Session 3A

Sociological and Ethical Issues Associated with Crop Protection

An International Perspective

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Sociological and ethical issues associated with crop protection: An overview

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Most current crop protection meetings are inevitably dominated by discussions of the chemistry or the effectiveness of crop protection materials, sometimes by consideration of their associated economics or how they might integrate into a farming system and increasingly their environmental impact. However recent public debates about the use of pesticides and the types of agriculture which have developed because of pesticide use, bystander exposure, pesticide residues in foods and the debate about the acceptability of food derived from Genetically Modified (GM) crops have addressed very different issues. These public debates have centred on ethical issues and on factors which are clearly sociological rather than technical or even economics based.

In Western Europe and in some other parts of the world the current major limitations to novel chemical or genetic approaches to crop protection are not technical but relate to public acceptance and increasingly to what is considered ethical within a particular society. The papers given in this session all aim to explore issues of this type. Although the public will have views on how agriculture as a whole and crop protection in particular should be practiced at the end of the day what is proposed must be able to be delivered. Societal views must be rationalised in the context of practical crop protection, real problems and currently possible solutions.

The above issues can be visualised in the form of a grid. The columns are represented by the issues which are subject to debate by the public at least those in the westernised world and within the wider crop protection industry, including those who must produce food in economic quantities and of acceptable quality. Currently these relate to types of agriculture and include organic farming, the growing of genetically modified crops and the use of pesticides as the basis of crop protection. The rows then become the major issues related to the above in respect of key crop protection targets, public perception of the main ethical issues associated with available approaches and the technical solutions currently being considered.

An approach of this type has the additional advantage of allowing agriculture as practised in different parts of the world and agriculture with very different histories and that working in different environments to be considered on the same basis. This matters because it is clear that in different areas of the world these issues are perceived very differently. Understanding what are these differences and why they exist is important and critical to the development of international trade. Why are pesticides, which have done so much to reduce the cost and increase the availability of foods regarded with such suspicion by so many in western society? Why are the risks associated with the use of pesticides considered to be so much more important that the apparently higher risks linked to travel on the roads or the use of a mobile phone? Why is the USA so content with GM crops while Western Europe looking at the same facts has so decisively rejected them? Selection of countries/ geographical areas will influence the out come of the discussion and so to make comparisons it is necessary to focus on countries with similar overall objectives in relation to their agriculture. Consideration of agriculture in Europe and North and South America

provides a suitable basis for evaluation. Clearly this does not provide the basis for a truly international evaluation and it restricts the comparison to a limited range of crops and farming systems. It does however provide comparisons within geographic areas where the debates about the use of pesticides and genetically modified crops are most active at this time. Arkansas in the USA is a state a state whose agriculture is dominated by Soya and maize and which has, as a result, been at the forefront of the use of GM technologies.

Argentina was an early user of GM technology but subsequently this approach has not been without its technical problems. In addition Argentina has a significant organic farming industry, Austria is the EU member with the most highly developed organic sector and some of the strongest anti GM views in the EU. France has remained ambivalent about the issues. Bulgaria is a relatively recent entrant to the EU. It has been used as a pilot area for GM crops within Europe although much of its agriculture remains traditional. All of these countries have common elements, e.g. similar crops and production systems, in their agriculture but have currently reached very different positions in relation to their balances of organic agriculture and agriculture which depends on the use of pesticides supplemented by the use of genetically modified crops.

Although the introduction of GM crops tends to have featured most highly in popular debate the use of pesticides remains an issue which affects much larger areas of current agriculture. For the foreseeable future most of agriculture in most westernised countries seems likely to depend on the use of pesticides. Exploring the basis of current public distrust of this technology thus remains important. Until relatively recently the introduction of new chemicals depended exclusively on their ability to solve significant problems, to work in a dependable manner and to have relatively few detrimental effects on heath or the environment. This is no longer the case. On the basis that such public views and public consideration of ethical issues now represent some of the most formidable blockages to the introduction of new chemical or transgenic solutions the papers in this session provide a means of assessing which approaches are likely to receive public acceptance in the future and why some approaches which are acceptable on the basis of technical criteria seem likely to be vetoed by consumers on ethical grounds.

Sociological and ethical issues associated with crop protection in Austria: consumers prefer organic and GMO-free foodstuffs

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Currently, Austria has the most highly developed organic sector among the EU member states as well as worldwide: approximately 15% of total acreage is cultivated organically according to the EC regulation 2092/91. The demand of Austrian consumers for organic foodstuff is increasing and cannot be fully covered by domestic production, especially fresh vegetables and fruits have to be imported. Supermarkets provide around 80% of organic supply. Public and municipal authorities increasingly use organic foodstuff, especially the City of Vienna buying 50% of organic meal components for kindergartens and 30% for hospitals and retired peoples´ homes.

Recent polls of consumers´ attitudes towards organic foodstuff are headed by the demand of 'healthy' products, followed by 'regional' and 'unsprayed' ones. Despite the success story of trading organics in Austria, there are certain deficiencies on the producers´ side, often due to insufficient plant protection measures, especially in field-grown vegetables, fruits and wine. Due to the ban of synthetic-chemical pesticides according to EC regulation 2092/91, only a very limited choice of direct plant protection agents from the so called 'positive list is available for organic farmers. It is mainly copper and wettable sulphur against plant diseases and natural-derived pyrethrum, azadirachthine (neem), *Bacillus thuringiensis* (BT), potassium soap and a few virus and entomopathogen preparations against insect pests. Therefore, plant protection in organic agriculture (not to be used synonymously with classical biological control) has to be backed on an alternative approach, the so-called 'plant protection pyramid': the broad basement are cultivation techniques derived from 'good agricultural practice', like proper choice of cultivars, crop rotation and soil cultivation, overlaid by the enhancement of so-called 'agro ecological infrastructures' (i.e. hedges, flowering strips etc.) for strengthening the self-regulatory capacity of the agro-ecosystem. The third layer of the pyramid consists of mechanical and biotechnical measures (e.g. pheromone distraction technique), whereas direct control by spraying alternative pesticides is the narrow top of the pyramid. In general, integrated fruit and wine production systems follow a similar approach, but contrary to organic systems, they finally can rely on a sufficient choice of chemical pesticides when the crops are threatened earnestly.

Significance of plant protection in Austrian organic plant production increases with the degree of specialization. In field crops, usually only a few diseases and pests cause significant damage in certain years and regions, e.g. phytophthora, Colorado beetle and wireworms in potatoes. Whereas the first ones can be controlled more or less sufficiently by spraying copper and a BT preparation, respectively, the latter up to now lacks any direct control measure. Against soil- and seed-born diseases (e.g. bunt, *Tilletia caries*), prevention by exclusively using certified seeds as well as keeping strictly to hygienic measures in case of already infested crop has to be followed in organic cereal production. Weeds can be regulated sufficiently by mechanic measures. In field-grown vegetables, especially of cruciferous crops, broader spectrums of pests occur regularly. Only a certain number of which can be controlled by BT, neem or potassium soap.

In orchards, apple codling moth and apple scab are the main plant protection problems controlled by granulose virus and copper, respectively, whereas in organic wine production oidium infestations are sprayed more or less regularly with wettable sulphur.

Generally, in the majority of main pests and plant diseases, there is a great need for researching and implementing species-by-species control strategies emphasizing a systemic approach of preventive and indirect control measures, direct control by spraying only to be included as a 'last exit' measure. A few current research projects in organic plant protection conducted by Bio Forschung Austria are presented briefly: control of broad-leaved docks (*Rumex obtusifolius*) by reducing cultivation intensity and enhancing the dock leaf beetle (*Gastrophysa viridula*) in grassland farms, preventive wireworm control by monitoring species composition and age-structure of wireworm populations for risk assessment, hover-fly enhancement by flowering-strips for natural aphid control in field crops. Only a few of these strategies are already implemented successfully in practice, like flowering strips in orchards in Switzerland.

The second part of the paper deals with the current public reflection of GMOs in Austria. Besides increased yields, the main pro-argumentation for introducing GMOs in crop field production is based on advantages in plant protection. As voted in a recent petition for a referendum, the majority of Austrian population generally rejects the consumption of GMO-derived foodstuffs. Following these consumers' demands, the leading Austrian dairies recently have decided for GMO-free milk production lines from conventional as well as organic agriculture. This can be achieved more or less easily since the rather small-scale dairy production in Austria is based mainly on domestic fodder obtained by haying, silage and grazing. More difficult is the situation in Austrian meat production, especially of pork and turkey: here an estimated 90% of imported soya-fodder are already derived from GMO-crops.

Besides the duty of declaration for foodstuff containing more than 0.9% of genetically modified substances in accordance with EC-law, Austria has the following specific national regulations concerning GMOs: According to the law of genetic engineering, any genetically modified substances need admission for release. If admitted, genetically modified substances require notification if to be released. Currently however, no admission for the release of genetically modified seeds as well as farm animals exists in Austria. According to the law of seeds, a threshold of 0. 1% contamination with GMOs hold for seeds. Further on there is a directive for the production of foodstuffs with the declaration 'GMO-free' in the framework of the Codex Alimentarius Austriacus, including feeding stuff.

Up to now the question of responsibility in the frame of the so-called coexistence is unregulated, i.e. when GMOs are transmitted into crops, where there application is prohibited, namely in organic and declared GMO-free production systems. This is especially a problem in oilseed rape, where pollen of genetically modified cultivars might be wind-blown over large distances and might cause cross-breeding into conventional cultivars.

In conclusion, for the Austrian agriculture organic farming and GMO-free production are economically crucial production lines corresponding with the consumers' expectations. Therefore currently, in omitting ideological discussions, proper legislative requirements for these alternative production lines are generated in Austria.

Public perception and technological approaches to crop protection in the south-eastern USA

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Like agricultural producers across the globe, farmers throughout the south-eastern USA are constantly dealing with the negative impacts of weeds, pathogens, and arthropod pests. Economic concerns and market issues, environmental safety, and human health are all factors that contribute to the decisions that growers make in how to deal with these pests.

In Arkansas, rice and soybeans dominate as the two largest food crops in terms of area and total monetary value. In 2005, rice was grown on 1.6 million acres in Arkansas, representing almost one-half of all the rice grown in the USA. Soybeans were planted on 3.1 million acres in Arkansas during that same year. However, Arkansas is like most south-eastern US states having variable landscapes and growing conditions across the state. Therefore, other row crops such as wheat, corn, and sorghum are grown, as are important fruit and vegetable crops like tomatoes, tree fruits, grapes, blackberries, spinach, and others. In addition, cotton is produced throughout the region.

Awareness and concern by consumers of the potentially harmful environmental and health effects of synthetic pesticides have altered many crop protection practices in recent years. An example of the difficulties faced by growers in transitioning away from chemical controls is illustrated in the case of methyl bromide. This compound has been used for many years to treat soils as a broad-spectrum fumigant control for pathogens, insects, and weeds. Although it is effective in controlling pests, it is a toxic compound and leads to ozone depletion. For these reasons, the use of methyl bromide is being phased out in the USA. The importation and production of this compound was banned by the US Environmental Protection Agency in 2005, although it still can be applied. Unfortunately, in some cases this chemical represents the most effective control measure for some pests on some crops. In the absence of an effective control of pathogens that might be entrenched in a region, the only alternative that growers have is to not plant susceptible crops. Switching to other crops is often not viewed as an economically feasible option and so some growers will continue to use such chemical controls whenever possible. Growers face a considerable difficulty in decisions of whether to use chemical controls. Pests cut into yields and profits and so they need to be controlled by effective means. Although chemical pesticides are generally viewed as dangerous, consumers want clean, attractive, and inexpensive foods. They are not always willing to pay the premium price that accompanies more expensive control methods or to accept foods that might be of lower quality. Agrochemical companies continue to develop new chemical controls, but this is an expensive endeavor wrought with difficulties in terms of regulatory and economic constraints. It is likely that conventional growers of food crops will continue to rely heavily on synthetic chemicals to manage pests, but that future emphasis will be on developing safe and environmentally friendly controls.

Genetically modified transgenic (GMO) soybeans with enhanced herbicide resistance now make up the vast majority of the soybeans grown in the USA. Likewise, GMO corn and cotton expressing BT-toxin genes for insect control are also widely used. Growers have adopted these GMO-based technologies rapidly as they are effective and lower inputs in terms of pesticide use and fuel costs associated with passes through the field.

In general, surveys of US public opinion of GMO food products show high acceptability. However, overall awareness of the technology behind GMO plant products is also low, and so the technology has been successfully applied in some cases. An interesting exception to this is the case of GMO rice in the USA. Almost all of the soybeans grown in the USA carry the transgene for glyphosate resistance, making them RoundUp Ready. A similar approach of developing herbicide resistant GMO rice has been tested and the rice lines have been produced. However, these LibertyLink varieties, expressing resistance to the herbicide glufosinate, have not been grown in the USA for commercial use. In 2006, it was discovered that a very low level of the LibertyLink transgene was present in samples of USA rice. Some of these samples were discovered after they had been shipped to Europe, while others were found in storage in the USA. An outcry from foreign markets and consumers in the USA and abroad led to temporary bans of shipment of USA-grown rice to the EU countries. This situation provides an interesting paradox involving the two major crops of Arkansas. Both GMO soybean and rice were developed to be herbicide resistant. RoundUp Ready soybeans are widely grown and consumed, whereas there is essentially zero tolerance for growing LibertyLink rice. The reasons for these differences are many and they are not always clear. However, market desires are an obviously critical factor. Consumer awareness of how food products are produced and distributed may also play a role. Although soybean components make their way into many prepared foods in the form of oils, flour, and other fractions, consumers do not seem to be concerned that these might have originated from GMO plants. Rice grain, on the other hand, is often consumed after limited processing. This closer association with the plant product as a food might explain the tendency to reject some GMO foods. Foods that are directly consumed, such as rice, apples, and tomatoes have often met with opposition when they are delivered in a GMO form. Whereas soybean, cotton, and corn, which are typically consumed by humans after considerable processing, have found their way into US and world diets with less opposition.

Certainly, GMO products aimed at pest control will continue to be developed. One of the greatest threats to continued success of this technology is the selection of resistant populations of pests that come with using insect- or herbicide-resistant crops across large areas. The emergence of glyphosate-resistant weeds and BT-resistant insects is a growing problem. Future GMO products will likely rely on stacking of multiple transgenes to control development of resistant pests. In addition, developing technologies such as marker-free selection of transgenic plants might have more appeal for consumers.

Since 1997, the organic food industry has experienced annual growth ranging between 15-20%. In 2005, the $13.8 billion (USA) in organic food sales represented about 2.5% of the total of USA food sales. Control of pests can often be the deciding factor that determines whether a given crop can be grown in a local area or region using organic methods. Small scale, local growers tend to utilize more labor intensive methods for pest control. The growth of organic sales has attracted many more industrial scale producers, who by necessity adopt more automated controls or simply grow their plants in areas where the major pests on a crop are less of a threat. The tremendous growth in sales of organic foods is an obvious indicator of the desire of consumers to obtain foods that they consider healthy and safe. As acreage of organic production continues to rise, difficulties in controlling pests using approved methods will also increase. There are efforts in the USA research community to enhance sustainable control practices and to use integrated pest management schemes. The economic benefits to organic growers and industry will likely drive development of new technologies that are effective and fall within regulatory limits.

Genetically Modified Organisms (GMOs) in Bulgarian agriculture

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Bulgaria, one of the newest members of EU, occupies an area of 111 000sq. km with a population of approximately 7 800 000. Agricultural land is 5 885 500ha. Bulgaria is a traditional producer of agricultural goods. In 2005, agriculture contributed 13% of GDP employing 26% of the population. Agriculture is one of the few branches in the national economy where exports exceed imports.

In Bulgaria conventional agriculture is still predominant. In 2006 among the principal crops about 62% of the agricultural land was used for growing of cereals; 31% oleaginous crops; 5% forage; 2% industrial crops. The production of wheat takes a leading position and totals 3 301 882t with an average yield of 3 403kg/ha, followed by maize (1 587 805t) and sunflower (1 196 570t). Recently there have been no significant deviations in production with the exception of the continuously increasing sector of energy crops – mainly rape. The substantial use of fertilizers and crop protection chemicals is common practice in Bulgaria. For example, in 2006, 89% of the area sown with wheat was treated with nitrogen containing fertilizers (phosphorus – 9%, potassium – 4%). In relation to crop protection chemicals the corresponding figures were: herbicides – 80%; insecticides – 14%; fungicides – 16%.

Traditionally, high quality vegetable crops are grown in Bulgaria and form an important part of the diet. Usually the farms are small (up to 10ha) although since democratization these are often included in private collectives. In 2006, 71 008ha were used for vegetable production. The yields of common vegetables are as follows: 212 969t tomatoes; 156 684t peppers; 51 300t cucumbers - only 2% of these were produced under protected cultivation. Recently, vegetable production is decreasing, mainly due to the import of cheaper but low quality goods from FYR Macedonia and Turkey. The problem is additionally complicated by crop diseases on a mass scale, and the low quality of the planting material. The traditionally vigorous Bulgarian agriculture, generally speaking, is slipping into a period of crisis, which requires urgent legislative and financial measures to be taken.

Organic farming
At the moment organic farming in Bulgaria plays a small part in agriculture – 0.2%. However, in the national strategy plan for the development of agriculture for the period 2007-2013 it is envisaged that organic farming will occupy at least 8% of the agricultural land. In Bulgaria there are very good preconditions for the development of organic farming – favorable climate, legislation, and a positive attitude of consumers. Organic farming, especially in the mountainous and hilly regions can be naturally linked with eco-tourism and other related activities, which will be of value for solving the social problems associated with unemployment and depopulation of these places in Bulgaria.

Biotechnological farming

According to ISAAA, almost one third of the agricultural land in the world is used for growing of biotechnological crops, and there is a 20-25% yearly increase. Until 2005, all permissions for field growing of GMOs in Bulgaria were issued by the Council for Biosafety of Genetically Modified Higher Plants. The main genetically modified crops grown in Bulgaria are maize, potato and sunflower. Maize (by Monsanto, Pioneer, Novartis) was grown as follows: 1999 - 13 000ha; 2000 - 19 000ha; 2001 - 6 400ha; 2002 - 2 200ha; 2003 - 2 120ha. The modification characteristics of maize are the *Bt* gene alone or in combination with resistance to the herbicide glyphosate.

The first field experiments with Bt-potato 'Superior New Leaf' were conducted by Monsanto in 1999 - 30ha; 2000 - 3ha; 2001 - 3ha. Limited field experiments with sunflower with resistance to the fungal disease *Sclerotinia* (Monsanto) were performed in 2000. At no time were the volumes of GMOs a large proportion of the total – albeit, substantially more than in W. Europe. The fact that the growing of these crops met little opposition early on can be attributed to a number of factors – all arising from the emergence from more than four decades of communist dictatorship. Thus, the free media were not well developed – so, a lack of information and debate. Equally, there was reluctance by people to speak out, as under the old regime this would have had serious repercussions.

Recent state of Bulgarian legislation

The development of a legislative system for regulation of the use of GMOs in Bulgaria was initiated as early as 1991. However, the regulations were widely drawn and applied elastically. The fact that the government agencies responsible were also involved in trials led to accusations from pressure groups that 'The fox was guarding the hen-coop' Under pressure from environmental groups such as ANAPED and EcoSouthWest, in 2005 a new law regarding GMOs was passed – probably one of the most restrictive laws on a world scale and considerably more stringent than EU rules. However, a strong body of opinion claims that the new laws were prepared without regard to all dimensions of the problem and some of the scientific, commercial and sociological aspects were not taken fully into account. The law applies a number of restrictions: It is forbidden to release into the environment, or onto the market, genetically modified tobacco, vine, cotton, oil-yielding rose, wheat, and all vegetable and fruit crops. Curiously, some major crops – maize, soybean, rape – are not so regulated. It is forbidden to release any genetically modified organisms in the territories of the National Eco-Net, as well as in the adjacent areas covering a 30km of buffer zone. Laboratory experiments with some species like tobacco, widely used in scientific investigations, are also forbidden. As a rule, all molecular-genetic experiments must be carried out under a restricted regime after permission. As a result, since this law came into force (two years), no permits for field growing of GMOs have been issued, and no one laboratory has been licensed to work with GMOs. In fact, the law is preventing the extension of the biotechnological branch of agriculture and of scientific investigations commonplace in W. Europe.

Conclusion

Agriculture is a traditional sector in Bulgaria and appropriate regulations in this field are of considerable economical and social importance. According to the Common Agricultural Policy, agriculture in Europe will be developed on the basis of equal opportunity for conventional, organic and biotechnological farming and it is important that such an even-handed approach obtains in Bulgaria.

AG-Biotech from an Argentine perspective: a 'soybean republic' or a bet to the future?

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Argentina was among the first countries which put the biosafety regulations in place for the safe research, experimentation and deregulation of transgenic crops, micro-organisms and animals developed both locally and in other countries. First field trials were conducted in 1991 (see www.sagpya.mecon.gov.ar/new/0-0/programas/biotecnologia/index.php). First commercial releases (starting with glyphosate tolerant soybean and Bt maize and cotton) were authorized in 1996 and ending with stacked events and transgenic cows for pharmaceutical aims.

Since then, Argentinean soybean and, to a lesser extent, maize production underwent a dramatic increase (from 26 million tons in 1988/89 to over 90 million tons in 2006/07). Adoption of GM soybean rose from nothing in 1995 to almost 100 percent of the 15 million hectares grown in 2006/7. Every year, a new record of crop production gets established due to this success, to expansion of agricultural frontiers and good international prices for commodities. As a consequence, the Pampas agricultural sector succeeded in reversing labor dismissal trends and went on to generate new jobs. However, direct employment of farmers (especially small farmers) continued to diminish and, very likely, became more pronounced after massive adoption of GMO crops. Still, direct benefits of GMO crops for farmers were calculated to amounted more than 3k million dollars. Increase of jobs was mostly reflected in the related service activities and particularly in the oil and feed production ag-industry which ranks among the most competitive, worldwide.

During the recent and dramatic crisis of the Argentine economy, agricultural production was the locomotive of the ongoing recuperation and due to currency and banking crisis, the solidarity of the farmers with starving people in the cities was canalized through donation of soybeans instead of money. Soybean and maize export taxes are still the main single source of income for the Argentine government budget, which allows devoting important resources to social programs or to subsidy public transportation, for example.

In parallel, Argentina is one of the world most important producers and exporters of organic products. Although coexistence of organic and transgenic farmers is affected by strong ideological differences, it demonstrated to be possible in spite that, as a difference from Europe, actual regulations favor the competitiveness of the commodity production because, for example, organic farmers have to take care and assume the costs of isolation distances to avoid pollen flow or agrochemical contamination. Due to this, organic farming concentrates in species that have important premium prices (like flint maize for human consumption) or species for which no GM events were approved, yet (for example canola). Thus, organic soybean, for example, is only produced for very small special market niches like tofu production or soybean milk for human consumption.

This presentation resumes the benefits and limitations for producers as well as some of the environmental and social impacts associated with the introduction of GM technologies particularly the synergies between GM soybeans and maize with no-tillage technologies and negative environmental consequences due to agriculturization of marginal areas displacing native ecosystems.

As an item of interest for this specific congress, some results on the selection and molecular epidemiology of glyphosate resistant weeds and monitoring of insect resistance to Bt will be briefly commented.

It also explores on the putative negative consequences of the present evolution of EU regulations on the adoption of GM technology innovations generated by local scientists (like virus resistant maize) since internationalization is a requisite for their commercial release and thus to be applied by farmers in developing countries like Argentina. The uncertainty of European consumer reactions is the largest impediment for assessing the future potential of local GM technology in Argentine agriculture.

How are opinions about GMOs changing over time? The case in the EU and the USA

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This paper intends to examine changes in opinions on GMOs over the past ten or so years – a key issue, as divergences on the subject make it difficult to define common policies and can result in conflict. This examination will use the results of miscellaneous surveys as a basis for comparing viewpoints in the USA and the European Union (EU) countries. Changes in opinions on GMOs will then be analysed, firstly in the USA and then in the EU States. Lastly, the conclusion will analyse whether there is a certain convergence of views or quite the opposite, whether the gaps are static.

Transgenic crops were already planted on 102 million hectares throughout the world in 2006, but with a highly uneven distribution. Although cultivated in some twenty countries, the USA accounted for over half the surface areas whilst the EU had less than 1%. How can these variations be explained? Part of the surface distribution gaps between the USA and the EU would appear to relate to contrasting acceptability and differences of opinion over GMOs. There appears to be rather more anti-GMO feeling in the EU than the USA, but how are opinions changing over time? They can of course be modified as the years pass and differences between countries become blurred, or conversely they endure and even gain momentum. What are the noticeable changes either side of the Atlantic?

The sources and methods used to compile the opinions on GMOs and their evolution are presented in the preamble. The focus has been on comparing survey results recorded in different countries over time, without addressing the miscellaneous interpretations proposed. A sort of meta-analysis of quantitative data available on opinions in the USA and EU has been chosen, especially surveys and polls on representative samples between 1996 and 2006 and occasionally before that. To be able to compare the responses over time or in different countries, identical questions have to be asked, which is fairly rare. This means that despite the many polls on the topic of GMOs, their usable data has been considerably reduced faced with the need to compare responses to identical questions between countries or years. Attention has centred on the differences between countries rather than on the variations in opinion between the miscellaneous population categories within each one.

Comparing the results from miscellaneous surveys on GMOs and biotechnology on both sides of the Atlantic highlights the problems faced by this analysis, as identical questions are rare. Modifying the terms used can produce fairly pronounced differences. In particular, biotechnologies are often given a positive reception in Europe, whereas GM foods are relatively frequently viewed with suspicion, even in the USA. The miscellaneous international surveys show that the viewpoints on GMOs vary considerably from one country to the next as well as according to the applications involved. Some questions on GMOs reveal a not-insignificant rejection by Americans also, particularly over their potential introduction into the food chain. But there is always less anti-GMO feeling in the USA than in Europe and biotechnologies are always welcomed more warmly.

For the USA, surveys from several bodies have been used; they asked identical questions for several years and have circulated detailed results. One fact stands out: a significant

proportion of Americans have not heard of GMOs, or only very slightly. The views about biotechnology and genetic engineering are fairly positive, but optimism seems to be declining somewhat as the years pass. A fairly significant proportion – and one that seems to be growing steadily over the years – says it is against GMOs in the food chain.

In the EU, an opinion measuring tool has been introduced. The Eurobarometer regularly questions citizens in Member States on a variety of topics and several of its surveys have covered biotechnological applications and science and technology. European opinions towards biotechnology and genetic engineering have not evolved in a straight line: viewpoints tend to become more hostile between 1991 and 1999, whilst, conversely, improved opinions are noted between 1999 and 2005. Opinions do, however, vary strongly depending on the types of GMO and the applications put forward. Those involving biotechnologies in general or their medical applications are normally well received, but GM foods incite tremendous suspicion and clear opposition from part of the population. Opinions do seem to improve in some respects between 2002 and 2005, but this requires more in-depth analysis. The enlargement of the EU does not modify its views substantially, with the opinions of the EU-25 matching those of the EU-15 fairly closely.

Conclusion

Is there a certain convergence of opinions on GMOs, or is the gap still there, or even widening, between Europe and the USA? Analysing changes in opinions towards biotechnology, genetic engineering and GMOs over time and between miscellaneous countries is a highly difficult task, for the questions raised are frequently modified. The responses depend greatly on how the questions are asked. The various studies analysed show the points of view to be varied and contrasting; we can hardly talk about Americans always for and Europeans automatically against! The opinions are without doubt more favourable in the USA than in Europe, however.

It would seem that the opinion gap has diminished between the EU and the USA over the years, especially since the early 2000s, although clear differences still exist. There are two reasons for this. Firstly, opinions are less favourable in the USA in the first half of the 2000s than in the previous decade and there is a slight decline in optimism towards fallout from biotechnology and genetic engineering. The reverse is true in the EU, but here opinions have not evolved in a straight line: initially, viewpoints from 1991 to 1999 tend to become more negative, followed by a seemingly general improvement from 1999 to 2005.

These first conclusions are still provisional. Work must continue and explore the changes over time – between different countries and miscellaneous biotechnological and genetic engineering applications and lastly for the transgenic crops between the diverse types of traits introduced. These first results must be researched further, for a field as vast and complex as GMOs crystallises many questions in the opinion. However, the adoption of an agricultural innovation is linked to a range of economic, social, institutional and cultural factors. The future of GMOs on both sides of the Atlantic also depends on their characteristics, including new traits, and therefore on the industry's strategies in this field.

Reference

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