2, 2008). However, the AEBC suggestion takes a step further. It opens up questions about the relevance of this project to the GM field more broadly i.e. how did this project fit in the GM field? And who was this project addressing (i.e. scientists, the government, corporations, members of the public)?

The interviews I conducted consistently show there were numerous issues beyond the FSE that GM researchers considered more urgent. So, if the FSE was not necessarily addressing the scientific community, three possible audiences remain: the government, corporations and the general public. I do not think the FSE was targeting the public as the FSE largely ignored the public. In fact, up until this point in the story of the FSE, the only public encountered seems to be the one institutions imagined, and furthermore, the FSEs were not even focused on GMOs per se, but

[102] This body will be known as the Science Panel Review. It will gather 'scientists from a spectrum of disciplines and perspectives, two lay representatives a social scientist and a leading scientist with cross membership with the Public Debate Steering Board' (http://www.gmsciencedebate.org.uk/panel/default.htm) (last visit 15/07/2010).

rather the cropping management of specific GMHT varieties. The government and corporations seem to have been the key audience this project sought to address.

By the end of 2002, the Consortium had completed trials for three out of four GMHT varieties, for a total of 58, 67 and 66 sites for maize, beet and spring oilseed beet respectively (Haves et al, 2003). The following 10 months saw researchers actively engaged in the analysis of the data and preparation of the papers, which were published on October 16th, 2003 in *Philosophical Transactions of the Royal Society*.

In summary, the Consortium found evidence that, when planted under the FSE's conditions, the three GMHT varieties on trial (fodder maize, spring oilseed rape and beet) were likely to affect the British farm-wild life. However, while the impacts for GMHT maize were proven to be positive for the environment, GMHT beet and oilseed rape were found to be detrimental. In this context, scientists underlined that these effects should not be related to the nature of the crop, but rather the different treatments imposed by the specific varieties (ACRE, 2003a).

Interpretations of these results were further complicated following the EU's decision to withdraw three triazine herbicides[103] (atrazine, cyanazine and simazine) from the market (October 10th, 2003). Obviously, this event impacted significantly on the representations of this project. It should be noted that 3/4 of the conventional maize trials used triazine herbicides. Scientists who participated to the trials explained the decision to use atrazine herbicide by suggesting that, at the time of the trials, atrazine was the most popular British herbicide control system with maize,

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[103] Triazine herbicide is a family of herbicides that includes atrazine. Atrazine is a broadspectrum herbicide. Its use is controversial because of its effects on non-targets species, and contamination of water. Although it has been banned from the European Union in the fall 2003, it continues to be one of the most widely used herbicide in the world.

and it was crucial to them to stick as closely as possible to the national cropping strategies. The latter, and not the GM variety, were the object of scientists' inquiry. When atrazine was withdrawn, scientists refused the possibility that the results had been compromised, while suggesting some adjustments to the final interpretations given to the GM maize portion of the data.

On the other hand, opponents of the trials argued the use of atrazine had been a wrong choice from the beginning. They suggested scientists chose this herbicide *because*, and not *in spite,* of its detrimental effects on wildlife. They claimed scientists knew atrazine was going to be withdrawn from the EU, but they also knew that any other cropping system, even GMHT ones, would have easily performed better in comparison to atrazine. Mr. Meacher, who was disposed as Minister of Environment on June 13th, 2003, was one of the more vocal about this issue. Below is an excerpt from the reactions to the launch of the FSE results taken by the *Daily Mirror*. The article combines comments from the former Minister of Environment, Greenpeace and Friends of the Earth. Broadly speaking, these actors suggested the results of the FSE left no room for GMOs within the British agricultural system.

> Greenpeace said: 'For years, GM corporations have claimed their crops would reduce weed killer use and benefit wildlife. Now we know how wrong they were, Tony Blair should close the door on GM crops for good.' Michael Meacher, sacked by the Prime Minister as Environment Minister because of his scepticism towards 'Frankenstein farming', said: 'GM oilseed rape and beet should not be grown in Britain. The effect of using broad spectrum weed killers that kill everything - the network of lice, insects, worms, butterflies as well as weeds - was significantly worse than conventional weed killers.' He added: 'The trials showing GM maize was better for the environment are invalid.' Friends of the Earth said: 'Going ahead with the commercialization of any of these GM crops would be totally unacceptable. Information collected at public expense now confirms that GM crops harm the environment, make no economic sense

and are deeply unpopular' (Gilfeather, *Daily Mirror*, 2003).

In November 2003, scientists in the Consortium went over the results again and used the four trials that did not use atrazine to make inferences about the overall results on maize. On January 27th, 2004, *Nature* accepted the Consortium's paper that discussed the case of atrazine, which concluded that 'the comparative benefits for arable biodiversity of GMHT maize cropping would be reduced, but not eliminated, by the withdrawal of triazines from conventional maize cropping' (Perry et al, 2004: 3).

Meanwhile ACRE organized two public meetings to discuss the FSE results, one in Edinburgh and one in London. In preparation for these meetings, ACRE members asked interested parties to submit potential topics. From the 60 written submissions, ACRE selected 14 contributions to be heard in person. The selection process aimed to provide a range of opinions concerning the implications of the FSE results, with a focus on submissions that the Committee found relevant to their deliberations. In addition, ACRE invited FSE researchers to present their position at the meetings. At the end of each meeting, ACRE planned a discussion period with members of the audience. When reading carefully the transcriptions of these meetings, it emerges that, for the majority of the time, members of the audience listened to the presenters. Only in Edinburgh did participants get the chance to ask a few questions to the invited speakers.

Does this mean that ACRE did not consider the audience's opinions relevant to the discussion? On the one hand, ACRE did invite members of the public to send their submissions and participate in the public events. On the other hand, ACRE settings did not allow the audience to actively contribute to the debate. This, which

Davies (2009) shows might have been due to a lack of familiarity with dialogue, suggests ACRE failed to engage the FSE audience, and ultimately silenced members of public. As Reardon argues (2006: 353-354) 'while the focus on inclusion of subjects is laudable […] participation is not an innocent act. Instead, it is an institutionalized governmental practice that expresses some values and interests while excluding others.' In addition, this decision embodies a culture of scientism, which is typical of the UK and, as Wynne (2006) argues, idolatrizes science and expertise.

Following these events, ACRE published its formal advice to the government (ACRE, 2004), which was in favour of the cultivation of GHMT maize, and against the commercialization of GHMT oilseed rape and beet. The EAC report on the FSE was published on March 2nd, 2004, and was extremely critical of this project (2004). In addition to issues of secrecy, which I have already commented on earlier in this section, the EAC formalised critiques to the use of atrazine, which had been already moved by NGOs members and other opponents of the FSEs. First, EAC members noted that '[s]ince atrazine was such a devastatingly efficient herbicide, almost any other herbicide used, however potent, might still appear beneficial when in comparison' (EAC, 2004: 21). In addition, EAC members condemned the phasing out and replacement of atrazine, which raised serious doubts on the value of the forage maize trial results. The timing of this report, which was published a few months after *Nature* accepted scientists' evidence in favour of GHMT maize cultivated without atrazine, shows that at that time the debate around this issue was still open.

On March 9th, 2004, Mrs Margaret Beckett, the new Minister of Environment, announced to the parliament the government's final decision with regards to the first three GHMT varieties analysed through the trials. Essentially, the government opposed the commercial cultivation of GM beet and oilseed rape anywhere in the European Union under the same conditions of the Farm-Scale Evaluations, while it supported that of GMHT maize. Notably, Beckett clarified that GM maize could only grow in the UK under the same management regime enforced during the trials. In addition, and with regards to the upcoming phasing-out of atrazine, Beckett suggested that those farmers/corporations who were about to cultivate such crop should also carry out further scientific analysis on the effects on wildlife of conventional maize coupled with non-atrazine herbicide management (Interviews recorded online[104]).

Commenting on the government's decision, one of my interviewees argued that the Consortium was pleased with Beckett's interpretation of the results, which shows the government's commitment to an expert-based approach, in which each crop is assessed on case-by-case basis (GR2, 2008). Disappointed by this decision, a group of MPs were surprised that the government decided to dismiss the EAC advice, and claimed the government failed to even read it[105]. Along these lines, on February 20th, 2003, twenty days before Beckett's announcement, *The Independent* published an article stating '[t]he Government knows that the case for authorising herbicide-tolerant GM maize is weak, but it is a sufficient fig-leaf to give the biotech companies what they want' (Ruddock, *The Independent*, 2003). These comments open up important questions about science policy, but also about how democracy is to be realised in modern biosocieties.

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104 http://www.rothamsted.ac.uk/pie/sadie/reprints/beckett_1.mp3 (last visit 24/07/2010).
105 http://www.rothamsted.bbsrc.ac.uk/pie/sadie/reprints/HoC_9_march_2004.pdf (last visit 24/07/2010).

What happened next enhances our understanding of the relations of power existing between the government, scientists and corporations. At the time of the trials, Bayer held the UK license to grow GMHT maize. On March 30th, 2004, the company stated that the government had placed 'several ill-defined new regulatory hurdles in the way of commercialization, delaying it until 2006-2007, […] making an already ageing variety economically unviable' (Clennell, 2004). In other words, Bayer decided to not pursue the commercialization of GMHT. This meant that no GMHT varieties were going to be commercialised until 2008 at the earliest. The disappointment of the business community regarding the government's final decision is clear, and contrasts with the support showed by the experts. Does this mean that, in situations of scientific uncertainty, the British government opts for expert opinion over corporate interests?

The last piece of the puzzle on the implications of the use of atrazine came on April 2nd, 2004, when ACRE sent its advice to the government. The Committee found the work provided by Perry et al (2004) sufficient to support the hypothesis that 'conventional herbicide regimes used in the FSEs that did not involve the triazine herbicides (such as atrazine, simazine and cyanazine) lead to a similar impact on weed populations as the management regime associated with GMHT maize' (ACRE, 2004: 2).

Finally, on March 21st, 2005, the Consortium published the last portion of its results, with regards to winter GMHT oilseed rape. According to these, there was enough evidence to demonstrate that this variety would have had a negative impact on the UK environment. Even if this news did not generate as much newspaper coverage as the other crops on trial did, *The Independent*, which used the image of a coffin to describe the British GM industry, took this chance to underline that GM food had become a rather unlikely possibility in the UK landscape.

> Yet another nail was hammered into the coffin of the GM food industry in Britain yesterday when the final trial of a four-year series of experiments found, once more, that genetically modified crops can be harmful to wildlife (Connor et al, *The Independent*, 2005).

This episode concludes the story of the FSE. The careful chronology of how these trials were carried out in the UK strongly supports the idea that science depends on both society and politics (Leach et al, 2005). It unveils the complex web of interactions between the government, science, corporations and members of the publics. This suggests that GMOs are not a neutral technique, but co-produced (Jasanoff, 2004) in the society they are part of. In this context, the government functions as the host, while scientists and corporations can be described as invited guests. Paralleling previous studies (Jasanoff, 2005), this case shows that in situations of uncertainties, like the ones raised by GMOs, the British government opts for a scientific, expert-based approach. This embodies a culture of scientism (Wynne, 2006) that champions science (Rayner, 2003), and contributes to a further strengthen in the relations between government and science.

A separate discourse develops with regards to the public. According to the government, the FSE responds to public concerns about GMOs; however, careful analysis of the project's aims shows that the FSE is not directed at the study of GMOs, but rather the environmental consequences of GMHT cropping. Notably, the latter used to be specific concerns of the government itself and conservation bodies. Wynne et al (2007) distinguish invited and uninvited publics, a distinction that is analytically useful here. Invited publics are those to which institutions direct public engagement experiences, i.e. the public attending ACRE open meetings. Uninvited publics, on the other hand, can take different forms – NGOs, journalists, or even government committees can fall under the umbrella of uninvited publics, as can anybody in society who decides to express his or her opinion on an issue without being invited to do so. As this case shows, the actions of uninvited publics (i.e. NGO members' protests) are crucial to spark changes in the relation between science and society. While the FSE was in response to the sparks generated by the NGOs, such actors were not invited to participate in the FSE project per se. Finally, this case study supports other scholars' findings that contemporary forms of public engagement are still entrenched with deficit model assumptions regarding public ignorance and mistrust for science (Wynne, 2006; 2007), and have in turn consistently failed to democratize science (Ellis et al, 2009; Reardon, 2006).

In *Acting in an Uncertain World* (2009), French sociologists Michel Callon, Pierre Lascoumes, and Yannick Barthe propose an explanation of why these failures might occur. They argue that delegative forms of democracy, like the ones characterising Western countries, are grounded on a double 'break' between a) science and society, and b) politicians and citizens. By putting politicians and scientists in positions of control, these breaks contradict the idea of public engagement and what Callon et al call 'dialogic democracy'. The term indicates enriched forms of democracy that put uncertainties at the centre of the debate. In the face of scientific uncertainties, like the ones raised by GMOs, members of the public have been challenging these 'breaks' and the power of scientists and politicians. In order to protect their positions, those in power have developed a series of strategies that made these 'breaks' more bearable and contemporaneously moved away the realization of dialogic forms of democracy. In the following excerpt the scholars better explain this last idea.

> From time to time the latter [lay people] is worried about what the specialists in white coats are hatching in the silence of the laboratories and research departments. […] Initiatives are taken to calm these anxieties whose legitimacy increases the more they seem to be well founded. It is decided that science is a show and open days are organized for laboratories, thus revealing the remorse felt for keeping them closed in ordinary time; […] All these initiatives make the wound inflected by the breaks between specialists and layperson more bearable, they strive to bring the two sides of the wounds together, the better to suture it. But they do so in order to save what seem the better safeguards against the disorder that could be introduced by sudden irruption of uncertain knowledge in the public.[106](Callon et al, 2009: 123)

With the FSE, new engagement interventions barely camouflaged deficit model assumptions and reiterated the separations between science and the public, and politicians and citizens.

### 4. Case study Two: *OGM in Agricoltura* in Italy

While I was setting up my research project, Italian newspaper *Il Corriere della Sera* organised an online forum to discuss the topic of GMOs with two GM experts.[107] I contacted both scholars and asked for their help as I sought to familiarize myself with the Italian GM research field. They suggested I speak to a couple of journalists, who had been following the GM case over the past decade. I eventually met with both.

During one meeting, a journalist mentioned the *OGM in Agricoltura* study. She commented 'if you are really interested in understanding the policy of GMOs in

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[106] Notably, a few pages before this quote, the scholars argue that disorder is extremely dangerous for those in power, who see this as a threat to their positions in society. In other words, disorder threatens the form of democracy Callon and his collegues call 'delegative', which in turn purges the political debate from all the uncertainties proposed by members of the public.

[107] http://www.corriere.it/salute/esperto/esperto_risponde_20fc930e-1aa2-11dd-b32c-00144f486ba6.shtml (last visit 24/07/2010).

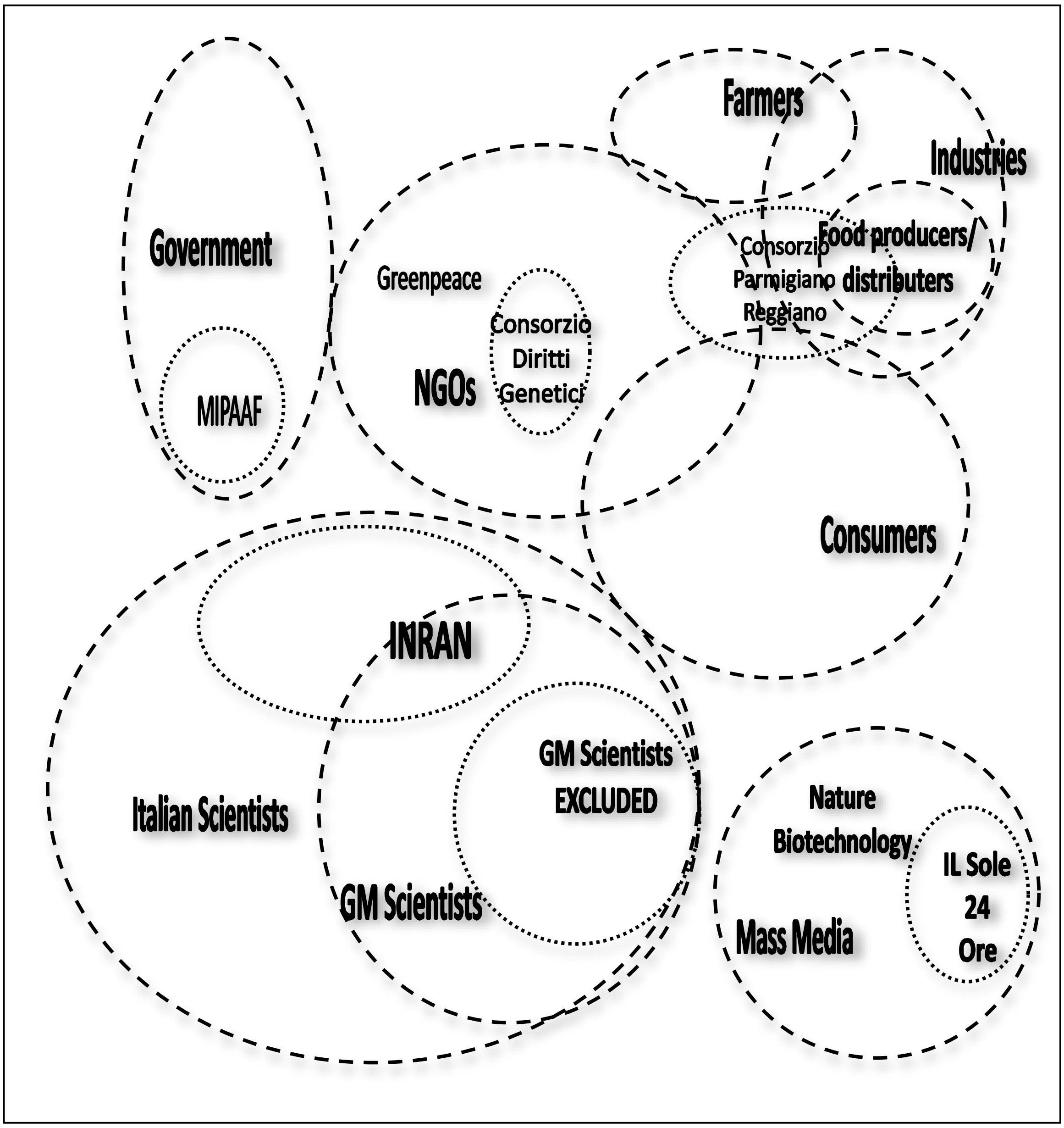
Italy, you should consider this study in detail. It is just so typical of this country' (J1, 2008). She went on to give me her personal account of the project and allowed me to use her archived material regarding the study. This includes all the press releases related to the project and her articles on this topic. Finally, she invited her husband, who participated to the press conference that launched a large portion of the project's results, to join us.

While working with my transcript of this interview, I noted that the journalists had recurrently made reference to the people involved in this project, but also to the group of GM researchers excluded by the study. I decided to schedule a few more interviews with members of both these groups. I also thought it would be useful to try to contact the former Minister of Agriculture and ask for a meeting. I successfully met with a researcher involved in the overall organisation of the project and two of the researchers who were indicated as excluded. Some of the scholars included in the project turned down my interview request, while Giovanni Alemanno, former Minister of Agriculture at the time of *OGM in Agricoltura*, never responded to my numerous contacts.

In order to fill the gaps in interview data, I sought further information regarding this project online. In doing so, I immediately noticed that the study hardly made its way into the popular press. Checking the archives of the *Il Corriere della Sera* and *La Repubblica*, I found that neither of the newspapers mentioned the phrase 'OGM in Agricoltura'. Following further searches on the web, I collected a total of two articles from the popular press, two from scientific publications, and a further three from online magazines. I also found two websites that consistently referred to this project. The first one is the web site of the Institute of National

Research on Alimentation and Nutrition (INRAN), which coordinated the project. Here, I found a series of documents and press releases on the study. The second website that covered this project is a blog called Salmone.org. It is the website of SAgRI, an NGO made up of Italian scientists and researchers. Following a meeting with a member of SAgRI, I regularly monitored the blog. In addition, I was given an edited book that covers the results of the project. Through an online search, I also found three correspondence documents between MPs and the former Minister of Agriculture that mentioned this project.

**Fig. 20: Social Worlds Map *OGM in Agricoltura* (2003-2007)**




I carefully read all my data and began mapping the project. The figure above represents the social worlds of the actors touched by the Italian study. It will be used as a reference in recounting the case of *OGM in Agricoltura*. Despite the gaps in the material, I feel confident I have enough information to write a narrative of this project that would serve for my analysis of the factors implicated in the way scientists listen, or fail to listen, to public opinion.

> In the current debate about GMOs, it happens frequently that confused and disordered messages prevail. This has not helped to make clarity, while Italian citizens wish to know more, and from valid sources, about this technology. Consumers, farmers and other food producers would like to understand the consequences, either positive or negative, of using GM varieties within the Italian agricultural system. They would like to understand the advantages and disadvantages of a choice that so far has been biased by personal preferences. Thus, there is a need to further study this technology, possibly without previous bias. In order to respond to such need, the Ministry of Agriculture, under the guidance of the Minister Giovanni Alemanno, has strongly wanted and financed the project OGM in Agricoltura, with 6.2 million Euros. The project, which began in 2003, is a 360-degree study on the numerous issues related to the cultivation of GMOs in Italy. (Monastra, 2006)

According to this extract, taken from the presentation of the second work-in-progress conference held in 2006, *OGM in Agricoltura* is a project designed by the government to respond to some, not specified, concerns about GMOs expressed by Italian citizens. Furthermore, I was particularly intrigued by the emphasis on bias that transpires from this document. From the quote above, we learn that the project started in 2003, was funded by the government with €6.2 million and promoted by the Ministry of Agriculture and former Minister Giovanni Alemanno. In the paragraphs that follow this excerpt, the reader learns that the government assigned the coordination of the project to the Institute of National Research on Alimentation and Nutrition (INRAN), and specifically the Institute's director Giovanni Monastra. It is also explained that the project focused on two varieties of plants, MON810[108] and GM tomato. Scientists looked at the safety of these crops and their environmental impacts. The study of the techniques of DNA detection into food to control GM

[108] MON 810 is a variety of genetically modified maize developed by Monsanto. It contains a gene from the *Bacillus thuringiensis* bacteria that expresses a toxin (Bt toxin) poisonous to some pest insects. It was approved for use in the European Union in 1998.

contamination was also included under the project's umbrella. In addition, scholars involved in the project studied the economic and social impact of these technologies in the Italian context, while contemporaneously trying to develop better strategies for communicating science to the public (Carbone et al, 2006)[109].

> The story of OGM in Agricoltura is almost impossible to tell. Alemanno was very clever, he did not want to show his blunt opposition to GMOs, and so he decided to fund this project, which allegedly is on GMOs. When looking carefully, though, you can see this study is actually just trying to prove the risks of using GMOs. It is extremely weak in scientific terms, as always happens in this country, and cost the government an incredible amount of money. (J1, 2008)

Here we see a very different interpretation of *OGM in Agricoltura*. In the first account, this study was portrayed as the government's response to public concerns about GMOs. In the second statement, however, the project, which contributed to construct Alemanno's public image, is exclusively directed to study the risks of GMOs. Both stories make sense, and it is relevant that both of them were produced.

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[109] Here is a more detailed breakdown of *OGM in Agricoltura*'s themes, translated from the book 'Le Agrobiotecnologie nel Contesto Italiano' (Carbone, 2006)*:*

1. Create a database that collects all the information on the research that has been done so far on GMOs
2. Update and develop new strategies to track transgenic traces into foods that are meant for both animal and human consumption
3. Study the impacts of GMOs on the Italian economy, with particular attention to comparing what it is that GM cultures allow that we cannot already do with traditional varieties
4. Evaluate public perception with regards to DNA recombinant techniques in the Italian agricultural setting – especially with regards to a few symbolic products – and understand the processes that lead to the acceptance or resistance to GMOs
5. Develop a system that improves public communication and public debates, citizens' awareness of these products and informed choice
6. Improve DNA detection techniques into seeds/foods to trace the presence of GM sequences
7. Analyse nutritional profiles of certain GM products (i.e. MN810 and GM tomato with increased levels of beta-carotene), with particular interest to the parameters usually neglected by the literature, and analyse the effects of GM diet on animals
8. Study the impacts of certain GM plants (i.e. MN810) on the soil
(Carbone et al, 2006: 13).

However, is there one that better describes what happened when the Italian government set up the project *OGM in Agricoltura*?

Lets us start from the beginning. We already know that the project started in 2003. At that time, Giovanni Alemanno was the Minister of Agriculture, a position he held until 2006, when Paolo De Castro replaced him. Alemanno has never kept secret his skepticism towards GMOs in general, nor the introduction of these products in the Italian agricultural system in particular. Notably, under Alemanno's legislation all government funding to GM projects was halted, with the exception of *OGM in Agricoltura*, a project the Minister assigned to the Institute of National Research on Alimentation and Nutrition (INRAN). There is no explanation of the process that brought the government to choose INRAN. According to one of the journalists I interviewed, the government allocated the funding to the Institute *before* the project was even outlined. Supporting this possibility, one of the GM researchers excluded from *OGM in Agricoltura* underlined that 'there has never been a public call for this project, and I never had the chance to be involved in it, or at least try to participate' (UR4, 2008). These accounts suggest a tension within the GM science community, which distinguishes those included in the project from those excluded from it. This opens up questions about the logic behind this exclusion, i.e. why INRAN? What made this institute more qualified than other research centres? And why wasn't there an open call for research? Finally, it raises issues of secrecy, and calls for further reflections on the role of science in Italian politics.

The first time the mass media covered this project was in relation to the first work-in-progress conference on October 5$^{th}$, 2004. Noticeably, this event was held 22 months after the project's launch. As we read in the article published in the

Ministry of Agriculture's online magazine, which is also the only media featuring the event, the conference revolved around three main points[110]. First, according to INRAN, studies on the Mediterranean diet showed the integration of GMOs might prove detrimental to the local diet. Second, INRAN expressed concerns about the spread of allergens associated with gene transfer techniques that would compromise consumers' safety. Finally, it was noted that, as part of the project, INRAN was in the process of developing a database of all publications on GMOs to be made publicly available[111].

Describing exactly who was invited to the first *OGM in Agricoltura* work-in-progress conference, and who was excluded, remains unclear. Was it closed to the researchers working on the project?  Was it open to all members of the scientific community, and perhaps the mass media? This gap in the data raises questions about the lack of media attention that characterises this project. Was it specific to this study, or was this lack of reporting characteristic of GMOs or, perhaps, of the way the Italian popular press covers scientific topics?

On March 7th, 2006, INRAN scheduled a second work-in-progress conference to release a large portion of the project's results.  Importantly, the popular press largely ignored this episode, which was barely mentioned in a few newspaper articles (see below). According to the INRAN press release, a significant section of the conference dealt with MON810. Specifically, INRAN found one case of instability in MON810 (Bogani, 2006) and *certain alterations* (this is not specified in further detail) in the immune system of tested laboratory animals fed with this GM variety

[110] http://www.agricolturaitalianaonline.gov.it/content/view/full/441/(offset)/60 (last visit 24/07/2010).
[111] Noticeably, as of February 2010, no such database has been activated.

(Nuti, 2006). INRAN did not find any difference with regards to the nutritional composition of traditional and GM maize, except for the higher values of lignin in MON810 (Maiani, 2006). In addition, the open release of GM maize showed that, as a variety, MON810 produces greater yields when compared to its traditional equivalent. Finally, some differences were found with regards to the impact of GM cropping on microorganisms (Mocali et al, 2006). A second group of studies regarded GM tomato. INRAN found increased levels of beta-carotene in the GM variety, when compared to the traditional variety (Palozza, 2006). Finally, other topics discussed during the conference included new methods for detecting foreign DNA sections in conventional foods, the results of the database collection on GM research, and socio-economic studies on the introduction and commercialization of GMOs. With regards to the latter, it is interesting to note that a public perception survey on GMOs was discussed. This indicates 62% of the respondents were against the introduction of GMOs, 87% of the interviewees suggested there were still many uncertainties with regards to GM products, and 76% showed concerns with regards to GM safety for human consumption (Saba, 2006). Notably, *OGM in Agricoltura*'s findings indicate that only 18% of the farmers interviewed were willing to cultivate GMOs (Vieri, 2006).

Somewhat surprisingly, considering the wide range of results I just described, what mostly captured the attention of members of the GM community was a set of data on the cultivation of GM maize that was omitted from the conference. Tommaso Maggiore, professor at Universita' degli Studi in Milan, and supervisor of the Angelo Menozzi research centre was excluded from this conference. The Angelo Menozzi research centre housed the open release of GM maize for the *OGM in*

*Agricoltura*. According to Maggiore's data, 'MON810 corn contained 60 or fewer parts per billion of fumonisin, whereas non-GM varieties contained over 6,000 parts per billion' (2007). Fumonisins 'are toxins that are produced by fungi able to infect plants through lesions caused by the corn borer' (2007: 379). According to EU law, fumonisin levels cannot exceed 4,000 parts per billion. These data were relevant because they show that GM crops have lower levels of fumonisins, and contemporaneously indicate that the levels of this toxin in conventional varieties of maize were unsustainable under the current legislation. Nevertheless, these results never made their way to INRAN's conference.

Why did this happen? Was it intentional, or are there other possible explanations? What were Maggiore and INRAN's views on this episode? I contacted Maggiore to try to address these questions; an interview was scheduled, however, for personal reasons, we were not able to meet. Nonetheless, this event interested many of the scientists I spoke with who were excluded from the research program. Using this material in conjunction with written record, I was able to reconstruct the episode as follows.

Fifteen months after the conference that omitted Maggiore's data, a group of MPs wrote to the former Minister of Agriculture. They asked the government for clarification regarding the allocation of funding for this project, the affiliation of the project with Consiglio dei Diritti Genetici[112], and the exclusion from the project of some of the most esteemed GM researchers in Italy (Quagliarella et al, 2007). They also questioned INRAN's decision to communicate scientific data not yet submitted

[112] *Consigli dei Diritti Genetici* is an NGO that widely campaigned against GMOs in 2007.

for peer review to the public. Finally, they denounced INRAN's omission of Maggiore's data and asked for further explanation regarding this episode.

This document is relevant in three important ways. First, it is interesting that it took MPs fifteen months to comment on INRAN's work-in-progress conference. Why did they wait so long? What does this say about the position of science in the Italian landscape? Second, the lack of clarity that characterises the way the government handled the project from the beginning is cricised, which ultimately climaxed with the omission of data on fumonisins. Finally, and in addition to the decision of the government to assign to INRAN the coordination of the project, MPs introduced a new question – why did the government not think to include GM researchers academically known for their expertise in the field of GMOs? Questions like this support scientists' experiences of exclusion, pointing to the tension between two groups of GM researchers in Italy, i.e. those inside and those outside the project.

Trying to address this exclusion, bioethicist Gilberto Corbellini argues, in an article published by the financial newspaper *Il Sole 24 Ore*, that the selection of participants was informed by the researchers' position with regards to GMOs. In other words, participation in the project, which also meant receiving funding, was guaranteed to those scientists whose personal views on GMOs aligned with the government's anti-GM position.

> Why have outsiders of the GM community been involved in the project, instead of Salamini, Sala, Delledonne, Defez, Ruberti, Costantino, in other words, the best Italian GMO biotechnologists? I propose an answer to this question. Several articles [included in the INRAN edited book] were published by researchers who have always been ideologically involved in anti-GM campaigns. (Corbellini, 2007: 37)

In the same month parliamentarians wrote to the Minister of Agriculture, a group of scientists sent a letter to the government. Below is my translation of two particularly salient paragraphs.

> It appears strange that the only GM release in the field conducted over the last few years in Italy has produced extremely interesting data with regards to the fumonisin content, yet has not been publicised. The data show that, as well as an increase of approximately 40% of yields, the content of fumonisin in GM maize is 100 times lower than that of its conventional equivalent.
>
> Thus, it can be argued that the GM option represents a potentially valid option for Italian farmers, and also the consumers, who would have a better quality of products. Nevertheless, the impossibility of studying GM products without limits and biases that characterises the present situation of Italian public research leaves this option in the hands of a few politicians who have their own interests and are not particularly attentive to consumers' safety.[113] (SIGA, 2007)

Paralleling the MP's document, scientists raised questions about the lack of transparency that characterises the way INRAN handled Maggiore's data. However, the scientists went one step further and denounced the impossibility of carrying out unbiased research on GMOs vis-à-vis the government's anti-GM position. This elicits important questions about the role of politics in Italy, and its impact on science practices.

In December 2007, *Nature Biotechonology* published an editorial on a conference that took place on November 13th 2007 and was organised by SagRI to publically disclose the data on fumonisins. Below is a paragraph taken from the

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[113] 'Appare strano che nell'unica prova in pieno campo con OGM condotta in Italia negli ultimi anni siano stati ottenuti dei dati molto interessanti sulla riduzione nel contenuto di fumonisine nel mais OGM, ma che tali dati non sono stati divulgati. I dati ottenuti indicano, oltre ad aumenti di produzione del 40%, una riduzione di 100 volte nel contenuto di fumonisine nel mais da OGM rispetto ad un mais tradizionale.
L'opzione OGM si evidenzia quindi come una opzione potenzialmente vincente per gli agricoltori italiani e nutrizionalmente più sicura per i cittadini, ma l'impossibilità per gli Scienziati Pubblici italiani di studiare gli OGM in pieno campo senza condizionamenti e senza pregiudizi, come avviene in tutta Europa, lascia questa partita nelle mani di pochi politici legati ad interessi di categoria che hanno dimostrato scarsa attenzione per la sicurezza alimentare dei cittadini' (http://www.siga.unina.it/Appello_OGM.html) (last visit 24/07/2010).

editorial, which introduces discourses of transparency in relation to science and science policy, in arguing that GMO science in Italy had been heavily influenced by the government's anti-GM approach.

> There were new data from Italy in mid-November but, oddly, they were largely ignored. Usually, the slightest evidence derived from potatoes loaded with toxins or caterpillars force-fed in sandwich boxes can be apparently accorded significant media merit if there is a sniff of genetic modification around the protocol. Similarly, highly predictable observations on gene transmission are heralded as surprising and deep if the DNA involved has been anywhere near a ligase in vitro in its past 1,000 replications. The reason the new Italian data—from the only field trial of Bt maize in Italy since 2000—was ignored is simple: it showed GMOs in a positive light embarrassing to the coalition. (2007: 379)

Similar arguments also featured in *Il Sole 24 Ore* (Corbellini, *Il Sole 24 Ore,* 2007a). Notably, *Il Giornale* and *La Stampa*, two other popular Italian newspapers, also briefly covered the conference organised by SAgRI, whilst, according to *Nature Biotechnology*'s editorial, the periodical *L'Espresso* decided against running the story as the fumonisin data contrasted with the editorial anti-GM position (2007).

Setting out to prove that INRAN excluded Maggiore's documents, SAgRI published online the email exchange between Maggiore and INRAN. This was denied by Monastra in a *Nature Biotechnology* article.

> [Maggiore] claims he sent Gianni Pastore of INRAN a letter by e-mail on February 23, 2006, with a file containing his data on fumonisins, but we have carried out a careful check and have no record of such a letter. Both the INRAN server and Pastore's computer do, however, show that on February 27, 2006, a report was received from Maggiore. In the accompanying letter, he apologises for the delay in submitting his report, and he also writes that it does not contain the data on fumonisins, which he had not yet analysed. Not only do we have no record of the letter dated February 23, but it is hard to understand why, if he had sent a report including the fumonisin results to INRAN on that date, he would have followed it four days later with a second letter that makes no reference to the earlier one, informing us that he had not yet carried out the analysis. (Monastra, *Nature Biotechnology*, 2008)

The position of INRAN was that Maggiore had never been asked to produce the data on fumonisins. In addition, the coordinator of the project noted that INRAN did not receive the data in time for it to be discussed during the second work-in-progress conference. When the data finally reached INRAN, the Institute decided that, because it was unique in its genre, the findings needed further confirmation. This elicits questions about the criteria used by INRAN with regards to the communication to the public of scientific data. We already know that the Institute had communicated data before peer review. However, it remains unclear how they discriminated between the data to communicate and data not to communicate. The scientists I interviewed who were excluded from the project claimed that INRAN only communicated those findings that fit with the idea that GMOs are risky to society (GR2, 2008), the government's view on this topic.

On November 18th, 2007, the former Minister of Agriculture, Paolo de Castro[114], wrote a letter to the Italian Parliament that fully supported INRAN's position with regards to Maggiore's data. Noticeably, De Castro substituted Alemanno as Minister of Agriculture. Nevertheless, it seems that this did not change the government's position on GMOs. This suggests the government's view on this issue goes beyond the person in charge, and the parties he, or she, represents.

This event closed the fumonisin episode, which is important for three main reasons. First it is significant that GM scientists excluded from the project found it appropriate to act as a minority group, i.e. they created an NGO, wrote to the government, and organised public protests (a contra-conference to publicly disclose

[114] Contrary to Giovanni Alemanno, who belongs to the centre-right coalition, Paolo de Castro represents the Italian centre-left coalition.

the data on fumonisins). This supports the discourse of marginalization, which featured in GM scientists' narratives (Chapter 4) and is confirmed by the lack of media attention regarding this project. In addition, like many other aspects of this project, this episode raises questions about transparency, scientific practices and the government within the Italian landscape. According to Corbellini, science is politically irrelevant within the Italian context. It has become a political tool used by MPs to gain more authority and support personal views (Corbellini, 2009). Omitting these data would make sense in this context, because scientific findings were not paralleling the position of those in power.

The most recent update on *OGM in Agricoltura* is dated December 2007, which is also when MPs sent a new complaint letter to the Minister of Agriculture. In this document, INRAN asked for a one-year extension to be able to complete the project. During 2007, INRAN failed to obtain the authorizations for open releases of MON810, which meant they could not carry out the studies on fumonisins. On this occasion, INRAN declared that several other works were on the verge of being finished, and could benefit from this period of extension. With regards to socio-economic issues, the report notes that the project was halfway through its research. After gathering information from experts on GMOs, which were in turn discussed with scientific journalists, researchers had began developing participatory exercises that would include the public and GM stakeholders in scientific decision making. The following excerpt provides a description of the aims and methods of this subproject.

> We are now organising a series of participatory processes that include all the stakeholders that are relevant for the future of GMOs. These will allow new forms of communication between science and society to emerge, including and surpassing the ones we had in the past. It is our aim to improve the quality of the public debate on GMOs in the Italian

> landscape… a debate that will gather all the stakeholders touched by GMOs and is now in the process of realisation. This will take the form of an online debate and will include farmers, corporations, NGOs and consumers. It will be closed to the public, and the access to the forum will be password restricted. In the end, we aim to construct a website that will summarise all the various stages of the participatory exercise to the large public. (Monastra, 2007)

Even if written in the language of public engagement, ideas regarding the separation between science and society, nested in the deficit model, are prominent in this participatory project.

The INRAN web site does not report any other information on *OGM in Agricoltura*. There is no further data available on the results of the project in the media; there are also no other scientific publications that can be associated to this research. Only SAgRi is continuing to monitor this project, and from time to time does write articles about it. This leaves open important questions, i.e. which subsections of the project were completed, and which remained unfinished? What was the final outcome of the portion of the works completed? Was INRAN able to provide further evidence to support the idea that GM products could be risky for human consumption? And finally, what kind of participatory exercises was INRAN able to organise?

The lack of information with regards to this data leaves many possible scenarios open, i.e. a) INRAN is still working on the subprojects and in the process of publishing their results, and b) INRAN was unable to conclude the project and has moved on; c) INRAN has concluded the project, however it failed to find the results it was expecting and decided to not inform Italian citizens.

I began the story of *OGM in Agricoltura* with two possible storylines. One was the official story, while the second one was drawn up by a journalist and represents her point of view of this project. Both storylines portray a relation between the public and *OGM in Agricoltura*. However, in one case, the government developed this project to respond public opinion, while in the second case the project represents a tool for ending GMOs in Italy. The historical account of this project shows that, apart from one press release document, there is no other verbal or written evidence that supports the idea that this project responded to public opinion concerns about GMOs. For example, it was never explained which public concerns this study was exactly responding to. This supports the idea that public servants and scientists construct imagined forms of publics (Wynne, 2007; Ellis et al, 2009). In addition, the fact that, throughout the entire narrative of this project, the different actors implicated in the project made constant references to issues of transparency supports the second of the two possible storylines presented above.

Callon's theory of the double breaks that characterise delegative forms of democracy challenged by the uncertainties associated with GMOs helps me think about what happened with *OGM in Agricoltura*. However, in order to fully understand this case study, it is necessary to place it into its national and cultural context. In other words, I argue that the way this project unfolded only makes sense vis-à-vis the marginal position occupied by scientists within Italian society.

In his book *Why scientists are not dangerous* (2009), Corbellini argues for a cultural imbalance between human and natural sciences that favours the former in Italy. In this context, he suggests natural sciences have become politically irrelevant and are only called into question if they can support public figures' views on selected issues. This would explain why Maggiore's data, which clashed with the government's view on GMOs, never made it into INRAN's conference. In addition, the analysis of *OGM in Agricoltura* shows how this practice might be detrimental to the unity of the science community. It also opens up important questions about the impact of politics into scientific practices.

**5. Comparison and discussion**

I began this chapter by asking which social, political, economic and other factors shape the way scientists get to know public opinion, and how this happens. I mapped the stories of two projects on GMOs, the *Farm Scale Evaluation* and *OGM in Agricoltura*, which I chose both for their similarities and for their differences. In this section, I bring together the two case studies, which I compare and contrast.

Asking which social, political, economic and other factors shape the way scientists get to know public opinion requires focusing on the human, non-human, individual, and collective actors I encountered through the chapter. In order to do so, I began with an analytical exercise and compared the two social world maps in Figures 19 and 20. This exercise pointed to the complexity of the relation between science and society, which has been popularised under the name co-production (Jasanoff, 2004). In addition, it allowed me to identify a list of six factors which I believe influenced the ways scientists got to know public opinion, i.e. government, position and culture of science, type of publics, private companies, mass media and PUS academic debate. In the following, I systematically discuss each of the factors separately.

Paralleling other scholars (Bauer et al 2007; Burchell, 2009; Reardon, 2006; Wynne, 2006), this study shows that the government occupies a relevant position in the relation between science and society. It is the government that funded the two projects I have analysed, and it is the government that encouraged, or failed to encourage, public engagement interventions. In other words, as American sociologist Jenny Reardon (2006: 371) suggests, the capacity ‘to hear’ and ‘learn’ from the public would require institutional support and specific policies that encourage scientists to genuinely engage with the public.

A second important factor that impacts the way scientists got to know public opinion is the position occupied by science. I suggest this is related to the national culture of science. It can be argues that Italy and the UK have a different culture of science. In Chapter 3, we already saw one difference between Italy and the UK, which emerged when comparing the number of patents on GMOs published in these two countries. As I noted there, between 1990 and 2008, Italian scientists only patented 71 patents on GMOs, while British scientists published almost 2,000 patents. Building on this difference, in Chapter 4 I explored the different emphasis Italian and British scientists devoted to discourses of science loss. This chapter further clarifies this matter. It here emerges that the UK is a society that champions science and expertise (Rayner, 2003). In the case of Italy, the situation is completely different and in fact science is marginalized and located at the bottom of society (Corbellini, 2009). In addition, it can be argued that the lack of authority of Italian scientists and their marginalized position in society encourages scientists to act as a minority and look for support from the public, rather than its engagement. Nevertheless, it is interesting to note that both countries use science to legitimise policy, even if the policies science is supporting is in one case in favour and in another against GMOs. Furthermore, as Wynne (2006) shows, we also see here that societies that use scientific facts to support policy tend to be entrenched with deficit model assumptions of ignorant publics who mistrust science. This ultimately ends up increasing the distance between science and society, and limiting the listening capacity of science.

A third factor that affects the ways scientists listen to the public is made up by the kinds of publics that are implicated in, and co-constructed vis-a-vis GMOs, or more precisely the FSE and the *OGM in Agricoltura*. This study shows, as Wynne et al (2007) point out, that there are different kinds of publics, i.e. invited and uninvited ones. Both these publics have been relevant for the development of the FSE in different ways. When the publics are uninvited, as in the case of the NGO protesters who destroyed the farm scale trials, they impact on the relation between science and society differently from the way invited publics (i.e. those who participate in the meetings organised by ACRE in the UK) are able to.

In addition, this case study points to a lack of interest shown by both scientists and institutions towards the images, thoughts and opinions of the publics with regards to both the FSE and *OGM in Agricoltura*. This supports the idea that scientific and political institutions own specific images of the public and public opinion, according to which they shape public engagement interventions (Ellis et al, 2009; Wynne, 2007). I suggest this study indicates that communication problems might arise on those occasions in which imagined publics misrepresent the ideas of the individuals who constitute the public for that particular technology, or project.  Thus why it is so crucial that science and institutions of other kinds, which are implicated in the relation between science and society, abandon preconceived ideas about the public and shift their attention from 'talking to' towards 'listening to' the publics. Of course, this shift will only help if not limited by preconceived ideas of the public. Notably, the fact that a project, like *OGM in Agricoltura*, failed to gather both invited and uninvited publics, suggests that, where science is marginalized, science is also deprived of its publics.

The fourth factor on the list is the mass media. Several scholars have explored the mediating role played by the mass media in the relation between science and the public (Bauer et al, 2002; Gutteling, 2005; Mazur, 1981, Petts et al, 2001). In Chapter 4 of this thesis, I argued Italian GM scientists look at the mass media as the main form of communication with the public. In light of this finding, it is striking to note the lack of coverage that characterises *OGM in Agricoltura*, which is especially evident when compared to the considerably higher coverage of the British project. Does this mean Italian scientists implicated in this project were not interested in communicating with the public? If that is the case, why did this happen? Could it have something to do with the negative attitude towards GMOs that characterises *OGM in Agricoltura* participants?

Furthermore, both projects show how the mass media can act as uninvited publics. *The Independent*, in the UK, and the Italian website SAgRI exemplify how this happens. The former of these two uninvited publics, which followed the FSE step by step, continued throughout the whole period of time the project was run to elicit questions about the legitimacy of this project and the use of GMOs in the British landscape. Similarly, SAgRi systematically reported on *OGM in Agricoltura* and denounced the project's failings. Overall, this suggests the mass media's role in the relation between science and society is not limited to the transfer of information from science to the public, but can contribute to the construction of interactive forms of public engagement.

Another factor that contributes to shape the way scientists listened to public opinion has to do with private agrifood companies. This factor exclusively emerges when looking at the British context, where a consortium of private companies producing GMOs had been supplementing the FSE. One possible explanation for this difference might lie in the projects' nature. In the UK, the field trials were meant to test GMOs in the field, and needed a significant quantity of GM seeds. Meanwhile, the project in Italy included multiple purposes, and only a few field trials. Having said this, one might also look at private companies' lack of involvement in the *OGM in Agricoltura* project as another characteristic of the way Italians carry out scientific research. This would take us back to the different cultures of science that we have seen characterise these two national landscapes. Finally, it could be that the exclusion of agrifood companies reflects the anti-GM position taken by the *OGM in Agricoltura* study. This would in turn support the hypothesis that this study represents a tool for ending GMOs in Italy.

Focusing on the UK context allows me to see the primary position occupied by corporations, alongside government and scientists. This leaves members of the public in a marginal position, which makes any communication process with scientists unbalanced. In addition, this situation contributes to increase the distance between science and the public.

The last factor that impacts on the way scientists listen to the public is related to the academic attention towards the modern PUS debate. This case study compares a nation (the UK) that initiated the modern PUS debate to a country (Italy) that only experienced the ripples of those PUS discourses emerging in the EU. The analysis of these two case studies suggests that, where there is less academic experience, attention and interest towards the issues related to the modern PUS debate, discourses about dialogue find more difficulties in circulating. *OGM in Agricoltura* did not simply fail to engage the public, but it did not even try to do so. In the UK, where PUS discourses have by now become constitutive of the local culture of science and policy making, society faces crucial questions about the role of science in society and the role of the public on the process of knowledge construction. This does not mean that the UK succeeded in engaging the public. Rather, it created a space for reflexivity that is crucial to improve the current forms of communication with the public and facilitate how scientists get to know public opinion. This space is only just now emerging in Italy.

In sum, by comparing and contrasting Italy and the UK, this chapter helps break down the complexity of the relationship between science and members of the public. This chapter has pointed to six factors that inform how scientists learn about public opinion, including: government, position and culture of science, types of publics, the mass media, private companies and the extent to which PUS discourses are circulating in the national academic debate. In this context, significant attention goes to the government, which proposed and funded both these projects. Nonetheless, these projects show that, despite the governments' efforts to use these initiatives as a way to democratize science, they ended up marginalizing some members of the public. Overall, this study supports Reardon (2007), who argues that calling for democratization of science is not enough to democratize science. Finally, I agree with other scholars (Jasanoff, 2005; Leach et al, 2006; Wynne 2007) and position discourses of communication between science and society in close relation with the local cultures of science.

## 6. Conclusions

The main questions of this chapter asks which social, economical, political or other factors impacted on the way GM scientists got to know public opinion and how. The projects on GMOs carried out in Italy and the UK that I analysed tell two different stories, which nonetheless share some similarities. In one case, there is a project that was carried out to study the environmental effects of GMHT cropping. This project came together with public engagement interventions encouraged by the government that typically failed to democratize science and did not make it easier for scientists to listen to public opinion. In Italy, on the other hand, scholars planned a study that looked at GMOs from multiple perspectives. Also, in this case scientists failed to listen to public opinion. Importantly, here the government neither encouraged or discouraged public engagement exercises. In both cases, the political sphere shaped how scientific research is carried out.

Comparing the two projects, I have identified six factors that impact, in specific ways, on the listening capacity of science. These include government, position and culture of science, types of publics, mass media, private companies and the extent to which PUS discourses are circulating in the national academic debate. The analysis of these factors shed some light on the dynamic interactions between science and society that is typical of co-produced technologies.

The last step that remains to be done consists of exploring the listening process, how it works and what kinds of listening scientists used.

# Chapter 6
# Listening Capacity

Dialogue and public engagement have characterised the last decade of PUS studies. This engagement presumes and requires that scientists listen to public opinion regarding research; however, little attention has been given to if and how scientists listen to the speaking public. Accordingly, Cook (2004: 124) contends that members of the public are 'the missing half' of dialogue. This thesis has been developed in order to address this gap in the literature; taking a reversed approach, it asks if and how scientists listen to public opinion.

In this chapter, my aim is to clarify the process of listening and analyse how it occurs in both Italian and British social contexts. Chapters 3, 4 and 5 have done the groundwork for this chapter. In Chapter 3, I analysed what public opinion was available to be heard by scientists. I tried to find out if scientists listened to public opinion by testing for an association between lowered public acceptance of GMOs and GM scientific output, and assumed that these outputs represented an indication of scientists' responses to public opinion. This analysis was characterised by numerous flaws, which pointed to the complexity of the relationship between science and the public. In order to start clarifying this relationship, Chapter 4 explored scientists' thoughts on public opinion and how this did or did not impact on their individual research as well as the GM field generally. In Chapter 5, I put this topic into its social context and looked at the social, cultural, political and economic factors that influence how scientists listen to the public in conducting GM research. Albeit informative, these chapters did not examine the listening process per se. This chapter aims to create a model for listening in order to synthesise the findings presented across the previous chapters.

I begin this chapter by presenting my understanding of the listening process, which comprises three moments: hearing, interpreting and responding. I have developed this model using an iterative process, which moved between reviewing the literature and reading and rereading my interviews[115]. After describing this model, I explore how scientists hear, interpret and respond to public opinion. My focus is on both the nature of this process and its social context. I argue that many scientists describe the listening process in similar ways, but significant variations are also presented. I conclude by focusing on the patterns that characterise how scientists listen to public opinion in Italy and the UK.

## 1. The listening process

> If we apply a symbolic lens to examine human communication […] communicative activity becomes listening defined; a message means whatever the listener believes it means. Speakers are at the mercy of listeners who interpret what they heard and act on that basis. (Brownell, 2010: 143)

Scholarship on listening is grounded in the field of communication. In this context, the activity of listening has usually been sacrificed in favour of its counterpart – speaking. Nonetheless, as we read in the quote above, listening is central to any communicative process.

Traditionally, the majority of works on listening analyses this process from a cognitive perspective. Margarete Imhof (2010: 97), an expert in educational psychology, defines cognitive psychology as an umbrella of studies that consider the

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[115] The interviews, which are my main data source for this chapter, are the same as those I have used in Chapter 4, where I provided a detailed explanation of these data.

‘processes through which humans acquire, interpret, remember and make use of information’. Cognitive psychologists assume that there are pre-existing meanings or *schemata* that filter and organise information coming from the outside social world.

However, Michael Purdy (2010), scholar in communication studies, contends that this framework is limited in its assumption of universal and fixed meaning. He comments that ‘if there is an *essence* in any process of listening/communication it is that communication is about connection and relationship’ (2010: 37). Cognitive anthropologists and cultural sociologists, who also use schemata, agree. In his seminal paper on culture and cognition, cultural sociologist Paul DiMaggio underlines the relation between culture and schemata, suggesting that schemata are the structures people use to transform information, and that the ways people select such structures are greatly influenced by the cultural and social environment in which they live (DiMaggio, 1997). Taking this a step further, Derek Edwards (1991), who prefers the term *categorisation* to schemata, suggests that categorisation is something we do in order to carry out social actions. I follow cultural sociologists and cognitive anthropologists in assuming that communicated information does not have a universal meaning, but is instead culturally mediated. In doing so, I suggest that the way scientists listen to public opinion is deeply informed by the cultural and social environments they experience.

In addition, I think that sociologists have done too little to try to understand the process of listening in relation to ethnicity, policy and cultures. In response, I try to address this gap in the literature by beginning with a definition of the listening process. It should be noted that this definition is not meant to be definitive, but represents my preliminary understanding of scientists' listening process in the context of public dialogue.

While a variety of definitions of listening have been suggested, the one I use is based on Andrew Wolvin's (2010) review of scholars' works on listening. Wolvin, who studied communication, proposes to think about listening as the process of receiving, constructing meanings from and responding to spoken and/or non-verbal messages. This definition, which, as Wolvin contends, effectively organises the physiological, psychological and social elements of listening, led me to identify three constitutive moments/activities of scientists' listening process: hearing, interpreting and responding. It should be noted that the boundaries between these three moments are somewhat blurred and thus allow for overlap. With this in mind, I move to briefly explore each component of the listening process.

Scientists' listening begins with hearing. Not everybody agrees that hearing should be included in the process of listening, Imhof (2010), for examples, considers hearing to be an unconscious and automatic action that paves the way for listening. On the other hand, communication scholar Judi Brownell (2010) disagrees and understands hearing as integral to the listening process. In fact, Brownell argues that it is through hearing that individuals decide what to focus their attention on. In addition, Brownell highlights that hearing is 'influenced by the individuals' cultural orientation, past experiences, interests, attitudes, beliefs and a range of other personal filters that count for individual and personal differences' (2010: 144). It can be argued that this approach puts the sociological component of hearing to the fore, and as a result, it differs from most of the more physiological approaches to hearing written in communication (Baddeley and Hitch, 1974; Cowan, 1995; Goss, 1995; Lang and Basil, 1998; McCroskey, 1971; Rokeach, 1969). This study uses Brownell's definition of hearing because it allows me to recognise structural aspects that shape and delimit scientists' listening process.

Although there is broad disagreement with regards to the definition of listening, Ethel Glenn's (1989) review of the literature shows that most of the works on listening include, in one way or another, the action of interpreting new information. In her review of theories on listening, Wolvin (2010) envisions interpreting as the stage in which the message is placed into the proper linguistic categories stored in the brain and associated to a specific meaning. Cognitive scholars argue that individuals' internal schemata serve an important interpreting purpose, guiding individuals during the process of meaning assignment. In this context, interpreting indicates the moment when individuals assign meanings to what they have heard.

In accordance with cognitive anthropologists and cultural sociologists, I do not assume that the schemata used to interpret what is heard are innate or universal. Rather, I understand these schemata as socially mediated. I follow American sociologist Herbert Blumer's (1986) approach to interpretation, which divides the action of interpretation into two steps. In the first, an individual identifies the things being responded to, and in second, the individual 'selects, checks, suspends, regroups and transforms the meanings in light of the situation in which he is placed and the direction of his actions' (Blumer, 1986: 5). Blumer focuses on interpretation as a process of meaning selection that allows individuals to make sense of new information, but he grounds the interpretative process in its social context. Significantly, this approach is crucial for understanding how a signal can be interpreted in different ways, depending on social context. As such, this is a crucial intervention if we are to understand misunderstandings.

Responding is the final moment in the listening process, and probably the most debated. Some scholars exclude responding (feedback) from the process of listening, and argue that overt responses to listening play a separate function. 'Knowledge effects, the reconstruction of memory, and the evocations of schemas before response all point toward a complex series of steps that make feedback distinct from the three stages of listening' (Perry, 1996: 23–24). However, when listening is understood in its social context, it is difficult to exclude responding. As Wolvin (2010) argues, the listener's feedback 'takes listening beyond the internal, self-controlled cognitive process and back into the communication relationship' (2010: 14). Similarly, Laura Janusik (2002), who also studied communication theories, suggests that responding is crucial to distinguish listening from other cognitive processes. John Daly ([1975] in Wolvin, 2010), a communication expert, argues that in any conversation, little can be accomplished unless relevant parties are perceived as listening in a responsive manner (pp. 1–2). Revising the listening process, Bostrom (1997) argues that when individuals listen with a view to bringing about social change, definitions of listening that fail to include responding are likely to be insufficient. When applied to the context of science and society, Wynne suggests that qualitative processes of public listening only occur when scientists abandon preconceived ideas of the public and are open to questioning themselves and their actions (2006: 76). The direction towards a change that characterises Wynne's argument, and the sociological perspective that shapes this project, convinced me to include responding in scientists' listening process.

Importantly, responding also highlights how the listening process is an iterative and dynamic process. Responding is the point at which the listener becomes the speaker, providing material that requires to be heard, interpreted and acted upon.

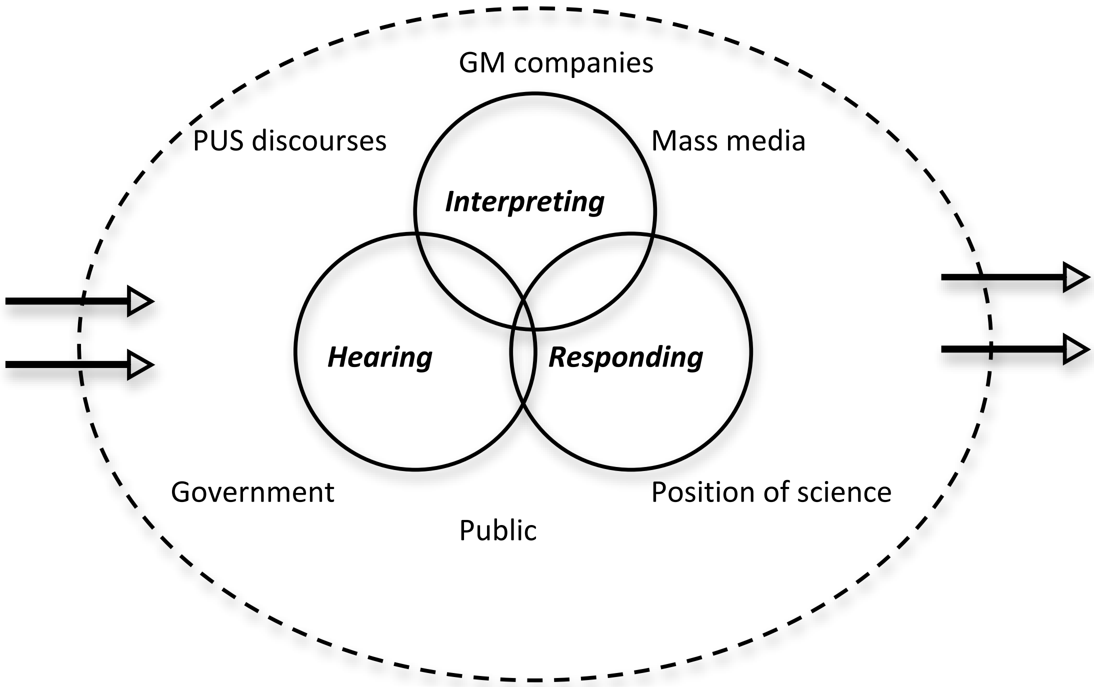


**Fig. 21: Scientists' listening process in its social context**

This section presents how scientists I spoke with listened to public opinion, as described in the interviews. I understand scientists' listening process as a three-step process that includes hearing, interpreting and responding. Notably, the boundaries between these three moments are somewhat blurred, which makes this process more flexible and subject to overlap across its three constitutive moments. Hearing represents the phase in which scientists decide what to focus their attention on. Following Blumer, I understand interpreting as a twofold moment, during which scientists indicate to themselves the things that they consider meaningful and go on to select proper meanings for interpreting those signals. Finally, I conclude by describing how scientists responded to what they heard. I envision the listening process as circular, as opposed to linear, where the response provides material that is available to be heard in a manner that restarts the process.

**2. Hearing**

The first moment of listening consists of hearing public opinion on GMOs. In the following, I present what Italian and British scientists hear about public opinion on GMOs. Overall, they perceive a general sense of uneasiness towards GMOs on the part of the public, and the majority I spoke with hear this from the government, corporations, NGOs and mass media.

*General uneasiness towards GMOs*

> A member of the public will point at GMOs and say 'I believe this technology is very dangerous'. So I have asked 'and why you think so?' Members of the public would answer something like 'I don't know, I am not a biologist' […] the public may have very general concerns about GMOs, but usually they don't know specifically what they are concerned about. (UK-GR2, 2008)

As we read in the quote above, many respondents heard a sense of uneasiness towards GMOs coming from members of the public. However, most scientists did not hear what the public like (if anything) and dislike about GMOs. As this quote makes clear, this heard uneasiness was rapidly interpreted, and this will be discussed next. First, however, I discuss the uneasiness about GMOs that was heard and the sources from which this information was received.

While many reported hearing uneasiness about GMOs for unknown reasons, a few scientists said they heard the reasons for the public's concerns. When this happened, the scientists I spoke with reported hearing four key reasons: 1) the impact of this technology on the environment; 2) the safety of these products; 3) the involvement of multinational companies; and 4) the naturalness and/or unnaturalness of GMOs.

Numerous GM scientists I interviewed also heard a gradually evolving public debate on GMOs. This hearing may have, in part, been an artefact of the interview itself.[116] Nonetheless, GM scientists did seem to perceive a gradual increase in public resistance towards GMOs during the 1990s, usually followed by a period of relaxation that, on some occasions, changed to support.

> In the 1980s and early 1990s, there was little opposition to GMOs. Research Councils were doing their best to explain the situation and there was little reaction from the public […] I think it was around 1997 when the media started to run headlines against GMOs, talking about 'Frankenfoods'. And then, around 1999, the controversy was probably more intense than ever. (UK-GR2, 2008)

Notably, this finding mirrors the analysis of public opinion presented in Chapter 3, and this is important for two main reasons. First, it shows that scientists have been attentive to some, if not all, the things that are out there to be heard, and second, it shows that although scientists might have used different tools to hear public opinion from those I have used in Chapter 3 (as noted in Chapter 4 and in the sections below, British scientists used meeting with members of the public to learn about public opinion), the analytical approach I use to explore public opinion in Chapter 3 provides me with an image of public opinion that parallels scientists' understanding of this concept.

[116] Part of my interview guidelines includes specific questions on the evolution of public opinion on GMOs. On the other hand, it was not my plan to ask specific questions about the nature of public opinion on GMOs. Although this does not mean that I did not end up asking questions about scientists' views on public opinion on GMOs, this might partially explain the imbalance between scientists' attention on descriptions of the nature of public opinion and the time they spent describing the chronology of events that characterised the public debate on GMOs.

*Public surveys and members of the public*

A prominent way in which the scientists I interviewed heard public opinion was through public perception surveys. These were frequently mentioned in the Italian context, but also in the UK, albeit less often. In the quote below, for example, we read about Italians' relative support for GMOs in comparison to other parts of Europe. Early on in this interview this researcher reported learning of this relative support through the *Eurobarometer* report, as opposed to through 'direct contact' with the public.

> So, for example, a new Eurobarometer report was recently released, which shows that Italians are not more resistant to GMOs than other European countries, and in fact they are probably quite supportive compared to the north of Europe for example. (Italy-GR2, 2008)

Another Italian respondent, who worked on the *OGM in Agricoltura* study project, proposed a different picture of Italians' perception of GMOs.

> Within this project, we also looked at public perception of GMOs. The study supports other researchers' findings, which show that Italians are pretty sceptical about GMOs. They don't think this technology is suitable for our country and economy, they feel this technology is unnatural; they seemed a little bit less concerned about transferring genes within the same plant variety, instead of using for example bacteria genes. In addition, it appeared from the study that many Italians are concerned about intellectual property right issues and the monopoly of multinational companies. (Italy-GR4, 2008)

This respondent heard that the Italian public is sceptical of GMOs, which contradicts what the scientist above heard. He also heard that the public is specifically concerned about GMOs because they are 'unnatural' products, protected by property rights, and commercialized by a few multinational companies. While what was heard differs in these two statements, it is important to point out that both scientists reported hearing this contradictory information through a similar source:

public opinion polls. There are numerous surveys available on public perception of GMOs, which means that what scientists hear might be influenced by the survey they choose.

Meanwhile, of the British respondents I interviewed, a minority talked about meeting with members of the public. As the respondent in the quote below explained, during those meetings scientists ‘talked to’ the audience, but also ‘heard‘ members of public.

> I suppose, as a lot of people do, I get a view of what the public thinks when I have to stand up in front of a lot of people … I mean, I have been to meetings … there was one for which I went to this small village in Norfolk, where a trial of GM crops had been proposed … and I found myself in this completely full room … I mean there was not room for everyone and it was an unusually warm day – 25°C at 9 a.m. – and you sensed that nobody in that room had any sympathy for me at all … it’s a sort of threatening experience … you certainly know what a subsection of the public thinks when you go to those kinds of meetings… (UK-UR3, 2008)

Quotes like this indicate that some respondents heard public resistance towards GMOs through meeting with members of society, where both verbal and non-verbal cues provided important information to be heard regarding public opinion.

*Mass media and NGOs, and other campaigns against GMOs*

As noted in Chapter 4, scientists often heard public opinion through the mass media. This included mass media reporting on NGOs and their opinions regarding GMOs. Numerous respondents heard the mass media and NGOs’ campaigns as being against GMOs.

It was striking to note some scientists’ accuracy in describing which newspapers and television channels were supportive of GMOs and which were against this technology. As shown in the quote below, taken from an interview with a government researcher in Italy, scientists were attentive to changes in the mass media coverage of this technology.

> The situation is now changing. At the moment, Rai Uno[117] is more or less supportive of scientific research and GMOs. But the newspapers have become more tolerant too: *Il Corriere della Sera* is much less aggressive, and when you read *Il Sole 24 Ore* you have the feeling that the person who writes the article has a good idea of what he is talking about. On the other hand, there are newspapers like *La Repubblica*, for example, which continue to attack GMOs. (Italy-GR2, 2008)

This finding supports the analysis in Chapter 5, which characterises the mass media and scientists' relation to this institution as a relevant factor in scientists' listening process. From this we gather that scientists use the mass media as a relevant mediator when communicating with members of the public.

Furthermore, numerous scientists I met with heard NGOs' campaigns against GMOs. Noticeably, when British scientists talked about NGO campaigns, they frequently mentioned acts of vandalism and physical destruction of GM fields. Meanwhile, Italian scientists heard supermarkets' anti-GMO propaganda.

Both Italian and British scientists also heard public campaigns run by public figures that captured significant media attention (e.g. actors, writers or politicians in Italy, and Prince Charles in the UK). We see this in the following statement, made by an Italian scientist I interviewed:

> I remember a few years ago public figures campaigned against GMOs, just like they had done with nuclear power. Apparently, this is now happening again and you can see how popular individuals like Mario Capanna[118] are running campaigns against GM technology. (Italy-GR1, 2007)

[117] Rai Uno is the flagship state television channel in Italy.
[118] As noted in Chapter 3, Mario Capanna is known as one of the leaders of the Italian student movement during the 1960s. Furthermore, he is the leader of Fondazione dei Diritti Genetici an NGO campaigning against the use of GMOs.

Finally, it is interesting to note that a cross-country comparison between Italy and the UK shows that Italian scientists focused on the mass media as a prominent manufacturer of public opinion, while in the UK scientists frequently mentioned NGOs.

*Policy of GMOs and changes in funding allocation*

> Living in a democracy, I assume that politicians have to some extent to be responsive of public opinion. (UK-UR3, 2008)

Another thing that scientists heard were the changes in policy on GMOs and corresponding funding allocations from both private and public sources. I am aware that including these changes under the umbrella of things available to scientists to hear public opinion on GMOs may be unusual for the literature on public opinion. Nonetheless, I was guided by the respondents, who drew direct relations between public opinion, politicians and companies, and this is especially clear in the quote that opens this section. As such, I suggest that changes in GM policies and funding allocation represent another means through which scientists heard public opinion on GMOs.

Scientists I spoke with heard negative public opinion through funding restrictions. We see this in the following statements, made by a British respondent and an Italian scientist respectively:

> The BBSRC have continued to fund fundamental research; on the other hand, the DEFRA has significantly reduced its funding stream towards applied GM crops. (UK-GR6, 2008)

> In 1999 everything really changed, because the former Minister of Agriculture Alfonso Pecoraro Scanio decided to block all funding to agricultural biotechnology that used to come from public institutions and go to the universities. All of a sudden, funding simply stopped […] A few years later, Alemanno stopped the release of GMOs into the

> environment and the number of trials dropped from 200 per year in 1999 to 0 in the following two years. (Italy-UR4, 2008)

Respondents generally linked these funding restrictions to controversies surrounding GMOs.

> I remember when I met Alemanno early in his mandate as Minister of Agriculture. At that time he had nothing against GMOs; in fact, he was quite supportive. However, someone must have told him that if he changed his position and opposed GMOs he would receive much more public support. I guess that this is when he started to cut the funding for GMOs. (Italy-UR4, 2008)

Scientists also heard strained relations with multinational companies, who were pulling out of Europe as a consequence of negative public opinion and corresponding policies.

> Monsanto and Singenta were both working with us. When we were collaborating with Monsanto they were developing the gene Terminator technology, but then this collaboration stopped as Monsanto decided they did not want to go in this direction any more, and after some time they left the country.

As this respondent explained later on in the interview, Monsanto devised the gene Terminator technology to produce sterile seeds. This meant that every year farmers would need to buy new seeds from Monsanto, as second-generation seeds have been made genetically sterile. The respondent argued that following the spread of public campaigns against the gene Terminator, which linked this technology with anti-globalisation, Monsanto decided to pull out and leave the UK.

In summary, the scientists I spoke with hear a general sense of uneasiness and concern towards GMOs that gradually increased through the 1990s and decreased in the last few years. Generally, they fail to hear public opinion directly from members of the public, but rather through the mass media and public perception surveys. Nonetheless, on occasion scientists report hearing public opinion directly. This generally occurs when respondents participated to public meetings that gathered experts and non-experts on GM. In addition, respondents hear public opinion through the policy response of national governments, multinational companies and international organisations like the EU.

**3. Interpreting**

Interpreting is the second step of the listening process. It can be understood as the moment when the scientists select meanings and make sense of what they heard regarding public opinion on GMOs. In the following section, I present the different ways in which scientists interpreted public opinion in the interviews. Specifically, I show that many scientists I spoke with use the deficit model to interpret what they heard about public opinion on GMOs.

*Ignorant public*

The majority of scientists I spoke with talked about an ignorant and uneducated public, and we see this in the following statements made by different scientists I interviewed.

> The problem for them, and I mean the public, is that for the most part they are not educated with scientific information, and even less with scientific thinking. (UK-UR2, 2008)

> V: So would you say that the GM debate was in large part based on ignorance?
> I: Yes … well … I guess it is ignorance … a combination of ignorance and laziness … I think perhaps a lack of understanding of risk and what risk means. (UK-GR3, 2008)

> The problem is not really that they are not supporting GMOs, the problem is that they don't know what we are talking about. (Italy-UR2, 2007)

Aligning with findings in other studies, the scientists I spoke with often interpreted public opposition to GMOs as a consequence of their lack of knowledge (e.g. Cook et al., 2004; Gregory and Miller, 1998; Petts et al., 2001). The assumption that public concerns about science result from lack of knowledge is a core principle in the deficit model of the public understanding of science widely criticised by numerous PUS scholars.

> It is also worth emphasising the dangers of over-generalisation about 'the public' and its levels of understanding/ignorance. Once we move outside a simple 'cognitive deficit' model of the public understanding of science, we become increasingly aware of the range and variety of possible interactions between people's existing understandings of particular situations and those that emanate from science. (Wynne, 1991: 133)

Many of the scientists I spoke with assumed that if the public had more knowledge of GMOs, their support for this technology would increase. We see this in the following anecdote, in which a scientist met with one of her friends. The latter took for granted that GMOs cannot provide any benefits to the environment or the consumers; he was then especially surprised to learn that his friend had been working on a GM plant able to grow under environmental stress, an enhancement that could be especially beneficial to developing countries. According to the scientist, learning this helped change her friend's perception of the technology.

> While we were working on this new plant, which we were transforming to grow in a drought environment, I met a friend of mine and he asked 'But this is not a GM plant, right?' Of course, I answered that it was indeed a GM plant, and this is what DNA transformation allows us to do. So, with utmost surprise, my friend concluded that GMOs are not necessarily a bad thing. (Italy-UR5, 2008)

The belief that more knowledge of science creates more support for science is another cornerstone to the deficit model, which has been proven to be untrue by numerous scholars (Aldhous et al., 1999; Evan and Durant, 1995).

Other kinds of ignorance also featured in the scientists' interpretations of public opinion. As captured in the quote below, some argued that the public lacks confidence with modern agricultural practices.

> People want to believe that their food is grown like your grandma could grow it […] and they didn't notice that the agricultural industrial world has nothing to do with this and that there is widespread use of pesticides and herbicides. And this is happening with, or without, GMOs. (UK-UR1, 2008)

This respondent interpreted public opinion as stemming from naïve ideas regarding food production. He argued that this has led members of the public to overestimate the change introduced by GMOs.

A further kind of ignorance that GM scientists frequently mentioned has to do with public perception of risk. As the quote below shows, study participants owned a clear idea of what risk is, and disqualified alternative understandings.

> The public don't understand; they don't understand risk assessments even if they make them every day … every day people take a level of risk … even pretty high ones with alcohol or smoking … and people do even crazier things … and the risk of GM is very, very low because we have run a lot of tests and the benefits could be very high. (UK-GR1, 2008)

This finding aligns with Wynne's (2006) work on GMOs, which shows that where scientists cannot validate ethical concerns by scientific claims, they are prone to disqualify, or reduce them to private matters.

In this context, there were two interviewees who articulated very different approaches to interpreting public concern about GMOs. Captured in the quote below, one scientist I interviewed talked about a kind of knowledge that belongs to members of the public that is different from scientific knowledge, but nonetheless contributes to the process of knowledge construction.

> I would say that I have been educated by the participation in the discussion on GM foods. Like many scientists, I came to this research field with a very naïve perspective about how to produce crops. However, I think that, as a result of having participated in the discussion, my perspective has now become a little less naïve than what it was. What I appreciate now is that there is a lot of information out there about food production, and agricultural practices. These do not necessarily involve molecular biology. So, as a result of this, I think that the whole process of communication with the public is a two-way process, and scientists and technologists have things to learn from this discussion with the public as well. (UK-GR3, 2008)

This narrative interprets public opinion through an engagement approach to the public understanding of science as opposed to a deficit one. Below we read about public engagement practices as they have been recently summarised in the Department for Innovation Universities and Skills' updated Science and Society strategy consultation document.

> Public engagement: an umbrella term that encompasses many kinds of activity including science festivals, centres, museums, and cafes, media, consultations, feedback techniques, and public dialogue. Any good engagement activity should involve aspects of listening and interaction. (DIUS, 2008: 19)

A similar discourse emerged during the interview with an Italian researcher (Italy-UR4, 2008), who was discussing members of the public's concerns about the risk of losing track of allergenic substances due to GMOs. Paying attention to these concerns, the researcher exemplified her openness to include some public concerns in the process of knowledge construction.

In spite of the focus on dialogue in PUS, the majority of the scientists I spoke with continue to interpret public opinion through the language of the deficit model. As others (Wright and Nerlich, 2006) note, public ignorance serves a rhetorical purpose. This language simplifies the relationship between science and society, allowing scientists to put blame on members of the public. It also allows scientists to ignore public opinion when conducting their work. It appears that GM scientists are not comfortable with the 'ignore public opinion at your own peril' lesson, which synthetic biologists and stem cell researchers are now familiar with.

*Selfish public*

Many of the scientists I met with talked about members of the public as 'short-sighted' with regards to their opinions on GMOs. This discourse, which aligns with previous works on GMOs (Marris et al., 2001), guided some respondents to interpret the lack of support for GMOs as a consequence of the lack of consumer benefits in the 1st generation of GMOs. As we read in the quote below, the scientists believed that the public would be happy to eat GMOs if these products would benefit them.

> Last Monday, I participated in a radio programme, and before they interviewed me they had a guy going around and asking people whether they would eat a purple tomato, knowing that it was a GMO, but could help prevent cancer, and I think that around 80% said they would. So I think that people would like to eat them if they were good for them… (UK-GR5, 2008)

The underlying assumption for this set of interpretations is that members of the public support medical biotechnology but resist plant biotechnology. On several occasions, it was suggested that new food products that improve nutritional components of conventional foods (i.e. GM foods or 2nd generation GMOs) are more likely to gain consumers' acceptance than 1st generation GMOs, which are predominantly plants modified for the benefit of the producers. This belief led GM scientists to argue that if GMOs have a future, it will be independent from GM crops, which primarily fall under 1st generation GMO products.

Importantly, this belief is not supported by the *Eurobarometer* surveys on biotechnology between 1990 and 2005*,* which show that respondents were more supportive of GM crops than GM food. This raises questions regarding how scientists selectively hear some of the *Eurobarometer* findings and not others. In addition, Marris's (2001) work on GMOs indicates that the idea that the public prefer medical to plant biotechnologies is a widespread myth that contradicts members of the public's views on GMOs. How this myth has spread remains an open question; nonetheless, the scientists I spoke with generally use this myth to argue that the public are ultimately selfish in a manner that aligns with the deficit model approach to the public understanding of science.

Interestingly, numerous British respondents used discourses about public selfishness to interpret recent public relaxation in their opinions on GMOs. As reported in the quote below, a scientist explained increases in public support towards GMOs in relation to an increase in the cost of food.

> And the reason for changing is not because of any purple tomato or anything like that, but because people have suddenly become aware that we are not going to be able to produce enough food for the population of the world by 2050; what has probably made this clear is the sudden increase in food prices in recent years. (UK-GR5, 2008)

Whereas some scientists thought that more knowledge would improve public opinion on GM food, this study participant thought that household economics can provide the impetus for change. However, it is clear that ideas about an ignorant public converge with ideas about public selfishness to free GM scientists from questioning their scientific agenda.

*Popularisation of science as a problem*

> The culturally dominant view of the popularisation of science rests on a two-stage model: first, scientists develop genuine knowledge; second, popularisers spread streamlined versions to the public. (Hilgartner, 1990: 519)

In his work on the dominant view of the popularisation of science, Hilgartner argues that popularisation is rooted in the idealisation of scientific knowledge, as opposed to popular or 'folk' knowledge. This difference requires the transmission of scientific knowledge to the lay public. Popularisers are responsible for this diffusion of scientific knowledge into society. However, the assumption is that popularisation requires simplification. Scientists frequently claim that this amounts to a distortion or degradation of knowledge. This discourse was a recurrent theme during my meetings with scientists.

Many of the researchers I interviewed assumed that the controversy surrounding GMOs was an artefact of how the technology and products were communicated to society.

> …But this is a non-sense about GM, you know. If you take a crop that is difficult to breed like a potato … it is a very desirable thing to take a gene that is not common in potato, but can be a useful phenotype, and put that gene into your potato variety so you'll have a better variety of potato … even that is now considered a bad thing … so there has to be something we are not doing right in terms of describing this technology to the public. (UK-GR4, 2008)

Significantly, this researcher deemed scientists responsible for communication failures. However, the majority of people I interviewed indicated other social actors as being primarily responsible for miscommunicating scientific knowledge in making it part of popular knowledge. Burchell et al (2009) call these *malign* actors, which generally include journalists, corporations and NGOs.

As demonstrated in the extract below, some British respondents emphasised the misleading role played by NGO members.

> It was only when NGOs recognised that they could actually gain political advantages from protesting against GMOs that this technology became a problem. It wasn't really an issue until they made it one … I think it was

> in the late 1980s … NGOs thought that if they could create a really big scare, they would gain public support, people would join their parties etc… I mean, I don't think it was as clear-cut as that, but I am sure their hearts were in the right place. (UK-GR1, 2008)

Meanwhile, numerous Italian scientists talked about mass media and public figures as the malign actors responsible for public misinterpretations of GMOs. Furthermore, Italian scientists identified a cadre of mediators of science into society, which, as we read in the quote below, 'have done an awful job' in terms of public communication of science and were considered responsible for the public misrepresentations of GMOs and lack of support for this research.

> V: Are you saying that the responsibility for the misrepresentations of GMOs in the public's eyes rest on the mediators?
> I: Yes, I think that this is exactly the case, at least for GMOs. You know mediators have done an awful job when reporting on GMOs, and not always because of ignorance. No wonder people consider strawberries with genes of fish are the most likely outcome of GM technology. (Italy-UR2, 2007)

Only one respondent distanced her story from the popularisation model. This researcher was describing her most recent endeavour, to produce a GM variety of potato with more flavonoids and no other variation in terms of the organoleptic characteristics of the final products.

> I: So, for example, we could use genes and promoters from the same plant variety we are transforming…
> V: And would you say that this might have a different impact on society?
> I: I think it certainly helps if you say that you are moving a gene from potato to potato. Nobody seems to have a problem with it. People seem to have problems with other things, like spider DNA into an apple. But if you use the same plant variety, in terms of public perception, I think there would be fewer concerns.
> V: And would you say that this is also better in terms of the transformation as such, or perhaps this could be more problematic from a science perspective?
> I: I think it is definitely more problematic. I worked with transgenic plants for 20 years and they don't care about the origin of the genes. In fact, it

> is probably worse because you run more risks of getting gene silencing. (UK-GR5, 2008)

What is interesting here, and is captured in the quote above, is the fact that, even though the respondent separated genuine and popular knowledge, she nonetheless allowed public concerns about GMOs to influence her work. It can be argued that this account blurs the boundaries between genuine and scientific knowledge, echoing popular debates about the influence of members of the public, and society in general, in the process of knowledge construction (Callon et al., 2009; Jasanoff, 2004, 2005; Wynne 1992).

> Scientific knowledge, it is now widely accepted, does not simply accumulate, nor does technology invariably advance benign human interests. Changes in both happen within social parameters that have already been laid down, often long in advance. In the field of environmental regulation for example, concepts of risks and safety, methods of compiling and validating data, ideas of causation and blame, and (crucially for biotechnology) even the boundary between 'nature' and culture' have been shown to reflect deep-seated social assumptions that rob them of universal validity. (Jasanoff, 2005: 13)

*National culture of food*

Another popular interpretation of public lack of support towards GMOs draws on discourses about food and culture. The lack of knowledge, selfishness and problems with popularisation are all aligned with the deficit model. As such, the deficit model is a primary schema that scientists use to interpret public concerns about GMOs. However, by using the cultural aspects of food to interpret public concerns, the scientists I interviewed also acknowledged that social and cultural contexts must be taken into account when interpreting public anxieties about particular kinds of science. Nonetheless, concerns about GMOs located in the cultures of food were still frequently dismissed as overly emotional.

The quote below, taken from an interview with a British government researcher, reports on the peculiarity of the emotions people associate with food, which contributed to making GMOs so controversial. In this particular case, the respondent interpreted public concerns about GMOs in relation to the involvement of multinational companies. It should be noted that other scientists also relied on this argument when interpreting the lack of public support towards GMOs more broadly.

> V: So, would you suggest there is some kind of psychological component in it (opposition towards GMOs)?
> I: Of course, it is a huge component. Why do you think there was so much opposition and the campaigns were so successful? It is because food is different. I mean, it is possible that mobile phones are 'frying our brains', and also that there are only a few mobile phone companies, but people don't have the same emotional reaction to the fact that there are only a few mobile phone companies as to the fact that there are only a few seed companies controlling our food, because food is visceral and emotional. (GR2, 2008)

Frequently, when scientists talked about food, their arguments were related with discourses about culture and cultural differences. In particular, as we read in the quote below, scientists often assumed that in those countries where GMOs have been accepted (i.e. the USA), people have a different cultural relation with food. Respondents argued that the British and Italian public have high-quality standards with regards to food and are concerned about anything that could upset the quality of traditional products.

> Take the US for example; you can see they are not worried about food security; they trust their institutions, but they also consider food differently; it might be because in Italy we are used to eating high-quality food and food is important to us. Besides this, in the United States there is a different mentality. Just look at their houses, they are made of wood, and they have been there for what, 200 years? Here it is different; our culture is centred on art and literature and we have this heavy baggage from the past to carry. It kind of delays us. (Italy-UR6, 2008)

Cook (2004) argues that scientists explain public resistance to new technology by opposing members of the public who *feel* about science, to scientists who *think*. I similarly found that respondents would frequently disqualify public concerns about GMOs based on cultural priorities. Words like 'heavy baggage' and 'delay' in the quote above work to devalue cultural concerns about food in Italy. Here, GM researchers link the idea of an emotional public, which is nuanced with the deficit model assumptions, to cultural discourses about food and tradition.

One of the most interesting findings of this section is that ten years after the introduction of discourses of dialogue and engagement, scientists continue to draw on deficit model assumptions in order to interpret public opinion on GMOs. This finding aligns with other studies (e.g. Cook, 2004; Irwin, 2001; Hilgartner, 2006; Wynne, 2006), and indeed, the deficit model is an attractive proposition for scientists. This discourse frees scientists from having to engage with public concerns about GMOs, and as such, the deficit model – as a discourse – may hinder the pursuit of an engagement model amongst GMO researchers.

Having said this, it is interesting to note that there were exceptions. On three occasions, the scientists I interviewed made arguments that did not fit with the deficit model. Here, they either blurred the boundaries between science and society, or talked about local knowledge as valuable. This shows that multiple discourses about the public and science might circulate simultaneously.

**4. Responding**

Responding represents the last step of scientists' listening process. The way scientists responded to public opinion on GMOs is closely related to what they heard, and how they interpreted it.

A prominent way in which the scientists I interviewed responded to public opinion was to ignore it. The quote below, which is probably the clearest example of a scientist who decided to ignore public opinion, indicates that GM researchers considered this decision honest and in line with their vocation and ethics.

> Thus, from the researcher's perspective, the most honest thing to do is to ignore public opinion and try to do what you think is the right and most interesting thing to do. (Italy-GR3, 2008)

The scientists I spoke with also frequently responded by trying to improve the communication process with the public. As noted earlier on in this chapter, Italian respondents usually attribute the responsibility of communicating with the public to a cadre of science mediators. In this context, they call for a change in the way these mediators have presented GMOs to society, one that reduces the complexity of science without causing misinterpretations. Notably, Italian respondents understood journalists to be the best suited for this job.

> Scientists have a very specific language – they understand each other – but it is difficult for non-experts to understand them. Here is the great responsibility of mediators: they have to translate the discourses of science into society in a way that is comprehensible for people with an average level of education. […] You can certainly say that mediators should do more, and better, as what we have now is an incredible confusion about GMOs. (Italy-UR2, 2007)

Overall, these discourses support Bucchi's (1998) work on science and the mass media. Bucchi suggests that discourses on communication of science revolve around three arguments. The first is that science has evolved to such an extent that it has become too complicated and specialised for members of the public to understand. To this end, it follows the second argument, which assumes that mediators are needed in order to fill the gaps between science and the public. The last argument implies that when information is transferred from science to members of the public, a certain degree of simplification is necessary.

British scientists also directed their attention towards improving communication between science and the public. However, scientists' efforts included organising meetings with the public (UK-UR3, 2008), increasing transparency in the public arena to recuperate public trust and support (UK-GR1, 2008), and finally, facilitating greater media access to the science arena (UK-GR6, 2008).

Some scientists responded by changing their research topics. One British scientist told me he had to stop his research on GMOs and direct his studies towards another topic. Notably, the respondent drew a close relationship between this action and the lack of private and public funding that followed the public outcry against GMOs. Another British respondent decided to reinvent her work, and considering public opinion concerns, she decided to focus on intra-species DNA transformation. A third researcher talked about a broad shift in the GM research field towards environmental themes. Notably, the respondent embedded this shift in both public debate about GMOs and the nature of GM science research. Albeit reducing the gap between science and the public in different ways, all the three changes listed by British respondents seem to indicate a kind of dialogue.

> V: So are you saying that people's opinions on GMOs had an impact on this research field?
> I: Well, they certainly led scientists to environmental research … I think during the 1980-90s, the focus was predominantly on molecular biology and food safety, and then from the mid-1990s up to the present time, there has been a major focus on environment. (UK-GR1, 2008)

Italian scientists also indicated that there was a shift in research towards biosecurity, which was a response to public concerns about GMOs and corresponding cuts in funding. However, they often described this as more of a linguistic than substantive shift in their research, one that allowed them to continue doing their research in the midst of massive funding cuts.

This section explored GM scientists' responses to public opinion on GMOs. In line with the dominance of deficit model assumptions in scientists' interpretations of public opinion, this study also found these arguments prevailing in scientists' responses. The most striking example of this is the decision to ignore public opinion, which was proposed in numerous interviews. Another example of how the deficit model guides scientists' responses is represented by the Italian scientists' call for a change in the way scientific journalists present GMOs to members of the public. Nonetheless, on occasion scientists' answers do not necessarily fit with the deficit model rhetoric. We can see this in British respondents' decision to increase meetings with the public, improve communication with mass media, increase science transparency or change research topic.

**5. Patterns of GM scientists' listening**

In the sections above, I have analysed hearing, interpreting and responding largely as three independent moments, and mapped the variations that characterise the individual moments within the listening process. Drawing on this review, I now explore the listening process as a whole, asking if there are any recurrent patterns that characterise scientists' listening process. To answer this question I first asked if there is any indication of a relation between what scientists heard and how they interpreted it. I also asked if it is possible to identify a pattern between scientists' interpretations and their responses. Taking this analytical approach means that we will reencounter some of the themes explored in the sections above. These, however, will be here discussed in ways that are both original and relevant to the final outcome of this thesis. In particular, I argue that scientists listen to public opinion according to two most common patterns, which are accompanied by some interesting variations. I consider these patterns, which I explore in the following section, an example of scientists' civic epistemologies. Sheila Jasanoff defines civic epistemology as 'the institutionalized practices by which members of a given society test and deploy knowledge claims used as a basis for making collective choices' (2005: 255). Focusing on the listening process, this study has tried to expand this concept and look at how it works within the scientists' landscape. I contend that, within the logic of dialogue and public engagement, it makes sense to ask not only how the public legitimises scientific knowledge, but also if and what scientists know about society.

*Pattern 1 – Manufactured public opinion*

The first pattern is also the most prominent. I call this *manufactured public opinion* pattern. Scientists who listened to public opinion in this way heard a general sense of public uneasiness towards GMOs. They did not, however, analyse this discontent in detail. As we see in the quote below, scientists rapidly moved on to interpret this uneasiness as caused by public misunderstanding and corresponding fear.

> Maybe, in the future, the climate of opinion will change. At the moment, the situation is very difficult. People take for granted that GMOs are a bad thing, and it is very difficult to change this perception when all the newspapers and TV programmes talk about this technology in a negative way, and are not even discussing the potential of this technology, but have moved on to explore how to avoid it. (Italy-GR3, 2008)

As we see in the quote above, this study participant linked public uneasiness to the mass media. The latter circulated manufactured images of GMOs and created a false sense of concern over them.

Given that GMOs were misrepresented in the public's eyes, this respondent felt free from any commitment to consider public concerns about GMOs. As we read below, this interpretation guided the researcher to disqualify the relevance of public uneasiness towards GMOs, ignore public opinion and carry on with his work.

> I should say that I completely ignored the fact that the public did not show any support towards GMOs. This is mostly because by studying GMOs, you improve your understanding of plant biology, but also because one always hopes that, at some point, people will realise that there is nothing wrong with these products and will ultimately change their mind. (Italy, GR3 2008)

Ignoring public opinion and carrying on with their work represents a response to public opinion that contradicts public engagement and dialogue discourses, while it fits with the deficit model, which allocates the problem of public lack of support entirely to members of the public.

Notably, this pattern was shared across Italy and the UK without major differences. The only exception was the fact that, while Italian scientists focused their attention on the mass media as manufacturer of public opinion, British scientists usually talked about NGOs.

Just like this respondent, numerous other scientists heard a general sense of uneasiness towards GMOs and moved to interpret this as ignoring public opinion. I suggest that this pattern is deeply informed by deficit model assumptions. The latter, which clearly influences the way scientists interpreted and responded to public opinion, is also evident when considering the lack of interest towards members of the public's concerns about GMOs. This, as I have argued, is a prominent feature of the way in which scientists who used the manufactured public opinion pattern heard public opinion. If not from the public, scientists must have gathered their images of public opinion elsewhere. Numerous PUS scholars argue that science and other institutions such as the government own pre-existing ideas of the public. Following these lines, this thesis supports Brian Wynne's argument (2006; Wynne et al, 2007), which suggests that the integration of imaginaries of the public in the culture of science and institutions has resulted in alienating members of the public, who is believe to mistrust science.

> [T]he public is imagined, constructed and projected in reflection of the unspoken needs of the institutionally powerful. I suggest it is in these terms that we can understand the prevailing scientific and policy institutional culture and its creative construction of a stream of 'public deficit' versions of why publics mistrust 'science'. (Wynne, 2006: 218)

*Pattern 2 – Mediated public opinion*

The second pattern identified characterises a group of GM researchers who heard public opinion through the government and corporations, specifically through cuts in private and public funding for GMOs. Although this pattern is less common than the first, respondents still articulated it frequently. I call this *mediated public opinion* pattern. We see an example of this listening process in the following quote.

> Our funding comes from various sources; the main ones have been BBSRC, plus DEFRA, plus EU; with the last two, there has been a definite move away from supporting GM […] I mean, they are perfectly happy to consider GM as a research tool, but in terms of crop improvement, both DEFRA and the EU have, I think, moved quite far away, particularly the

> EU, but I don't think it has really affected the BBSRC funding. I guess this was their way of showing the public that they were not ignoring their concerns. […] Given the new direction of funding, everybody had to adapt to the new situation. For us, that was not a real problem, as we were already focused on basic research, but, for example, up until recently we avoided applying to release GM crops into the environment, as we knew that if we did that we were not going to receive funding. (UK-GR1, 2008)

Responding to public opinion in this interpretive context, this respondent explored a series of changes that had an impact on the nature of his, and his colleagues' projects.

Elsewhere during the interview, the researcher explained how public resistance to GMOs would decrease if the public knew more about them. In other words, just as we see in the manufactured public opinion pattern, we also see here how the deficit model informed scientists at each stage of the listening process. This finding aligns with other studies (Cook et al., 2004; Wright and Nerlich, 2006), pointing to the deficit model discourses as a popular repertoire for scientists' discussions of science and the public. However, scientists who heard public opinion through decreased funding responded by changing their research. In contrast, scientists who heard public opinion in the manufactured pattern described above simply ignored it. This difference points to the important role of the government and multinational companies in shaping how scientists listen to public opinion.

Looking at this pattern from a cross-national perspective allows several variations to emerge. First, GM respondents in the UK heard both a decrease in public funding for applied science and an increase in funding for basic science/research. This was usually indicated as a government strategy to balance public discomfort towards GMOs, with the government's tendency to support this research field. Italian scientists, on the other hand, saw the government as another opponent of GMOs. Having said this, it is interesting to note that, while British scientists' responses included shifts towards basic research, or the termination of scientific projects on GMOs, Italian respondents usually talked about a shift towards biosecurity issues that, nonetheless, mainly affected the form rather than the content of the projects. As such, British scientists may have responded – in action – to public opinion to a greater extent, at least as mediated through the government and corporations.

**Table 5 Two popular patters of scientists' listening process**

| Patterns | Hearing | Interpreting | Responding |
|---|---|---|---|
| *Manufactured public opinion* | Public general uneasiness towards GMOs | Deficit model repertoires | Ignore public opinion |
| *Mediated public opinion* | Public uneasiness manifested in funding changes by the government and private companies | Deficit model repertoires | Changes in the nature and form of GM science projects |

*Variations from the patterns*

Although these two patterns feature in most scientists' stories on listening to public opinion, there were also some interesting variations.

For example, a British university researcher, who spent his entire academic career working with plants, told me about public opinion and its influences on his work. As we read in the quote below, this respondent heard public uneasiness about GMOs and proposed four main reasons for this: the sense of unnaturalness and unpredictable nature the public associated to GMOs, the close relationship between these products and multinational companies, the belief that GMOs could represent a risk for the environment and concerns about human safety.

> There are all sorts of reasons why the public are not accepting the technology, so some people are resisting it because they see it as transferring foreign genes into plants. They are referring to the uncertainty principle and they are saying to us [scientists], ‘well, you don’t know what is happening in there.’ And in fact, they claim we could be doing all sorts of strange things. […] But you see, the public is also resisting the involvement of biotechnology companies like Monsanto, who are perceived as having a monopoly position in plant biotechnology. […] Also, you have some people who are still concerned that GMOs are not safe for the environment and man. (UK-UR3, 2008)

As many of his colleagues, this respondent used repertoires that are embedded in the deficit model. For example, he argued that ‘it is our [scientists’] job as people who understand this whole business to advise the general public, because let’s face it - the general public has not always had the most informed and balanced perspective on complicated issues’ (UK-UR3, 2008). Nonetheless, he was also more sympathetic to public knowledge and how it could contribute to the process of knowledge construction. He continued:

> Assume you grow fields full of the same specie, and then there is this virus that reaches one of your fields and attacks it; it will rapidly spread through all your fields. You have created an ideal situation for the disease, like a pandemic influenza in a city. In theory, you could deal with that by breading plants that are resistant to that disease or genetically modify them. However, if you do that, then you place a very strong selection pressure on the pathogen that evolves. And trust me, they do evolve very quickly. So that would be worse for you and your field. On the other hand, agricultural practices tell us that if you grow plants in more mixed situations and mix different genotypes of plants and species of plants in the same fields, you create a situation in which the disease is less likely to spread or at least you have introduced some barriers to the spread of the disease. So you can see there are lessons to be learned. And I believe that introducing these types of practices with the help of molecular biotechnology is clearly the way forward. (UK-UR3, 2008)

Notably, this respondent is not suggesting that all contributions coming from members of the public are equally valuable; on the contrary, he is arguing that the contributions of the users of this technology matter most. Given that he focused on crops as opposed to food, this researcher pointed to the importance of consulting with and learning from farmers whose expertise matters. This raises questions regarding which public matters, an area of sustained interest in the public understanding of science (e.g. Rapp, 1999; Saetnan et al., 2000).

It is interesting to note that this respondent redirected his research to focus on a new area of studies that, in contrast with the 'old' GM technique, allows for plants to be transformed using genes of the same species. Given that this new technique allows scientists to avoid mixing genes that are phylogenetically distant, I assumed it could also respond, at least to some extent, to public concerns about the unpredictable consequences of GMO transformations that this respondent had explored earlier on during the interview. I asked my interviewee for his view on this matter, and here is his response:

> I suppose you could say that what we are doing is a compromise. I mean, it is an alternative approach. You are certainly compromising because you are saying, 'well, okay, my approach using virus genes was not okay, so I'll try this one; how do you like it?' But, on the other hand, we would have gone in that direction anyway because we were interested in the 30,000 genes that are in plants' genomes, and we are interested in what they do and how we can use them. But yes, you are right, trying to promote both is maybe something you could see as a compromise. (UK-UR3, 2008)

Engaging with his own actions, this respondent underlined the circularity that characterises the listening process. In addition, as we read above, he put to the fore the tension between ideas of independent science, typical of the deficit model, and images of compromise with members of the public that follow the recent move towards dialogue and public engagement.

Another British scientist provided a further variation of the listening process. To understand how, it is necessary to follow the respondent through her line of thought. The researcher heard public uneasiness towards GMOs, and in particular suggested that people 'seem to have problems with things like spider DNA being put into apples, but if you use the same plant variety in terms of public perception, it is not as problematic' (UK-GR5, 2008). In addition, the respondent also commented that she heard a recent increase of public support first hand during a radio programme in which she recently participated. Both these comments were part of a narrative in which the researcher sought to understand the nature of public uneasiness towards GMOs. Rather than discount public concern, she tried to understand where the uneasiness was coming from and to address those worries in her work.

Noticeably, the respondent directed her attention to the study of new GM products that, using intra-specific transformation, allow the production of food products with enriched nutritional values. As we read below, the respondent assumed that these products were likelier to be supported by members of the public.

> People seem comfortable with transforming a potato with genes that come from potatoes. […] So for example,
> I set up a company with another researcher and tried to modify potato by inserting a very important resistance gene. As you know, at the moment there already are GM potatoes, but their colour is different from that of the normal ones. This, I think, is not very nice and attracts consumers' concerns and scepticism. Thus, we thought to combine the resistance gene with a transformation that would not alter the colour… So if you manager to have both transformations together, then you have

> a way of persuading consumers and also facilitate the production of this potato variety. (UK-GR5, 2008)

Notably, the respondent's assumptions that members of the public were ready to eat GM products contradict public survey studies on GMOs (see Chapter 3), which indicate that members of the public have been generally more supportive of GM crops specifically produced for the benefit of producers, but remained sceptical about GM food, which are being proposed as having a wider range of benefits, including some specifically directed to consumers. Nonetheless, the researcher's interest in making some changes that meet what she heard regarding public concerns demonstrates a willingness to include members of the public in the process of knowledge construction, in a manner that employs the language and ethos of public engagement. This raises questions about the ways scientists may misunderstand the public.

An Italian researcher presents the last variation to the main patterns of listening. In this case, the respondent heard a lack of public support for GMOs through the mass media and NGO campaigns, as well as through cuts in government funding for this technology. In addition, the respondent heard numerous kinds of public concerns, including those about the involvement of multinational companies and the possibility that the kinds of transformation undertaken by scientists are lost in the process of food production. She also heard that this would represent a risk for people who are allergic to certain substances, as they would have difficulties knowing which products to consume and which to avoid.

Interpreting what she was hearing, the respondent merged discourses of misrepresentation of GMOs in the public sphere, which she understood as the main reason for public resistance to GMOs, with the belief that members of the public are emotional about science. However, as we read below, she remained nonetheless open to considering the validity of some concerns pointed out by members of the public.

> Well, part of the problem with allergies could be avoided if all the steps of the transformation were reported in the labels; nevertheless, you have to admit that this situation is difficult to overcome when people go to restaurants. Take a person allergic to wheat: if you modify, say, rice with a wheat gene that causes the allergy, and this person orders a rice dish, he could get sick. (Italy-UR4, 2008)

This respondent moved away from conventional research on GMOs, and has instead focused on developing ways to continue her work without upsetting the public. One solution that she discussed during the interview that allowed her to use GM techniques without imposing the consumption of these products on the public, is represented by biofarmers. The latter are plants designed to produce substances that, once extracted, can be used in nutritional or industrial environments. This means that only this substance, and not the plant itself, is meant to be consumed. This, according to the respondent, translates into a different emotional impact on the public when compared to conventional GMOs. Her narrative shows how scientists can move between the logics associated with public engagement and deficit model discourses. The apparently clear difference between these two discourses for sociologists is less clear-cut among GM scientists.

Overall, the three exceptions described above could be grouped in one final pattern, which starts with the researcher hearing concerns about GMOs that they interpret through the combination of engagement repertoires and deficit model assumptions. Each researcher responded by making some changes to their research project. As such, this pattern can be seen as a minority pattern in the listening process.

**6. Conclusions**

Much of the PUS literature has ignored the process of listening and instead focused on how to talk to members of the public (Bauer, 2007; Bauer et al., 2002; Miller, 2001). I used this chapter to map scientists' listening process. This work builds on the more recent shift of attention towards scientists, how they perceive their role in dialogue and public engagement, how they perceive the public and finally, how they perceive themselves in relation to non-experts (Burchell, 2007; Burchell et al., 2009; Davies, 2008; Michael and Brike, 1995). In this context, this thesis examines if and how scientists listen to public opinion.

I suggest that the listening process includes three main phases: hearing, interpreting and responding. I understand the boundaries between these phases to be flexible in a way that allows them to overlap. Hearing is when scientists decide what to focus their attention on; interpreting consists of two moments, one in which scientists indicate to themselves the thing that they consider meaningful, and a second in which they go on to select the proper meanings; and finally, responding concludes the listening process. My suggestion is of a circular, as opposed to a linear, relationship between these three phases in the process of listening.

According to my findings, scientists hear a general sense of uneasiness and concern towards GMOs that peaked in the late 1990s. Only at times, scientists hear public opinion directly from members of the public, by attending public meetings with GM experts. In this context, a number of actors play a mediating role in the listening process, i.e. national governments, the popular press, public perception surveys, NGOs and private companies.

In most cases, the scientists interpret public opinion on GMOs by referring to the deficit model, and only rarely they mention public engagement and dialogue. This suggests that these two kinds of discourses currently coexist within the GM science landscape, but it also points to obduracy of the deficit model assumptions. This finding, which aligns with other scholars' work (Cook, 2004; Irwin, 2001; Hilgartner, 2006; Wynne, 2006), poses questions about how, if desired in policy circles, one can change this situation.

The imbalance between public engagement and the deficit model also features in scientists' responses to public opinion. Scientists ignore public opinion or, as we see in Italy, call for the development of a new cadre of mediators to fill the gaps between science and members of the public. Nonetheless, scientists at times diverge from this path and instead talk about needing to meet with members of the public and, in response, change their own research.

Finally, it is interesting to note that this study has identified three patterns in scientists' listening. I argued that, focusing on the way scientists listen to public opinion, these patterns are part of scientists' civic epistemology. Across these patterns, scientists hear public discontent about GMOs; however, many do not take the time to explore the nature of these concerns. Those who are not directly affected by policy changes simply ignore these critiques; meanwhile, those who are affected by policy changes are forced to change their research. Only a small group actively seek out public opinions to redefine their research in the context of controversy.

Given that the GM debate exploded while PUS scholars were abandoning the deficit model to move to public engagement, it is logical to assume that scientists could hardly miss the public controversy that arose around this technology and went through some kind of listening experience. However, this study shows that the answer is more complicated than this. My findings indicate that scientists hear the general sense of uneasiness towards this technology, but, nonetheless, rarely explore it. In addition, it seems possible to argue that interpretations play a significant role in the way scientists listen to the public, influencing their response but also echoing in what they heard of public opinion. Interpreting is usually informed by deficit model assumptions, and only rarely involves public engagement discourses. This suggests that, when possible, GM scientists prefer to use the deficit model to interpret public opinion, which is understandable because this model frees them from any responsibility with regards to public concerns about GMOs. Finally, and in line with the deficit model interpretations, my findings indicate that where money is not involved, numerous scientists ignore public opinion. When funding is part of the listening process, scientists come up with some changes in their projects. Ultimately, this points to the government and private companies, but in general the economic factor, as important elements of the listening process, and more broadly in the relation between science and the public.

# Chapter 7
# Conclusion

This dissertation took the case of agricultural biotechnology in Italy and the UK and asked if, how and under what conditions scientists listen to public opinion on GMOs. I concluded this research with a model of scientists' listening process that, albeit not in a definitive way, represents my understanding of this process. In the following paragraphs, I provide an overview of my findings. This informs my reflections on the implications of this study for PUS scholars and natural scientists, who I consider my main interlocutors.

## 1. Summary of the findings

This dissertation has sought to propose an alternative way to look at the relation between the public and science. PUS scholarship has traditionally concentrated on scientists as speakers and members of the public as listeners. This approach, which fits with the deficit model, has only recently started to change, following the introduction of public engagement and dialogue discourses. This shift means that scholars' attention has been focused on the ways in which publics, while interacting with science, come to understand scientific knowledge (Michael, 2009); or also the ways in which scientists understand themselves and their role in the process of science communication (Burchell et al, 2009). This thesis goes one step further and reverses the relation between science and the public, assuming that members of the public are the speakers and scientists are listeners. Following this approach, I have asked if GM scientists listen to public opinion and, if so, how.

When I initiated this dissertation, I assumed a stimulus-response model of listening, wherein public outcry (the stimulus) is followed by a change in scientists' work on GMOs (the response). This model assumes a causal relationship between public opinion and GM science, which I sought to analyse using quantitative measures of public opinion and GM science output. However, as I tried to answer my question, I was struck by the ambiguity of findings presented in Chapter 3. To reiterate, there were no clear associations between public opinion and scientific outputs. And this ambiguity meant that two different scenarios could be put forth to partially explain the relationship between public opinion and GMO science.

In the first scenario, I speculated that publications and patents are influenced by public opinion. This would explain their decline right after the peak of public uneasiness towards GMOs. In this context, field trials are independent from public opinion, and their decline is linked to some other factor. Here, I proposed that the decline of field trials is closely related to the government, which is also the primary filter for GMO releases into the environment. This scenario, which fits with the frequency arcs of publications and patents, as well as the one of public resistance to GMOs, nonetheless left some questions open. Is it possible that the same factor that caused field trials to decline would have affected publications and patents? This possibility asserts a limited, if at all present, influence of public opinion on GM science output. Notably, the information I gathered through this analysis opened the way to my following chapters.

In a second scenario, I speculated that field trials may be more sensitive to public opinion than publications and patents, and so began to decrease in the early stages of the GM controversy. A few years later, publications and patents also began to decline. It could be argued that negative public opinion had a causal effect upon GM scientists' output. However, the great limitation of this scenario lies in the timeline, which indicates that the decline of field trials began a few years before the peak of public uneasiness towards GMOs. This does not seem to leave scientists enough time to hear public uneasiness toward GMOs and respond with a reduction in GM field trials.

In this context, I decided that quantitative measurements alone could not answer my research question. Across the thesis, I have argued for the need to mix quantitative and qualitative methods. Thus, I have tried to challenge the traditional tension between qualitative and quantitative methods that is evident within the PUS scholarship. It has been argued that quantitative methods focus too much on the numbers, leave little room for the individuals, and usually assume causal relationships. All these limitations are apparent when looking at Chapter 3's findings. Nonetheless, descriptive statistics did allow me to answer large-scale research questions such as what was the representation of public perception on GMOs in Italy and the UK, and what was the path of Italian and British GM scientific output.

In order to overcome the limits of the quantitative analysis, in Chapter 4 I met a selected group of GM scientists who I interviewed to hear their stories on public opinion and its influence on their work and their field more broadly. Tracing the stories of GM scientists pointed this study in a new direction. Based on these interviews, I posited that the relationship between public opinion and science is indirect rather than causal. This shift in my conceptualisation of the relationship between scientists and the public allowed me to see how the government and private companies mediate this relationship. In addition, scientists did not experience their relationship with the public across countries in the same ways. Variations emerged pretty consistently through the cross-country comparison, which shows that British scientists continually associated the government’s anti-GM position to public outcry. Meanwhile, in Italy scientists understood public outcry as having been manufactured by the government. In addition, British scientists generally felt that they play an important and respected role in society, while Italian scientists generally felt marginalized. In this context, public opinion was understood as influencing scientists’ work but in a mediated rather than direct manner.

The theme of the government and its relation with science and members of the public is also explored in Chapter 5, where I compared two GM projects carried out in Italy and the UK. In this context, additional factors arose in the analysis, which also mediate the relationship between science and members of the public. These additional factors include the mass media, private companies, the kind of public being related with, the local culture of science and the circulation of PUS discourses. Notably, all these factors were also recurrent in scientists’ stories (Chapter 4), although it was difficult to point to them specifically in that context. Furthermore, these factors, together with scientists’ stories of public opinion, helped me go back to Chapter 3’s findings and clarify some of its ambiguities. For example, at this point I was able to argue that, while the decrease in publications and patents frequencies might have indirectly mirrored public opinion, the almost complete end in field trials in Italy was a consequence of the government’s anti-GM position. Meanwhile, in the UK field trials declined as both a reaction to vandalism as well as the cuts of funding for applied research. As such, to understand the GM controversy, we need to consider ways in which GMOs, scientists, public opinion, the government and private companies are co-produced (Jasanoff, 2005).

Studying if and how GM scientists were influenced by public opinion sheds some light on the listening process, which I began to lay out in Chapter 4. Here, I identified two main moments of listening, which includes hearing and responding to public opinion. In Chapter 6, I more fully developed an alternative model of scientists listening capacity based on my analysis across the previous chapters. In contrast to the stimulus-response model, the revised model starts with hearing public opinion, then moves to interpreting what is heard, and ends with responding to public opinion. In developing this model, I contended that the ways scientists listen to public opinion is deeply informed by the cultural and social environments they inhabit.

Chapter 6 indicated that many scientists listen to public opinion. However, study participants proposed a range of different ways to listen. I suggested these patterns shed some light on scientists' civic epistemology of the public. Sheila Jasanoff (2005) defines civic epistemology 'the institutionalized practices by which members of a given society test and deploy knowledge claims used as a basis for making collective choices' (Jasanoff, 2005: 255). Focusing on the listening process, this study has tried to expand this concept to look at scientists' civic epistemologies. With the expanding influence of public engagement approaches, it is important to ask questions about both public and scientific ideas regarding civic life.

My research found that the deficit model continues to deeply inform the ways scientists interpret public opinion. For example, many scientists I spoke with assumed that the public is ignorant and have only a little understanding of GMOs. Other recurrent themes that echoed the deficit model include notions of the public as selfish and emotional alongside the idea that public representations of GMOs are distorted and degraded. These themes were also taken up in Chapter 4.

But we also saw national differences emerge in comparing Italy and the UK. British scientists, who experienced governmental support for their work, focused their narratives on the problems of NGOs in misrepresenting GMOs. Meanwhile, Italian scientists, who felt marginalized from society, described being shut out by the government. These scientists focused on the importance of having a cadre of scientifically trained people who can speak to the public to dispel myths put forth by the government. As such, we saw that the deficit model is not monolithic, but can be taken up in different ways in different national contexts.

The analysis of the listening process also pointed to another characteristic of scientists' listening. In Chapter 6 there are a few examples in which scientists listened to public opinion directly. But in most cases the listening process unfolded through the government and private companies. In other words, scientists often hear changes in the funding allocation quite clearly. They have more difficulties hearing members of the public.

It needs to be emphasised that some scientists did use public engagement repertoires in interpreting public understandings of GMOs. This means that, in their stories, scientists allow members of the public's inputs, opinions and knowledge about GMOs to become relevant for the futures of GMOs. However, in Italy and the UK, these discourses were used differently. For example, in Chapter 4 we saw that some British scientists would alternate between public engagement and deficit repertoires without noticing any tension. When Italian scientists followed public engagement patterns, they did so without using the rhetoric that characterises dialogue and public engagement in the UK. This, in a way, might have made it more difficult for them to express their thoughts, while showing a genuine desire to engage with the public.

I am quite intrigued by one British respondents comments that members of the public, and farmers in particular, have a different knowledge of plants and agriculture that can beneficially contribute to the development of GMOs. This narrative recalls Jasanoff's concept of co-production (2004), raising questions about which kinds of public GM scientists are willing to listen to in the process of knowledge construction. This theme was also taken up in Chapter 5, where I referred to Wynne et al's (2007) distinction between invited and uninvited publics. Wynne et al define invited publics as those who are invited by scientists or other institutions to participate in public engagement exercises. The scholars contrast these with uninvited publics, who express their opinions about GMOs outside of engagement exercises and also successfully shape the GM field within the UK. This dissertation aligns with Wynne et al's findings, showing that scientists hear both invited and uninvited publics. However, scientists interpret and respond to these varying publics differently.

By way of concluding, I suggest that this analysis of listening process helps delineate some barriers to dialogue that characterise the way scientists listen to public opinion. I address the nature and significance of these findings in the next two sections, which explore the implications of this thesis for PUS scholarship and for scientists more generally.

## 2. Implications for PUS scholarship

Since the early stages of the GM controversy, PUS scholars have looked at GMOs with great interest. Following the recent shift toward dialogue and public engagement, some scholars have started to focus on the ways in which members of the public can contribute to the process of knowledge construction (Jasanoff, 2005; Callon et al, 2009). Other scholars have focused on scientists and asked how they have experienced public engagement exercises (Burchell et al, 2009). Yet others have looked at how scientists behave in relation to science and other publics (Michael, 2009). This thesis, which looks at science as the receiver in the communication process, takes another step in exploring dialogue and public engagement.

Focusing on listening, this dissertation indicates that scientists had difficulties in hearing members of the public directly. Chapters 4, 5 and 6 all showed that the government and private companies are crucial mediators that shape the relationship between science and the publics. However, these mediators are not always transparent, which exacerbates tensions between science and members of the public. For example, in the FSE study, we saw that the government proposed this project as a response to public concerns about GMOs. However, it addressed concerns held by the government and conservation bodies, which did not really align with those concerns voiced by NGOs or the popular press. Overall, this dissertation supports Reardon (2006), who argues that the capacity to hear and learn from the public requires institutional support, as well as specific policies that encourage scientists to genuinely engage with the public.

Along with the government, which we saw can facilitate but also hinder the realisation of public engagement exercises, this dissertation identifies other barriers to the listening process. The deficit model represents one. In Chapter 6, we saw that the schemata of ignorant, selfish and emotional publics shape how scientists interpret public opinion.  Certainly the deficit model let scientists off the hook quite easily, legitimizing their decision to ignore public opinion.  But I have also noted that the deficit model shapes what scientists heard, limiting their ability to hear the nature of public concerns about GMOs.

A further barrier to the listening process emerges when comparing Italy to the UK. The UK initiated much of the debate on the public understanding of science, and has been traditionally engaged in improving the relationship between science and the public. PUS interventions reached Italy through the EU and the community frameworks on the matter of science and society.  This means that there has been a lack of a format for dialogue and public engagement in Italy. In Chapter 4, we saw that, unlike their British colleagues, Italian scientists did not possess a specific vocabulary to talk about dialogue and public engagement. This, on the one hand, impeded them from using these discourses rhetorically. On the other hand, it also means that Italian scientists did not own a series of concepts which, in the case of the UK, proved useful in changing scientists' way of thinking about the relationship between science and the public (Burchell et al, 2009). Furthermore, this thesis shows that where formats for dialogue are available to scientists, scientists are encouraged to meet the publics, instead of talking to them through other actors, i.e. the mass media. As such, we can say that the absence of public engagement formats limits scientists' way of listening to public opinion.

Numerous PUS scholars argued that the case of GMOs represents a warning to scientists, as a lesson that should not be repeated (Kearnes et al, 2006; Calvet and Martin, 2009; 2009). Considering the public outcry against GMOs, it is important to note that the relation between scientists and members of the public did not change significantly in this context. Moving toward public engagement models is likely to be a long and slow process. This is, in part, because the deficit model is not simply a set of discourses that scientists use to legitimate their position in society but is also a significant part of their cultural milieu and civic epistemology. It follows that scientists are now entering a cultural shift that, as Inglehart (1990) explains, is usually gradual and might involve intergenerational population replacement. Contra other scholars, I found that GM scientists are wedded to the deficit model on a cultural level and so experience a shift toward dialogue as difficult. It may be that more recent developments in synthetic biology and nanotechnology will note this and may end up pushing engagement models further than GMO scientists have been able to.

**3. Implications for scientists**

I entered the world of GMOs eight years ago, in Italy, when I chose my undergraduate degree in Agricultural biotechnology. For three and a half years, I experienced what it means to work with GM organisms and I was surrounded by scientists who dedicated most of their time to the study of this technology. Afterward, I decided to change my approach and began to look at GMOs from a sociological perspective. Going back to the field and interviewing scientists and researchers who worked with GMOs was, for me, a return to my past. As I heard scientists’ stories, it was not difficult for me to identify myself with them. Their feelings and thoughts were also my feelings and thoughts just a few years earlier. Because of this, I feel this dissertation has a chance to speak to scientists, who might be interested in changing their current relation with members of the public. In order to do that, I will not try to explain public engagement or dialogue repertoires. These, as we saw in the UK, are already circulating among GM scientists. Rather, I will try to convince scientists that the deficit model is not the best fit to see the relationship between science and the public.

Scientists recurrently told me that members of the public do not understand GMOs. They told me that members of the public are selfish and emotional about GMOs. In addition, scientists mentioned that numerous maligned actors - including the mass media, NGOs and private companies - have misrepresented GMOs in the public sphere. In the following, I will discuss these narratives.

It is certainly important that, when talking about GMOs, all the parties involved in the conversation have some knowledge of science. Scientists claim that members of the public have a simplified, emotional, and culturally informed knowledge of this technology. This is certainly different from scientists' knowledge, as they understand GMOs in the context of the laboratories. However, different does not mean that it is not valuable. As one of my respondent pointed out in Chapter 6, farmers own some knowledge of GMOs, which is not available to scientists, but is crucial for the development of GM products. I contend that, as we see in this example, the context in which GMOs are placed matters. Scientists might know GMOs well in the context of the laboratories, but they know little about GMOs in the context of the farm, or in the home and everyday life. I hope this dissertation made scientists curious about these other kinds of knowledge, and how they might be integrated into the futures of GMOs.

Across this dissertation, I have also investigated how scientists talk with members of the public, and the ways of communicating with them. In Chapters 4 and 6, I extensively encountered the mass media and explored their role in the process of communication of GMOs to members of the public. I noted that numerous scientists, especially in Italy, relied on the mass media as the main source of communication with members of the public. Nevertheless, scientists are very sceptical about the mass media. As Hilgartner's (1990) model of popularisation contends, study participants distinguished between scientific and 'folk' knowledge and claim that, following the process of popularisation, GMOs have been misrepresented in the public sphere. I hope this dissertation showed that the mass media are not the only way to communicate with members of the public, and scientists could try to communicate their views on GMOs directly to the public.

We saw some examples of this in Chapter 5 when analysing the FSE. Here we also saw some of the problems of these experiences, as these exercises shut out a portion of GMOs publics, which I have called uninvited, and invited a group of citizens to listen to scientists talk about GMOs, rather than encourage a discussion between experts and non-experts. As suggested by Callon, Lascoumes, and Barthe (2009), I contend that one way to overcome some of these problems is to become more sensitive about all the actors touched by GMOs and create an institutional system that promotes the inclusion of these actors, rather than their exclusion or marginalization. This is certainly something that goes beyond scientists, but that at the same time cannot be achieved without them.

**4. Limitations and future research**

This study concentrates on the relation between science and the public, looking at how scientists receive information from the public. As I have analysed this relationship, I noted that it included numerous other actors. This dissertation has exclusively focused on the scientists, which means that I have not interviewed members of the public, nor have I met with government representatives or private companies. Future studies on this topic might want to investigate if and how members of the public describe the way scientists listen to them. Furthermore, considering the crucial role played by the government and corporations, it would be interesting to look at how these actors understand the relationship between science and the public, and what they make of their role in this relationship.

Focusing on Italy and the UK, this study can only provide a snapshot of the relation between science and society within a limited context. Even if the comparison between these two countries has proven crucial to answer my research questions, future studies might want to expand the geographical boundaries and look at how scientists listen to public opinion in other countries. Furthermore, this study only focuses on GMOs.  Other scholars may want to explore how scientists hear public opinion on other technologies. For example, future studies might want to focus on two different technologies and compare and contrast how scientists from different scientific backgrounds listen to public opinion.

As I noted throughout the thesis, the analysis of the listening process and how scientists listen to public opinion is still an underdeveloped area of research.  In light of the recent move towards dialogue and public engagement, scientists listening capacity deserves to be analysed further. This dissertation represents the first attempt to do so. While my findings are not meant to be conclusive, I hope that with this dissertation I have made the first step to fill a significant gap in the literature.

**5. Provisional conclusions**

Ten years ago, PUS scholars introduced the idea of public engagement. Building on the prominent literature developed on scientists, how they understand themselves, the public and public engagement exercises by scholars such as Brian Wynne, Mike Michael and Sarah Franklin, this thesis has asked if and how scientists listen to members of the public. The analysis of the listening process shows that scientists listen to public opinion in different ways. GM scientists rarely use public engagement and dialogue discourses when listening to pubic opinion, and the deficit model continues to be the most popular way to interpret public opinion. While scientists' listening might only cover a small portion of the dialogue process, analysing this tells us about the relation between science and the public and the barrier to forming new modes of relating into the future.

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## Appendix 1

*SET TERM 1:*

(transformed OR transformed plant* OR plant* transformed OR plant* transformation OR DNA integration OR efficient transformation OR gene integration OR improved transformation OR marker free OR selectable marker gene* OR stable transformation OR transform* efficiency OR transform* frequency OR transform* vector* OR transformation technology OR Transplastomic OR Negative selective marker OR Intron mediated OR Intron enhance* OR Plastid transformation OR Transient gene expression OR Improved vector* OR bollgard OR biosafety OR GMO OR roundup ready OR Agroinfiltration OR binary Ti vector OR biolistic* OR chimaeric gene* OR chimeric gene* OR direct gene transfer OR foreign gene* OR genet* manipulat* OR genet* transform* OR molecular farming OR particle bombardment OR reporter gene* OR transformed line* OR transient expression OR Ti plasmid vector OR transformed clone* OR transgen* OR Integrated gene copies OR Particle acceleration OR Particle bombardment OR T-DNA OR gus fus* OR gfp fus* OR luc fus* OR protein fus* OR Gene trap* OR Activation tagg* OR Enhancer trap* OR Promoter trapping OR Microprojectil* OR Binary vector* OR Extrachromosomal recombination OR DNA junction OR Transient assay OR Using Agrobacterium OR Particle gun OR DNA uptake OR DNA delivery OR DNA transfer OR Transfer of DNA OR Co-transform* OR regenerat* OR somatic embryo* OR organogen* OR Negative select* OR Positive select* OR Select* agent OR selection system OR Exogenous DNA OR PEG OR integration OR transient OR site specific recombination OR targeting OR intron OR epigenetic OR methylation OR inactivation OR silencing OR CaMV35S OR microprojectil* OR hairpin OR agrobacterium OR protoplast* OR cell suspension cultur* OR callus OR calli) AND (plant OR plants OR rice OR maize OR brassica OR arabidopsis OR tobacco OR rye OR wheat OR barley OR pea OR sugarcane OR soybean OR glycine max OR medicago OR potato OR zea mays OR populus OR cucumis OR lycopersicum OR prunus OR sunflower OR tomato OR sugar beet OR cotton OR gossypium OR sorghum OR nicotiana OR oat OR oats OR legum* OR apple OR strawberry OR cassava OR anthirrhinum OR lettuce OR petunia OR fescue OR banana OR solanum OR maize OR poplar OR cotton)

*SET TERM 2:*

(Genetically modified crops OR Genetically modified crop OR GM crops OR GM crop OR Golden rice OR GM canola OR GM corn OR GM crops OR GM maize OR GM oilseed rape OR GM soybean OR GM tomato OR transgenic crop* OR Transformed rice OR Transformed maize OR Transformed brassica OR Transformed arabidopsis OR Transformed tobacco OR Transformed rye OR Transformed wheat OR Transformed barley OR Transformed pea OR Transformed sugarcane OR Transformed soybean OR Transformed medicago OR Transformed potato OR Transformed maize OR Transformed corn OR Transformed poplar ORTransformed prunus OR Transformed sunflower OR Transformed tomato OR Transformed sugar beet OR Transformed cotton OR Transformed sorghum OR Transformed nicotiana OR Transformed oat OR Transformed oats OR Transformed legum* OR Transformed apple OR Transformed strawberry OR Transformed cassava OR Transformed anthirrhinum OR Transformed lettuce OR Transformed petunia OR Transformed fescue OR Transformed banana OR transformed alfalfa OR transformed millet OR transformed pulse OR transformed oilseed rape OR transformed pepper)

*SET TERM 3:*

(plant OR plants OR rice OR maize OR brassica OR arabidopsis OR tobacco OR rye OR wheat OR barley OR pea OR sugarcane OR soybean OR glycine max OR medicago OR potato OR zea mays OR populus OR cucumis OR lycopersicum OR prunus OR sunflower OR tomato OR sugar beet OR cotton OR gossypium OR sorghum OR nicotiana OR oat OR oats OR legum* OR apple OR strawberry OR cassava OR anthirrhinum OR lettuce OR petunia OR fescue OR banana OR solanum OR maize OR poplar OR cotton) AND (Kanamycin resistan* OR Hygromycin resistan* OR Phosphinothrycin resistan* OR PPT resistan* OR Herbicide resistan* OR GLUFOSINATE RESISTAN*)

*SET TERM 4:*

| |
|---|
| (plant OR plants OR rice OR maize OR brassica OR arabidopsis OR tobacco OR rye OR wheat OR barley OR pea OR sugarcane OR soybean OR glycine max OR medicago OR potato OR zea mays OR populus OR cucumis OR lycopersicum OR prunus OR sunflower OR tomato OR sugar beet OR cotton OR gossypium OR sorghum OR nicotiana OR oat OR oats OR legume* OR apple OR strawberry OR cassava OR anthirrhinum OR lettuce OR petunia OR fescue OR banana OR solanum) AND (Agrobacterium mediated genetic transformation OR Binary vector* OR DNA integration OR DNA transfer OR efficient genetic transformation OR efficient transformation OR gene integration OR improved transformation OR inheritance of transgen* OR integration of transgen* OR marker free OR segregation of transgen* OR selectable marker gene* OR single copy T-DNA OR single copy transgen* OR stability of transgen* OR stable transformation OR transform* efficiency OR transform* frequency OR transform* vector* OR transformation technology OR transgen* copy number OR transgen* expression OR transgen* inactivation OR transgen* inheritance OR transgen* integration OR transgen* loc* OR transgen* segregation OR transgen* silencing OR transgen* stability OR Transplastomic OR foreign DNA delivery OR foreign gene delivery OR foreign gene transfer OR integration site* of transgen* OR multi-copy T-DNA OR multi-copy transgen* OR transgen* delivery OR transgen* linkage OR transgen* rearrange* OR transgen* repeats OR T-DNA transfer OR Negative selective marker OR Microprojectile-mediated OR Intron mediated OR Intron enhance* OR Linked T-DNA* OR Unlinked T-DNA* OR Plastid transformation OR Microprojectil* bombardment OR Transient gene expression OR Improved vector*) |

*SET TERM 5:*

| |
|---|
| gene delivery to plant* OR gene targeting in plant* OR gene transfer to plant* OR homologous recombination in plant* OR plant cell transformation OR transformation of plant* OR Gene transfer to cereal* OR rice transformation OR maize transformation OR brassica transformation OR arabidopsis transformation OR tobacco transformation OR rye transformation OR wheat transformation OR barley transformation OR pea transformation OR sugarcane transformation OR soybean transformation OR medicago transformation OR potato transformation OR maize transformation OR corn transformation OR poplar transformation OR prunus transformation OR sunflower transformation OR tomato transformation OR sugar beet transformation OR cotton transformation OR sorghum transformation OR nicotiana transformation OR oat transformation OR oats transformation OR legum* transformation OR apple transformation OR strawberry transformation OR cassava transformation OR anthirrhinum transformation OR lettuce transformation OR petunia transformation OR fescue transformation OR banana transformation OR alfalfa transformation OR millet transformation OR pulse transformation OR oilseed rape transformation OR pepper transformation OR agrobacterium mediated DNA transf* OR agrobacterium mediated gene transf* OR agrobacterium mediated transformation OR agrobacterium rhizogenes mediated transformation OR agrobacterium tumefaciens mediated transformation OR genet* engineer* of plant OR genet* engineer* of plants OR plant expression vector* OR bt cotton OR bt crop* OR bt maize |

## Appendix 2

| UK RISK GM CROPS | 1991 | 1993 | 1996 | 1999 | 2002 |
|---|---|---|---|---|---|
| Definitely disagree | 6.98 | 6.09 | 8.5 | 8.8 | 9.4 |
| Tend to disagree | 29.08 | 28.7 | 24.8 | 14.3 | 18.2 |
| Tend to agree | 41.07 | 40.99 | 39.5 | 20 | 26.6 |
| Definitely agree | 12.55 | 15.38 | 14 | 19.8 | 21.5 |
| Don't Know | 10.32 | 8.84 | 13.2 | 37.1 | 24.3 |

| UK ENCOURAGEMENT GM CROPS | 1991 | 1993 | 1996 | 1999 | 2002 |
|---|---|---|---|---|---|
| Definitely disagree | 3.4 | 3.93 | 11.6 | 16.5 | 15.8 |
| Tend to disagree | 10.67 | 13.6 | 14.9 | 15.4 | 17.9 |
| Tend to agree | 38.14 | 39.11 | 38 | 17.9 | 29.0 |
| Definitely agree | 44 | 39.39 | 21.2 | 9.6 | 12.5 |
| Don't Know | 3.79 | 3.97 | 14.3 | 40.6 | 24.8 |

| UK RISK FOOD | 1991 | 1993 | 1996 | 1999 | 2002 | 2005 |
|---|---|---|---|---|---|---|
| Definitely disagree | 5.94 | 4.97 | 5.3 | 7.9 | 11.3 | 4.9 |
| Tend to disagree | 22.56 | 26.26 | 20.2 | 15.1 | 17.5 | 19.9 |
| Tend to agree | 43.81 | 42.9 | 41.6 | 23.6 | 28.4 | 37.5 |
| Definitely agree | 18.98 | 18.1 | 21.6 | 26.2 | 23.7 | 20.9 |
| Don't Know | 8.71 | 7.77 | 11.3 | 27.2 | 19.1 | 16.8 |

| UK ENCOURAGEMENT GM FOOD | 1991 | 1993 | 1996 | 1999 | 2002 | 2005 |
|---|---|---|---|---|---|---|
| Definitely disagree | 12.37 | 11.81 | 19.3 | 23.7 | 22.1 | 22.9 |
| Tend to disagree | 22.19 | 22.32 | 21.7 | 18.5 | 21.2 | 31.4 |
| Tend to agree | 37.29 | 37.89 | 31 | 16.7 | 23.7 | 22.6 |
| Definitely agree | 23.13 | 23.73 | 13.8 | 8.2 | 13.4 | 7 |
| Don't Know | 5.02 | 4.25 | 14.2 | 32.9 | 19.6 | 16.1 |

| ITALY RISK GM CROPS | 1991 | 1993 | 1996 | 1999 | 2002 |
|---|---|---|---|---|---|
| Definitely disagree | 9.31 | 9.37 | 16.7 | 11.2 | 9.0 |
| Tend to disagree | 20.5 | 21.77 | 26 | 17.1 | 18.1 |
| Tend to agree | 30.81 | 29.88 | 27.2 | 26.4 | 33.2 |
| Definitely agree | 22.25 | 20.5 | 16.9 | 17.1 | 13.0 |
| Don't Know | 17.13 | 18.48 | 13.2 | 28.2 | 26.7 |

| ITALY ENCOURAGEMENT GM CROPS | 1991 | 1993 | 1996 | 1999 | 2002 |
|---|---|---|---|---|---|
| Definitely disagree | 7.07 | 8.49 | 10.7 | 14.3 | 16.7 |
| Tend to disagree | 14.33 | 14.45 | 11.5 | 11.2 | 18.9 |
| Tend to agree | 26.53 | 26.85 | 29.2 | 20.2 | 15.3 |
| Definitely agree | 35.84 | 32.03 | 17.9 | 11.5 | 11.0 |
| Don't Know | 16.23 | 18.18 | 30.7 | 42.8 | 38.1 |

| ITALY RISK FOOD | 1991 | 1993 | 1996 | 1999 | 2002 | 2005 |
|---|---|---|---|---|---|---|
| Definitely disagree | 8.56 | 8.78 | 9.7 | 7 | 9.4 | 5.5 |
| Tend to disagree | 18.15 | 22.1 | 18 | 12.5 | 9.5 | 21.1 |
| Tend to agree | 34.07 | 31.25 | 34.3 | 29.7 | 27.6 | 39 |
| Definitely agree | 26.7 | 20.7 | 26.7 | 29.1 | 29.1 | 15.1 |
| Don't Know | 12.52 | 17.17 | 11.3 | 21.7 | 24.4 | 19.3 |

| ITALY ENCOURAGEMENT GM FOOD | 1991 | 1993 | 1996 | 1999 | 2002 | 2005 |
|---|---|---|---|---|---|---|
| Definitely disagree | 12.66 | 11.42 | 24.5 | 26.7 | 33.5 | 19.2 |
| Tend to disagree | 20.48 | 20.5 | 20.2 | 17.8 | 15.5 | 27.9 |
| Tend to agree | 26.53 | 26.85 | 29.2 | 20.2 | 15.3 | 29.2 |
| Definitely agree | 35.84 | 32.03 | 17.9 | 11.5 | 11.0 | 5 |
| Don't Know | 4.49 | 9.2 | 8.2 | 23.8 | 24.7 | 18.7 |

## Appendix 3

Chi-squared test

*The Independent* (total sample 146 articles)

**Crosstabulation**

| | | | GENERATION | | | | Total |
|---|---|---|---|---|---|---|---|
| | | | 1st | 2nd | 3rd | Basic research | |
| opinion | negative | Count | 12 | 12 | 0 | 6 | 30 |
| | | % within GENERATION | 25,5% | 20,7% | ,0% | 15,8% | 20,5% |
| | slightly negative | Count | 19 | 14 | 0 | 22 | 55 |
| | | % within GENERATION | 40,4% | 24,1% | ,0% | 57,9% | 37,7% |
| | none opinion | Count | 16 | 17 | 0 | 8 | 41 |
| | | % within GENERATION | 34,0% | 29,3% | ,0% | 21,1% | 28,1% |
| | slightly positive | Count | 0 | 10 | 1 | 2 | 13 |
| | | % within GENERATION | ,0% | 17,2% | 33,3% | 5,3% | 8,9% |
| | positive | Count | 0 | 5 | 2 | 0 | 7 |
| | | % within GENERATION | ,0% | 8,6% | 66,7% | ,0% | 4,8% |
| Total | | Count | 47 | 58 | 3 | 38 | 146 |
| | | % within GENERATION | 100,0% | 100,0% | 100,0% | 100,0% | 100,0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 53,000(a) | 12 | ,000 |
| N of Valid Cases | 146 | | |

a 10 cells (50,0%) have expected count less than 5. The minimum expected count is ,14.

## *Il Corriere della Sera* (total sample 130 articles)

**Crosstabulation**

| | | | GENERATION | | | Total |
|---|---|---|---|---|---|---|
| | | | Basic Research | 1st | 2nd | |
| opinion | negative | Count | 16 | 11 | 0 | 27 |
| | | % within GENERATION | 21,1% | 23,9% | ,0% | 20,8% |
| | slightly negative | Count | 25 | 23 | 1 | 49 |
| | | % within GENERATION | 32,9% | 50,0% | 12,5% | 37,7% |
| | none opinion | Count | 21 | 10 | 1 | 32 |
| | | % within GENERATION | 27,6% | 21,7% | 12,5% | 24,6% |
| | slightly positive | Count | 10 | 1 | 1 | 12 |
| | | % within GENERATION | 13,2% | 2,2% | 12,5% | 9,2% |
| | positive | Count | 4 | 1 | 5 | 10 |
| | | % within GENERATION | 5,3% | 2,2% | 62,5% | 7,7% |
| Total | | Count | 76 | 46 | 8 | 130 |
| | | % within GENERATION | 100% | 100,0% | 100,0% | 100,0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 43,944(a) | 8 | ,000 |
| Likelihood Ratio | 28,722 | 8 | ,000 |
| Linear-by-Linear Association | 2,202 | 1 | ,138 |
| N of Valid Cases | 130 | | |

a 7 cells (46,7%) have expected count less than 5. The minimum expected count is ,62.

In order to try to obtain a valid chi-squared test it was decided to adapt these data in two ways:

a) By collapsing slightly positive and positive into one category as slightly negative and negative into another one
b) By excluding 3rd generation articles (3 for the UK, and 0 for Italy)

*The Independent* (total sample 143 articles)

**Crosstabulation**

| | | | GENERATION | | | Total |
|---|---|---|---|---|---|---|
| | | | 1st | 2nd | Basic research | |
| opinion | negative | Count | 31 | 26 | 28 | 85 |
| | | % within GENERATION | 66,0% | 44,8% | 73,7% | 59,4% |
| | none opinion | Count | 16 | 17 | 8 | 41 |
| | | % within GENERATION | 34,0% | 29,3% | 21,1% | 28,7% |
| | positive | Count | 0 | 15 | 2 | 17 |

| | | | | | |
|---|---|---|---|---|---|
| | % within GENERATION | ,0% | 25,9% | 5,3% | 11,9% |
| Total | Count | 47 | 58 | 38 | 143 |
| | % within GENERATION | 100,0% | 100,0% | 100,0% | 100,0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 21,484(a) | 4 | ,000 |
| N of Valid Cases | 143 | | |

a 1 cells (11,1%) have expected count less than 5. The minimum expected count is 4,52.

## *Il Corriere della Sera* (total sample 130 articles)

**Crosstabulation**

| | | | GENERATION | | | Total |
|---|---|---|---|---|---|---|
| | | | Basic research | 1st | 2nd | |
| opinion | negative | Count | 41 | 34 | 1 | 76 |
| | | % within GENERATION | 53,9% | 73,9% | 12,5% | 58,5% |
| | none opinion | Count | 21 | 10 | 1 | 32 |
| | | % within GENERATION | 27,6% | 21,7% | 12,5% | 24,6% |
| | positive | Count | 14 | 2 | 6 | 22 |
| | | % within GENERATION | 18,4% | 4,3% | 75,0% | 16,9% |
| Total | | Count | 76 | 46 | 8 | 130 |
| | | % within GENERATION | 100,0% | 100,0% | 100,0% | 100,0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 26,291(a) | 4 | ,000 |
| Likelihood Ratio | 22,091 | 4 | ,000 |
| Linear-by-Linear Association | ,497 | 1 | ,481 |
| N of Valid Cases | 130 | | |

a 3 cells (33,3%) have expected count less than 5. The minimum expected count is 1,35.

## Appendix 4

| UK Publications GMOs | Total Frequency | Sample size | 1st Generation GMOs | 2nd Generation GMOs | 3rd Generation GMOs | Basic Research |
|---|---|---|---|---|---|---|
| 1990 | 315 | 15 | 4 | 5 | 0 | 6 |
| 1991 | 402 | 19 | 4 | 4 | 0 | 11 |
| 1992 | 485 | 24 | 7 | 1 | 1 | 15 |
| 1993 | 511 | 26 | 8 | 1 | 1 | 16 |
| 1994 | 555 | 28 | 7 | 5 | 2 | 14 |
| 1995 | 591 | 30 | 4 | 7 | 2 | 17 |
| 1996 | 608 | 30 | 7 | 5 | 0 | 18 |
| 1997 | 642 | 35 | 9 | 4 | 2 | 20 |
| 1998 | 738 | 37 | 12 | 5 | 2 | 18 |
| 1999 | 736 | 37 | 11 | 8 | 1 | 17 |
| 2000 | 772 | 38 | 12 | 6 | 1 | 19 |
| 2001 | 647 | 32 | 7 | 7 | 3 | 15 |
| 2002 | 706 | 35 | 9 | 7 | 1 | 18 |
| 2003 | 756 | 38 | 11 | 10 | 0 | 17 |
| 2004 | 758 | 39 | 11 | 7 | 1 | 20 |
| 2005 | 769 | 39 | 7 | 4 | 5 | 23 |
| 2006 | 707 | 32 | 9 | 5 | 0 | 18 |
| 2007 | 570 | 26 | 2 | 10 | 0 | 14 |
| Total | 11268 | 560 | 141 | 101 | 22 | 296 |

| UK Patents GMOs | Total Frequency | Sample size | 1st Generation GMOs | 2nd Generation GMOs | 3rd Generation GMOs | Basic Research | Don't Know |
|---|---|---|---|---|---|---|---|
| 1990 | 25 | 3 | 2 | 1 | 0 | 0 | 0 |
| 1991 | 29 | 3 | 1 | 0 | 0 | 2 | 0 |
| 1992 | 56 | 6 | 1 | 2 | 0 | 3 | 0 |
| 1993 | 75 | 8 | 2 | 2 | 0 | 3 | 1 |
| 1994 | 83 | 9 | 1 | 4 | 0 | 4 | 0 |
| 1995 | 91 | 10 | 3 | 4 | 0 | 3 | 0 |
| 1996 | 97 | 10 | 5 | 4 | 0 | 0 | 1 |
| 1997 | 112 | 12 | 6 | 4 | 0 | 2 | 0 |
| 1998 | 145 | 15 | 4 | 6 | 1 | 4 | 0 |
| 1999 | 150 | 16 | 8 | 6 | 0 | 2 | 0 |
| 2000 | 178 | 19 | 5 | 4 | 2 | 7 | 1 |
| 2001 | 178 | 19 | 6 | 8 | 0 | 5 | 0 |
| 2002 | 155 | 17 | 2 | 9 | 0 | 5 | 1 |
| 2003 | 156 | 17 | 6 | 4 | 2 | 5 | 0 |
| 2004 | 144 | 16 | 7 | 4 | 0 | 5 | 0 |
| 2005 | 108 | 12 | 2 | 4 | 0 | 6 | 0 |
| 2006 | 106 | 11 | 7 | 1 | 0 | 3 | 0 |
| 2007 | 92 | 10 | 4 | 6 | 0 | 0 | 0 |
| Total | 1980 | 213 | 72 | 73 | 5 | 59 | 4 |

| UK Field trials GMOs | Total Frequency | 1st Generation GMOs | 2nd Generation GMOs | 3rd Generation GMOs | Basic Research | Don't Know |
|---|---|---|---|---|---|---|
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 16 | 12 | 2 | 0 | 1 | 1 |
| 1993 | 17 | 6 | 4 | 0 | 2 | 5 |
| 1994 | 23 | 19 | 4 | 0 | 0 | 0 |
| 1995 | 37 | 26 | 9 | 0 | 0 | 2 |
| 1996 | 27 | 15 | 11 | 0 | 0 | 1 |
| 1997 | 25 | 18 | 7 | 0 | 0 | 0 |
| 1998 | 22 | 13 | 4 | 0 | 0 | 5 |
| 1999 | 13 | 10 | 2 | 0 | 1 | 0 |
| 2000 | 25 | 19 | 3 | 0 | 0 | 3 |
| 2001 | 12 | 8 | 3 | 0 | 0 | 1 |
| 2002 | 5 | 2 | 3 | 0 | 0 | 0 |
| 2003 | 8 | 4 | 4 | 0 | 0 | 0 |
| 2004 | 1 | 0 | 0 | 0 | 0 | 1 |
| 2005 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 2 | 2 | 0 | 0 | 0 | 0 |
| 2007 | 1 | 1 | 0 | 0 | 0 | 0 |
| Total | 234 | 155 | 56 | 0 | 4 | 19 |

| Italy Publications GMOs | Total Frequency | Sample size | 1st Generation GMOs | 2nd Generation GMOs | 3rd Generation GMOs | Basic Research |
|---|---|---|---|---|---|---|
| 1990 | 120 | 6 | 0 | 0 | 0 | 6 |
| 1991 | 107 | 5 | 1 | 1 | 0 | 3 |
| 1992 | 187 | 9 | 3 | 2 | 0 | 4 |
| 1993 | 208 | 10 | 3 | 2 | 0 | 5 |
| 1994 | 217 | 11 | 4 | 0 | 0 | 7 |
| 1995 | 274 | 15 | 3 | 1 | 1 | 10 |
| 1996 | 272 | 14 | 2 | 4 | 0 | 8 |
| 1997 | 255 | 13 | 2 | 5 | 0 | 6 |
| 1998 | 280 | 15 | 1 | 5 | 0 | 9 |
| 1999 | 340 | 18 | 2 | 5 | 0 | 11 |
| 2000 | 328 | 16 | 1 | 6 | 0 | 9 |
| 2001 | 297 | 15 | 3 | 6 | 0 | 6 |
| 2002 | 415 | 21 | 7 | 5 | 0 | 9 |
| 2003 | 385 | 19 | 3 | 6 | 0 | 10 |
| 2004 | 466 | 23 | 6 | 11 | 1 | 5 |
| 2005 | 427 | 22 | 4 | 9 | 0 | 9 |
| 2006 | 392 | 19 | 5 | 4 | 1 | 9 |
| 2007 | 392 | 20 | 4 | 6 | 0 | 10 |
| Total | 5362 | 271 | 54 | 78 | 3 | 136 |

| Italy Patents GMOs | Total Frequency | 1st Generation GMOs | 2nd Generation GMOs | 3rd Generation GMOs | Basic Research |
|---|---|---|---|---|---|
| 1990 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 1 | 1 | 0 | 0 | 0 |
| 1992 | 2 | 1 | 0 | 0 | 1 |
| 1993 | 2 | 2 | 0 | 0 | 0 |
| 1994 | 2 | 2 | 0 | 0 | 0 |
| 1995 | 4 | 2 | 1 | 0 | 0 |
| 1996 | 2 | 1 | 1 | 0 | 0 |
| 1997 | 2 | 2 | 0 | 0 | 0 |
| 1998 | 2 | 1 | 1 | 0 | 0 |
| 1999 | 5 | 3 | 1 | 0 | 1 |
| 2000 | 6 | 0 | 3 | 0 | 3 |
| 2001 | 7 | 1 | 0 | 0 | 6 |
| 2002 | 7 | 1 | 3 | 0 | 3 |
| 2003 | 5 | 0 | 4 | 0 | 1 |
| 2004 | 7 | 1 | 3 | 0 | 3 |
| 2005 | 6 | 1 | 3 | 0 | 2 |
| 2006 | 5 | 1 | 2 | 0 | 1 |
| 2007 | 6 | 2 | 2 | 0 | 2 |
| Total | 71 | 22 | 24 | 0 | 23 |

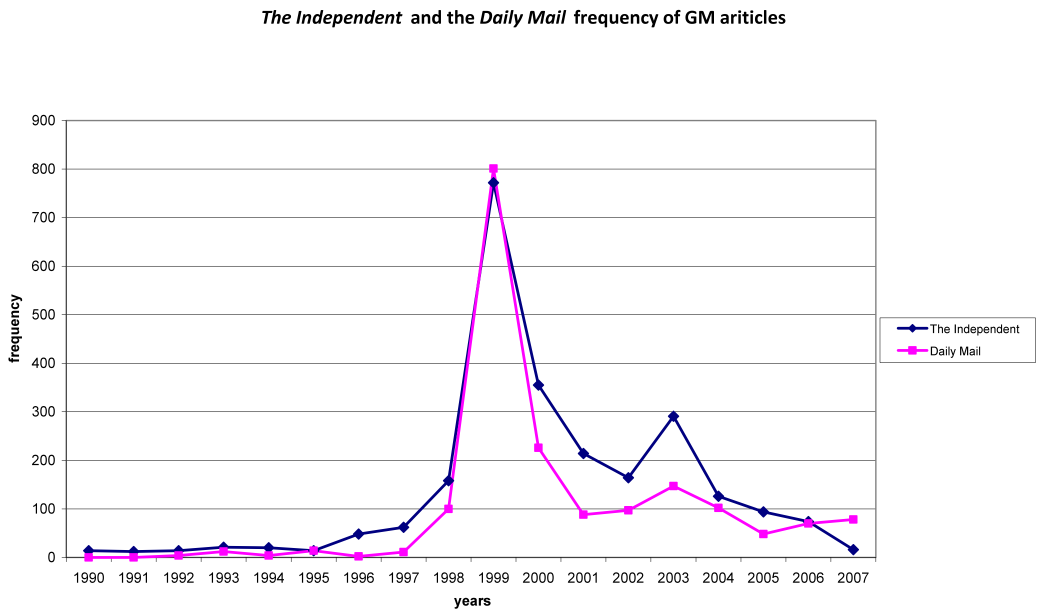
| Italy Field trials GMOs | Total Frequency | 1st Generation GMOs | 2nd Generation GMOs | 3rd Generation GMOs | Basic Research | Don't Know |
|---|---|---|---|---|---|---|
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1993 | 7 | 7 | 0 | 0 | 0 | 0 |
| 1994 | 20 | 14 | 2 | 0 | 0 | 4 |
| 1995 | 39 | 35 | 4 | 0 | 0 | 0 |
| 1996 | 59 | 53 | 6 | 0 | 0 | 0 |
| 1997 | 33 | 30 | 1 | 0 | 0 | 2 |
| 1998 | 49 | 42 | 3 | 0 | 4 | 0 |
| 1999 | 35 | 29 | 3 | 0 | 3 | 0 |
| 2000 | 20 | 18 | 1 | 0 | 0 | 1 |
| 2001 | 1 | 0 | 1 | 0 | 0 | 0 |
| 2002 | 11 | 6 | 2 | 0 | 3 | 0 |
| 2003 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 3 | 2 | 1 | 0 | 0 | 0 |
| 2005 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 278 | 237 | 24 | 0 | 10 | 7 |

**Appendix 5**

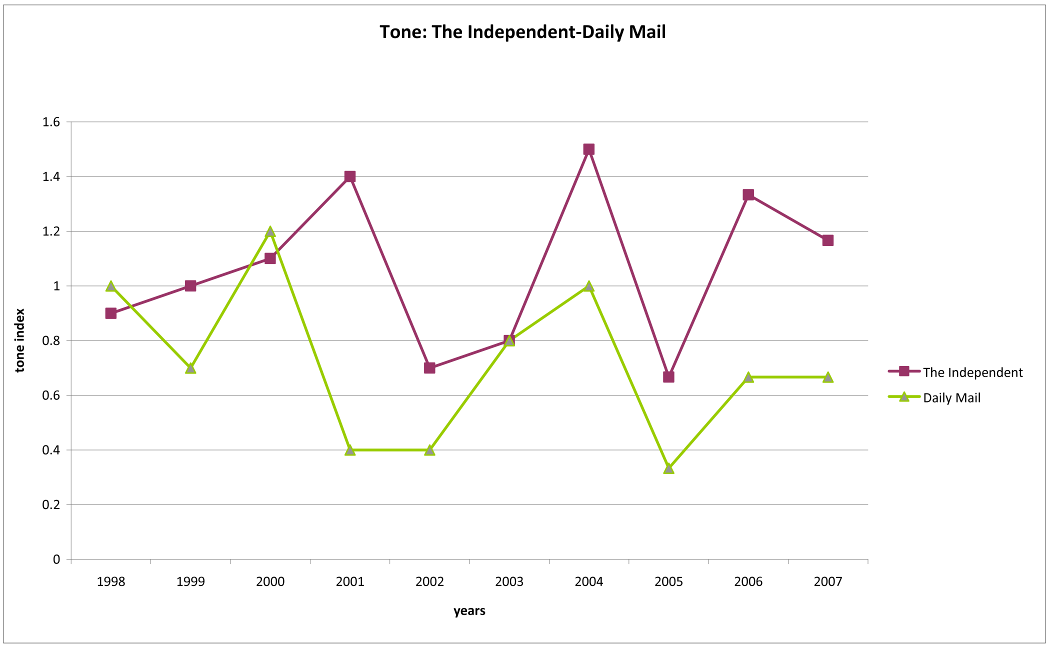
Daily Mail - The Independent

| *Frequency coverage* | *The Independent* | *Daily Mail* |
|---|---|---|
| **1990** | 14 | 0 |
| **1991** | 12 | 0 |
| **1992** | 14 | 4 |
| **1993** | 21 | 12 |
| **1994** | 20 | 4 |
| **1995** | 14 | 14 |
| **1996** | 48 | 2 |
| **1997** | 62 | 11 |
| **1998** | 158 | 100 |
| **1999** | 772 | 801 |
| **2000** | 355 | 226 |
| **2001** | 214 | 88 |
| **2002** | 164 | 97 |
| **2003** | 291 | 147 |
| **2004** | 126 | 102 |
| **2005** | 94 | 48 |
| **2006** | 74 | 70 |
| **2007** | 16 | 78 |
| **Total** | 2,469 | 1,804 |

| *Tone coverage* | *The Independent* | *Daily Mail* |
|---|---|---|
| **1998** | 0.9 | 1 |
| **1999** | 1 | 0.7 |
| **2000** | 1.1 | 1.2 |
| **2001** | 1.4 | 0.4 |
| **2002** | 0.7 | 0.4 |
| **2003** | 0.8 | 0.8 |
| **2004** | 1.5 | 1 |
| **2005** | 0.67 | 0.33 |
| **2006** | 1.33 | 0.67 |
| **2007** | 1.16 | 0.67 |



The Independent and the Daily Mail frequency of GM ariticles
900
800
700
600
500
400
300
200
100
0
frequency
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
years
The Independent
Daily Mail

Tone: The Independent-Daily Mail
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
tone index
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
years
The Independent
Daily Mail

**Appendix 6**

| Interview main phases | Questions guide |
|---|---|
| Phase 1) To understand the interviewee's experience with GM plants, how he got involved with it, when and why… | a) What happened with the arrival of GMOs in Italy/UK?<br>b) Have you noticed changes with GMOs (regulation, media, public attitudes, conversations etc) in Italy/UK over the last 18 – 20 years? What do you as a scientist think about GMOs, and more in general what do you think scientists in Italy think about this topic? |
| Phase 2) To understand public opinion, in itself and in relationship with GMOs | c) What, in your opinion, do people think in Italy/UK about GMOs?<br>d) How relevant have their thoughts been for scientists (their approach to GMOs issues) and for the development of research (refer here to publications, patents and field trials) in Italy/UK?<br>e) Could you recollect the main issues that people tend to raise when they approach GMOs?<br>f) How significant/valid do you think these issues are for you as scientist, for scientists in general and for the government?<br>g) When, and if, has public opinion started to become relevant in regarding to GMOs?<br>h) What do you think are currently the main issues of public opinion in Italy/UK?<br>i)How has that influence been manifested … Regulation; change of funding streams; change of research topic; decline in trial applications, change of communication about the topic; leaving this research field altogether; other?<br>j) If and how scientists have perceived the influence of public opinion. e.g. mass media, conversations with colleagues, conference events, street protest etc<br>k) As soon as the interviewee refers to public opinion ask to explain what he means by that. How do you think public opinion manifests itself in our society? Do you think newspapers are influenced by public opinion or maybe they influence it, or both? Why? |
| Phase 3) to understand the GMO biotechnology situation in relation with policy, funding procedures etc | l) Ask about how funding for research is usually distributed in Italy/UK, and if the interviewee thinks that with GMOs something has changed within the funding and policy realms. |

**Appendix 7**

**RESEARCH ETHICS REVIEW CHECKLIST**

This checklist should be completed for every research project that involves human participants, personal, medical or otherwise sensitive data or methodologically controversial approaches. It is used to identify whether a full application for ethics approval needs to be submitted. The research ethics review process is not designed to assess the merits of the research in question, but is merely a device to ensure that external risks have been fully considered and that an acceptable research methodology has been applied. This checklist applies to research undertaken by *both* staff and students, but it should be noted that the way the checklist is processed differs between these two groups.

**For staff**: if a full application is required please ensure that you complete the Ethics Review Questionnaire for Researchers and send the completed form to Michael Nelson in the Research and Project Development Division (RPDD).

Please accompany the questionnaire with a copy of this checklist and a copy of the research proposal.

**For MSc/PhD students**: if a full application is required please ensure that you complete the Ethics Review Questionnaire for Researchers and discuss the issues raised with your student supervisor in the first instance. You should ensure that the completed forms are accompanied with a copy of the research proposal to ensure that your supervisor can make a fully informed decision on the ethical implications of the research. Where the supervisor is satisfied that all ethical concerns have been addressed s/he must sign the checklist and ensure that a copy is retained as a record of the decision reached. It is appreciated that in certain cases the student supervisor may not be able to reach a decision on the ethical concerns raised. In such instances the matter should be referred to the Research Ethics Committee (please send all relevant forms and a copy of the proposal to Michael Nelson in RPDD).

**For undergraduate students**: After completing the checklist, undergraduate students should discuss any issues raised with their supervisor in the first instance. If fully satisfied with the research proposal, the supervisor can sign the checklist on behalf of the department. A copy of the signed form should be retained by the department as a record of the decision reached. It is appreciated that in certain instances the student supervisor may not be able to reach a decision on the ethical concerns raised. In such instances the application for ethics approval should be referred to the Research Ethics Committee (please send all relevant forms and a copy of the proposal to Michael Nelson in RPDD).

**Before completing this form, please refer to the LSE Research Ethics Policy.** The principal investigator or, where the principal investigator is a student, the supervisor, is responsible for exercising appropriate professional judgement in this review. For students, your supervisor should be able to provide you with guidance on the ethical implications of the research project. If members of staff have any queries regarding the completion of the checklist they should address these to Michael Nelson (RPDD) in the first instance.

This checklist must be completed before potential participants are approached to take part in any research.

**Section I:**

**Applicant Details**

| | |
|---|---|
| Name of researcher: | Valentina Amorese |
| Status(delete as appropriate): | PhD Student |
| Email address: | v.amorese@lse.ac.uk |
| Contact address: | 329 B Acton Lane<br>W3 8NU |

| | |
|---|---|
| Telephone number: | 07766013304 |

## Section II: Project Details

| |
|---|
| Title of the proposal: From Public Understanding of GMOs to Scientists' Understanding of Public Opinion. A case study of the listening capacity of scientists in the UK and Italy.<br>Brief abstract:Taking the case of GMOs in Italy, and the UK this study asks if, how and under what conditions scientists listened to public opinion. |

## Section III:

### Student Details:

| | |
|---|---|
| Details of study: | PhD Thesis |
| Supervisor's name: | Sarah Franklin and Carrie Friese |
| Email address: | S.Franklin@lse.ac.uk; C.friese@lse.ac.uk |
| Contact address: | BIOS Centre LSE Houghton Street London WC2A 2AE Room V1100, Tower 2, 11th floor |

## Section IV: Research Checklist

## Consent

| | Yes | No | Not certain |
|---|---|---|---|
| Does the study involve participants who are in any way vulnerable or may have any difficulty giving consent? *If you have answered yes or are not certain about this please complete Section 1 of the Research Questionnaire.* | | X | |

| | | | |
|---|---|---|---|
| *As general guidance, the Research Ethics Committee feels that research participants under the age of 18 may be vulnerable.* | | | |
| Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in public places) *If you have answered yes or are not certain about this please complete Section 1 of the Research Questionnaire.* | | **X** | |

**Research Design/Methodology**

| | | | |
|---|---|---|---|
| Does the research methodology use deception? *If you have answered yes or are not certain about this please complete Section 2 of the Research Questionnaire.* | | X | |
| Are there any significant concerns regarding the design of the research project?<br><br>a) If the proposed research relates to the provision of social or human services is it feasible and/or appropriate that service users or service user representatives should be in some way involved in or consulted upon the development of the project?<br><br>b) Does the project involve the handling of any sensitive information?<br><br>*If you have answered yes or not certain to these questions please complete Section 3 of the Research Questionnaire.* | | X<br><br>X<br><br>X | |

**Financial Incentives/Sponsorship**

| | | | |
|---|---|---|---|
| Will the independence of the research be affected by the source of the funding? *If you have answered yes or not certain about this please complete Section 4 of the Research Questionnaire.* | | X | |
| | | X | |

| | | | |
|---|---|---|---|
| Are there payments to researchers/participants that may have an impact on the objectivity of the research? *If you have answered yes or not certain about this please complete Section 4 of the Research Questionnaire.* | | | |
| Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants? *If you have answered yes or not certain about this please complete Section 4 of the Research Questionnaire.* | | X | |

**Research Subjects**

| | | | |
|---|---|---|---|
| Is pain or more than mild discomfort likely to result from the study? *If you have answered yes or not certain about this please complete Section 5 of the Research Questionnaire.* | | **X** | |
| Could the study induce unacceptable psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life? Will the study involve prolonged or repetitive testing? *If you have answered yes or not certain about this please complete Section 5 of the Research Questionnaire.* | | **X** | |
| Are drugs, placebos or other substances to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind? *If you have answered yes or not certain about this please complete Section 5 of the Research Questionnaire.* | | **X** | |

**Risk to Researchers**

| | | | |
|---|---|---|---|
| Do you have any doubts or concerns regarding your (or your colleagues) physical or psychological wellbeing during the research period? *If you have answered yes or not certain about this please complete Section 6 of the Research Questionnaire.* | | **X** | |

**Confidentiality**

| | | | |
|---|---|---|---|
| Do you or your supervisor have any concerns regarding confidentiality, privacy or data protection? *If you have answered yes or not certain about this please complete Section 7 of the Research Questionnaire.* | | X | |

**Dissemination**

| | | | |
|---|---|---|---|
| Are there any particular groups who are likely to be harmed by dissemination of the results of this project? *If you have answered yes or not certain about this please complete Section 8 of the Research Questionnaire.* | | X | |

If you have answered **no** to all the questions, staff members should file the completed form for their records. Students should retain a copy of the form and submit it with their research report or dissertation.

If you have answered **yes** or **not certain** to any of the questions you will need to describe more fully how you plan to deal with the ethical issues raised by your research. You will need to answer the **relevant** questions in the Ethics Review Questionnaire for Researchers form addressing the ethical issues raised by your proposal. Staff should ensure that the completed questionnaire is sent to Michael Nelson in RPDD. Students should submit their completed questionnaire to their supervisor in the first instance. It will be at the discretion of the supervisor whether they feel that the research should be considered by the Research Ethics Committee.

Please note that it is your responsibility to follow the School's Research Ethics Policy and any relevant academic or professional guidelines in the conduct of your study.

This includes providing details of your proposal and completed questionnaire, and ensuring confidentiality in the storage and use of data.

Any significant change in the question, design or conduct over the course of the research should be notified to Michael Nelson in RPDD.

I have read and understood the LSE Research Ethics Policy and the questions contained in the Research Checklist above.

**Academic Research Staff**

| |
|---|
| Principal Investigator Signature: |
| Date: |

**Undergraduate/MSc Student/PhD Student**

| |
|---|
| Student Signature: |
| Student Name (Please print): Valentina Amorese |
| Department: Sociology |
| Date: |
| Date of Research Ethics Seminar attended: December 2007 June 2008 |

| |
|---|
| Supervisor Signature: |
| Supervisor Name (Please print): |
| Department: |
| Date: |