# VIEW OF STAKEHOLDERS ON GMOS IN BRAZIL: WHERE WE ARE NOW

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## *1. Introduction*

The Cartagena Protocol on Biosafety (CPB[4]) was the first multilateral initiative to regulate the international handling and transport of genetically modified crops (GMOs). It is based on the precautionary principle, present in the Rio Declaration of 1992, and promotes the conservation and sustainable use of biological diversity. Several Latin American countries have signed the CPB, many of which are regions home to important indigenous plants or contain plant diversity of economic interest. To comply with the protocol regarding issues of strictly technical/scientific nature and training decision-makers, the project Latin America: Multi-Country Capacity Building for Compliance with the Cartagena Protocol on Biosafety was proposed by researchers from Brazil, Colombia, Costa Rica, and Peru. In response to issues regarding communication and public awareness for capacity building, the project Communication and Public Awareness Capacity Building for Compliance with the Cartagena Protocol on Biosafety was proposed. These two projects together are called the LAC-Biosafety project.

The development of agricultural biotechnology is a complex process that involves the participation of different stakeholders, including public research institutions, universities, biotechnology companies, corporations in the agrochemical sector, farmers, the processing industry, retail chains, and the end consumer. The development of agricultural biotechnology relies on cooperation among these various stakeholders, and such cooperation, in turn, relies on the recognition of its benefits and risks, and therefore its safety for agricultural production (BORGES; SILVEIRA; OJIMA, 2010).

A factor that compounds the problem of agricultural biotechnology is that, unlike biotechnologies used in other areas, especially the area of human health, there is an asymmetry in the awareness of both their benefits and their safety. The first generation of GMOs was developed to meet the needs of farmers, such as the development of herbicide-tolerant soybeans as well as insect-resistant cotton and corn. Although studies show that these crops have provided economic benefits to farmers and the industry that produces genetically modified seeds as well as environmental benefits for society as a whole, especially in the reduction of chemical pesticides and increased efficiency in pest control, very few of these benefits are being recognized by end consumers (BORGES, SILVEIRA, OJIMA. 2010; WU, 2006, SHELTON *et al*., 2002).

A potential consequence of this asymmetry regarding the perceived benefits is that it may increase the awareness of and aversion to the risk presented by the technology. Several studies on risk awareness show that the perceived benefits are the main explanatory variable of awareness and rejection of technological risk: the lower the perceived benefits tend to be, the greater the risk aversion, and consequently the greater the rejection of the technology (STARR, 1969; SLOVIC 2000). Other important

[4] For more information on the Cartagena Protocol, visit this page: http://www2.mre.gov.br/dai/m_5705_2006.htm.

variables involved in explaining the public's behavior concerning technological risks are: confidence in institutions that analyze and manage the risks, the degree of familiarity with the technology, and the nature of the risk; for example, if the risk is voluntary or involuntary, known or unknown, individual or collective (SLOVIC, 1987).

GMOs have a variety of characteristics that may create an attitude of rejection by the public. First, since GMOs are an innovative technology, this raises concerns about their long-term impacts. Second, in many cases, the benefits are recognized by farmers and other stakeholders in the production chain, but little noticed by end consumers. Third, in many countries, such as those in the European Union, the emergence of GM crops coincided with a period of eroding public confidence in the institutions responsible for risk assessments (BERNAUER, 2003). Fourth, most GM crops currently produced were developed by private companies in the agrochemical sector. This may strengthen the risk associated with GM crops as an imposed (i.e. involuntary) risk for economic reasons (ADAMS, 2010).

Thus, a major challenge to institutions taking charge in the process of developing agricultural biotechnology is determining how to reduce the asymmetry of the public's perception of the benefits and safety of GM crops among the various stakeholders, especially the consumer.

The Cartagena Protocol aims to implement a set of actions to improve human and institutional resources in their role of participating in decision-making processes related to biosafety (Article 22) and public awareness and participation, which includes facilitating access to information on par with scientific standards (Article 23). Currently more than 180 countries have ratified the CPB. The Biosafety Clearing-House (BCH) established by the CPB can be accessed via their web site http://bch.cbd.int with information on biosafety for several countries. This site, with respect to the Brazilian data, is managed and powered by the Ministry of Foreign Affairs (MRE). The impacts of biosafety standardization and of the CPB in Brazil are the subject of frequent studies, foremost among them those of CORDIOLI (2008) and BORGES *et a*l. (2006). The LAC-Biosafety project was approved and financed by the international funding organization, the Global Environment Facility (GEF), with the aim of strengthening technical capabilities and promoting public awareness and communication regarding GMOs so that better informed decisions can be made.

In Brazil, the project is organized as a network of experts from universities and various branches of EMBRAPA, with a focus on Ministries of Agriculture, Environment and Science and Technology, under the coordination of EMBRAPA Environment. In 2010, there were 48 researchers with doctoral degrees working on the four major components into which the project is subdivided (gene flow, impact on non-target organisms, socioeconomic aspects, and communication and public awareness). The four crops selected for the study are indigenous to and/or a source of biodiversity in the four participating countries.

An electronic questionnaire was drawn up to be administered to the general public, while for civil society organizations, representatives of public agencies responsible for biosafety decision-making, and the most active opinion-makers regarding the issue, direct structured inquiry, i.e., in-depth interviews, were chosen. Drawing on the respondents' awareness surrounding the issue, during the interviews the research tried to take into account the analysis of the country's situation on the issue, the respondents' awareness of the project's initiatives and information needs for each organization consulted. In constructing the questionnaire the research sought a design that would allow the information collected to be used to assist decision makers in understanding the social and cultural environment of the country concerning the development and use of GMOs.

The focus of the paper is to present the initial results of multivariate analysis (correspondence analysis) applied to LAC-Biosafety survey data on Brazilian general public perception on Biotechnology and GMOs. It generates five groups of respondents regarding the perception of the use of GMO on food and health and shows that even for a varied group (the majority of whom are college graduates) GMOs are viewed with more reservation than other uses of biotechnology. This result allows qualifying the hypothesis that the main cause of the negative perception of GM crops is the lack of information

## *2.Genetically Modified Crops: Controversies and Their Consequences*

GM crops are radical technologies, defined as those that are divisive and affect many people, both directly and indirectly (HALL; MARTIN, 2005). Technologies with these characteristics can result in discussions, controversies, and much uncertainty. In the case of GM crops, these technologies have greatly politicized issues surrounding regulation and even the legitimacy of the use of this scientific and technological knowledge in many countries, including France, Brazil, Mexico, and Ethiopia. The politicization of the process of developing a technology is characterized by an excessive public aversion to risk which translates into demand for government policies to reduce risk. Therefore, the regulation of controversial technology is characterized by the strong influence that the public's perception of risk may have on the decisions of regulatory policy makers. This means that risk control policies can be adopted without evidence that risks do in fact exist (BORGES, 2010).

This was what happened during the first steps of the genetic modification of plants in Brazil (the conflicts and controversies that gripped the country between 1998 and 2002 will not be discussed here). Based on this experience, it can be noted that in order to promote public awareness regarding GMOs it is necessary to facilitate access to scientific information. Furthermore to be able to make decisions concerning controversial issues it is also important for those involved in public policy, both directly (regulators) and indirectly (civil society) to understand the issues clearly and to not passively watch the news media in their race to be the first to break the story; some organizations seek to report on only the

negative aspects while other segments of the community attempt to show only the positive aspects. This has led to a disinterest in the issues among the general public and in many cases has amplified uncertainty (fear) concerning advances in GMOs.

Controversy can be interpreted as a product of different moral choices related to lifestyle. Difference is a moral good of modern life that must be preserved (HABERMAS, 1989; COSTA-FONT et al, 2008). According to these authors, it is necessary to understand the factors that influence choice to better understand the process as a whole and thus adopt strategies and efficient regulations. When conflicting information arises concerning an issue (as has happened with GMOs in Brazil) the values of the individual or "subjective knowledge" will inevitably win out over other information.

Monteiro (2009) studied the controversy surrounding the GMO issue from a communication standpoint and proposed that there should be greater exchange of information between scientists and society to deal with controversial risks and that Forum for discussion should be created while making negotiations and decision-making transparent rather than attempting to do away with the controversy entirely. Different fields of science and communication – such as journalism, marketing, psychology, sociology, and philosophy – are dedicated to understanding the components of decision-making at both the individual and collective levels. Concerns surrounding the application of new biotechnology techniques (recombinant DNA or transgenic techniques) gave rise to bioethics, which can be defined as using ethics to understand conflicts linked to the technological innovations of the life and health sciences (SAADA, 2008).

Article 18 of the universal declaration on bioethics and human rights[5] recommends that decision-making processes be transparent, especially by explaining all conflicts of interest and sharing knowledge. Thus, as in Monteiro (2009), it is recognized that transparency and public awareness boost confidence in public decision-making (SOARES, 2003), including public international organizations such as the FAO, WHO, and the World Bank which have used and proposed methodologies seeking greater public participation in the implementation of new technologies. One well accepted model of the formation of consumer attitudes is the Fishbein Multi-attribute Model (FISHBEIN, 1963) which indicates that attitudes towards products are based not only on knowledge of the product itself but also on the attributes or values of the consumer.

Demand for better communication related to the issue of biotechnology as applied to agriculture has recently become a priority based on the results of the International Conference on Biotechnology in agriculture in developing countries. The event was organized by the FAO in March of 2010 in Mexico with representatives of most of the countries participating in the LAC-Biosafety project in attendance.

[5] http://unesdoc.unesco.org/images/0014/001461/146180por.pdf

Another component contributing to the difficult environment is the confidence (or lack thereof) in the information source. Trust is also a value of complex nature that impacts the perception of risk (FREWER et al. 2003; SLOVIC, 1987, LASSEN *et al*., 2002). Credibility and confidence must withstand the arguments of each group, each rooted in its own value system.

Concerning issues surrounding GMOs, risk is a major component of the controversy. The implicit question is: can transgenic plants affect the environment and the health of living beings? Risk science attempts to provide an answer. By definition, risk is a function of danger (or harm) and exposure, that is to say, risk is made up of two probabilities: the probability of the damage occurring and the probability of how much and how often we are exposed to the agent that causes the damage. Given the various ways in which damage may occur, many fields of science must come together for this analysis. Risk science, present in many areas, both social and political, is new to society and it seems to have become more explicit since the introduction of new technologies for use in society and is also subject to value judgments. As such, one should not expect disagreements about risk to become settled definitively merely due to the existence of evidence (ODA; SOARES, 2000; SLOVIC, 1987), given the subjectivity of the perceived risks and benefits by the public.

In Brazil, public opinion on GMOs has been investigated in several studies (FURNIVAL; PINHEIRO 2008; GONZALEZ et al., 2009; GUIVANT; 2006; MASSARANI; MOREIRA, 2005; VOGT; POLINI, 2003). Furnival and Pinheiro (2008) showed in a study with focus groups that, with rare exceptions, people do not know what GMOs are, but voiced suspicion of "ulterior motives" of those "defending" GM. According to the authors, the public understands that where there's smoke (controversy) there is fire (malicious intent). Studies have also been carried out examining the dissemination and communication of scientific knowledge in genetics, such as the project “Biotechnology in the Streets” Labjor / UNICAMP, and the Museum of Life developed by FIOCRUZ. EMBRAPA has also developed a pilot experiment on communication and public participation regarding GMOs in the Pilot Project of Environmental and Social Assessment of Risks of Genetically Modified Organisms (PAR) (GUIVANT et al., 2010) within the context of the GMO-ERA international project. This project again acknowledges that the transfer of knowledge, in and of itself, does not necessarily promote or enhance the understanding of the process or product.

## *3. Lac Biosafety Project: communication and public awareness strategy*

The adoption of GMOs was made possible particularly by the formation of the National Technical Commission on Biosafety (CTNBio) and the periodic review of biosafety regulation in Brazil. Society and those involved in public policy must review the existing regulation and modify it objectively to avoid initiatives which violate the information provided by risk analysis or fail to benefit biodiversity

conservation (BORGES *et al*., 2006). Regulatory systems must follow scientific developments in the pursuit of sustainable agriculture, including in Brazil, as was recently reported in Nature (2010).The strategy for achieving this goal resulted in a pilot communication plan with several initiatives to promote public awareness, knowledge sharing, and the exchange of results with other countries participating in the project.

In the Communication and Public Awareness component of the LAC-Biosafety project, communication is structured as a two-way process: the strategy takes into account the perspective of those involved in the use of technology as well as those affected by it, engaging them to achieve sustainable results in the strengthening of public awareness. To our knowledge this is the first project of its kind in Brazil, aiming to strengthen autonomy of choice and public awareness, promoting or increasing the understanding of the GMO process/product. The involvement of the general public, organized civil society, groups that influence public opinion and decision makers was the initial premise that was adopted. Initiatives to identify fears, attitudes, practices, expectations, knowledge, and beliefs as well as knowledge gaps and language use were considered because they are essential to achieving the proposed goals.

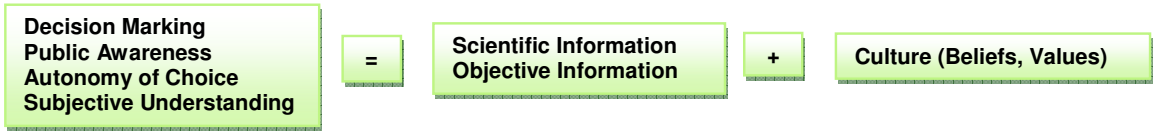
Along these lines, the communication products and training or information tools provided would take into account the results and information obtained from the other components in order to jointly strengthen decision-making due to the scientific basis of the results. Thus, the initiatives put forth by the project concerning the Communication and Public Awareness component should also take into account the results obtained from the other technical components of the project (gene flow, impacts on non-target organisms, socioeconomic aspects)

The challenge for the Communication and Public Awareness component of the LAC-Biosafety project was designing a communication plan for development that would strengthen public awareness and contribute to its sustainability as presented in the introduction. The objective is, prior to planning the communication strategy, to propose a model of consulting the public regarding the controversial issue surrounding the use of technological innovation – the case of genetically modified plants. The model detailed the following agenda: a) identify the information needs of stakeholders, their perceptions, fears and expectations, using the interview process and/or questionnaires; b) outline the strategic communication plan for strengthening decision-making capacity, both individually and collectively, based on needs identified above.

In neither of the initiatives should discussion or controversy be eliminated, but rather noted and described. The basis for the communication component of the project was the Cartagena Protocol, especially Articles 22 and 23, and the document "Communication for Development" (WB 2008, FAO 2009).

Figure 1 shows the conceptual framework from which the following were developed: the task of preparing the survey for the public; the guide for the interviews of representatives of selected organizations; and communications products. This conceptual model is based primarily on revisions of Costa-Font et al. (2008), Gracia (2003) and also on the Eurobarometer[6] that is used regularly to check public awareness of the member countries of the European community, including as it relates to biotechnology.

**Figure 1** Components of Decision-making




As a step in the development of a communication planning methodology, how the project would deal with/detect the awareness of the general public and civil society organizations involved with issues and decisions relating to biosafety in Brazil were discussed. Since the population is unevenly distributed in different regions of the country, and because there are limited financial resources and personnel to cover the whole territory, it was decided that the public awareness of biosafety of transgenic plants and its regulation would be addressed in two distinct formats, one being applied to the general public and other to decision makers or opinion leaders on the issue of biosafety.

An online survey with 15 questions was drawn up to be administered to the general public without discriminating based on the depth of their knowledge on the subject. This tool was developed with the goal of addressing cultural issues, identifying their knowledge of technology, practices, attitudes, and beliefs about GMOs and biosafety, and also identifying the needs of scientific information. The construction of this tool as part of the communication strategy, using the answers to online questionnaires, focused primarily on finding gaps in existing scientific information and on the lack of appropriate language used with different stakeholders in society.

## *4. Description of the Online Survey*

The purpose of the survey, as was already mentioned, was to obtain information about the general public's knowledge, sources of information, preferred information medium, perceptions, attitudes, expectations, and practices from the interviewees on the issue of the biosafety of GMOs. The formation of

[6] The European Union follows changes in public opinion in Member States in order to contribute to the drafting of pieces of writing, decision-making and evaluation of their work. An Analysis of Public Opinion of the aforementioned committee has been in existence since 1973 performing research and studies that address important issues related to European citizenship: enlargement of the EU, social issues, health, culture, information technology, the environment, the euro, defense, etc. Models and other information on the subject can be found on their web site. Official website: http://ec.europa.eu/public_opinion/index_en.htm

the 15 questions (multiple choice and/or open-ended) was based on the EUROBAROMETER (GASLELLI et al., 2006), and documents from the National Science Foundation (2008) and Vogt and Polino (2003). After drawing up the questions, the survey was validated by a group of 30 people, all of whom were over 18 years old with levels of education ranging from fourth grade education up to a college degree.

The indicators considered in the survey include: a) socioeconomic variables; b) technical knowledge about GMOs and biosafety; c) trust in sources of information/knowledge; d) awareness surrounding the debate controversy and attitudes towards it and; e) information needs to strengthen one's decision-making process.

The survey was available online on the project site (http://www.lacbiosafety.org) and on EMBRAPA's site (www.embrapa.br) from February to July of 2010. It was widely available (emails requesting participation in the survey were sent out via e-mail to users in EMBRAPA's database, to its various research units, through personal contacts, and by way of a stand at the Science for Life event held at Embrapa's Brasília location in May of 2010). The option of mailing a paper copy of the completed survey was also made available.

### 4.1 A summary of the methodology

Multivariate exploratory analysis is applied to evaluate the responses and results obtained in the survey. The relationships between respondents and the multiple categories of qualitative responses from the questionnaire could be better understood by combining correspondence analysis and classification techniques.

A reduction in the dimensionality of the relationships was achieved by correspondence analysis, an exploratory multivariate analysis technique that allows one to express countless qualities in one simultaneous spatial representation. The relationship typologies were defined differently using cluster analysis, a multivariate hierarchical classification analysis technique that distributes the data among mutually exclusive groups, so that the characteristics are homogeneous within groups and heterogeneous between groups.

ACM is based on the technique of principal components to simplify the structure of the data, explaining in a few sizes larger portion of the information present in the data (CUADRA, 1981). After identifying the key dimensions (components) representing the variation of data, ACM facilitates understanding the structure of associations between the categories. In ACM, the distances between the categories of interest are represented by the chi-square distances, a measure based on relative frequencies of the rows and columns of contingency table. For example, the distance between two columns (categories) in a contingency table , $j$ e $j'$, is expressed by (1):

$$d(j, j') = \sum_{i=1}^{I} \frac{1}{n_{i+}} \left( \frac{n_{ij}}{n_{+j}} - \frac{n_{ij'}}{n_{+j'}} \right)^2 \quad (1)$$

where I is the total lines of the contingency table, $n_{ij}$ (or $n_{ij'}$) is the frequency of the *i-th* row and *jth* (*j'-th*) column of the table, $n_{i+}$ the total frequency of the *i-th* row and and n + j (or n + j´) the total frequency of the jth (j'-th) column.

Under the assumption of homogeneity of the subpopulations, i.e., independence between qualitative variables of the analysis, the profiles columns (frequencies for the total of columns) would all be equal to average values observed in the population and the chi-square distances would be all zero.

The measure of total distance of the columns in relation to average values will be given by $\chi^2$ statistics (2) :

$$\chi^2 = \sum_{i=1}^{I} \sum_{j=1}^{J} \frac{n_{i+} n_{+j}}{n_{i+}} \left( \frac{n_{ij}}{n} - \frac{n_{i+} n_{+j}}{n} \right)^2 \quad (2)$$

where $n$ is the frequency of the total population and $J$ the total of columns.

Based on principles of algebraic singular value decomposition, according to which the basic structure of a matrix can be decomposed into basic values and vectors, the technique breaks down the structure of the distances between the categories of interest in (*i*) representing the eigenvalues partial contributions of each dimension in the total variability (D eigenvalues λ 1, ..., λ D, also called principal inertia), and (*ii*) eigenvectors that represent plans geometrical projection of the relative frequencies of categories of interest (GREENACRE & HASTIE, 1987). The total inertia corresponds to the average degree of detachment from multiple combinations of frequencies in relation to the average behavior of the population.

The geometric dispersion of the categories in the space defined by the dimensions of the ACM show the nature of associations between qualitative variables of the problem. Group categories reveal close similarities in the associations, while distant groups mean repulsion between the categories (HOFFMANN & FRANKE, 1986). Categories near the origin of a dimension (centroid) mean low contributions to its main inertia, i.e, their frequencies differ little in relation to the structure represented by size.

After achieving the factors of correspondence analysis, the next step is to generate groups of respondents, using *cluster analysis*. The clustering method adopted in this paper is that of Ward, whose goal is to create hierarchical groups so that the variances within groups are minimal and the variance between the groups are maximal (CRIVISQUI, 1999). Let P quantitative variables $X_1, \ldots, X_P$ from a population with n observations and *K* groups, where the number of observations of the *k-th* group is given

by *nk*, the total variability of the *P* variables can be decomposed into one component and another component in between groups:

*Total variability = Variability within + Variability between*

$$\sum_{i=1}^{n}\sum_{p=1}^{P}(X_{ip}-\overline{X}_{p})^{2}=\sum_{k=1}^{K}\sum_{i=1}^{n_k}\sum_{p=1}^{P}(X_{ip}-\overline{X}_{kp})^{2}+\sum_{k=1}^{K}\sum_{p=1}^{P}n_{k}(\overline{X}_{kp}-\overline{X}_{p})^{2} \quad (4)$$

where $\overline{X}_{p}$ is the average of $X_p$, and $\overline{X}_{kp}$ is the corresponding average for the *k-th* group. To avoid distortions coming from different scales of measurements of the P analysis variables, they should refer to standardized.

The criterion for each stage of this aggregation technique is to find the next class that minimizes the variability within the new group. To facilitate understanding of the sums of squares within groups (within variability), these tend to be divided by the total sum of squares (total variability) to represent a maximum proportion of the variability ($R^2$ semi-partial).

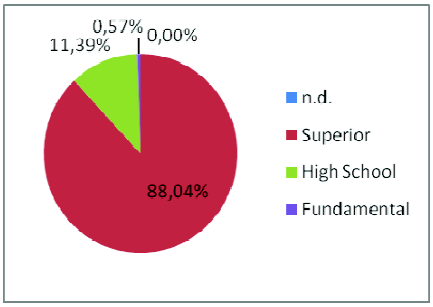
In the beginning, we have a zero degree of generalization (all observations are distinct from each other) and at the end of the process we have 100% generalization (all observations are similar to each other). It is for the researcher to decide between the number of groups that want to set the research, or the degree of generalization that plan to take, or an interaction between the two options, examining the gains and losses of each choice.

## *5. Results and Discussion*

The results obtained from the 15 questions in the online survey during the given period of time as well as previously described parameters are presented and discussed below. The total number of respondents to the survey was 1442, from 377 cities of the country. The respondents were distributed throughout different regions of Brazil as follows (%): a) North (3.8); b) Northeast (9.5); c) Central west (15.3); d) South (17.5); e) Southeast (54.0). This proportion maintains at certain extent the share of each region on Brazilian total population, with the exception of NE, under represented, what is due to problems with access to internet. By the other side the Central West participation is over represented in the "sample", what is explained by the particular interest of agriculture with the subject of the survey (BORGES; SILVEIRA; OJIMA, 2010).

Graph 1 shows the results based on level of education.

Graph 1. Schooling: **Education Level of Respondents**




Source: online survey

The survey represents mostly individuals with a high level of education, which could be considered, according to Hurwicz and Reiter (2006), a group with greater autonomy in decision-making.

## 5.1 Knowledge and Risk Awareness Regarding GMO

Only 20% of those interviewed knew what the Cartagena Protocol was and 24% of those who knew about the CTNBio knew how it was structured. If the regulation and role-players involved are little known or completely unknown to the public, a greater sense of insecurity regarding this unfamiliar subject may result. If people are not receiving the information being given out or if the information was not clear enough to clarify, they may have less decision-making autonomy.

Out of the 1442 participants, 37% and 39% showed a positive attitude towards the terms "transgenic plant" and "GM" while 81% and 70% had positive attitude towards the terms "biotechnology" and "genetic engineering".

The vast majority of respondents (94.6%) claim to know that transgenic plants were developed for the production of food and grain. Only 50% of respondents know that transgenic plants can be used to produce medicines. However, they have a more optimistic view of transgenic plants being used to produce medicine than of those used for food. Transgenic plants for use as a medicine (human health risk) are perceived to be lower risk while transgenic plants used as food (especially risk related to the environment) is perceived as higher risk.

The disparity between respondents' views regarding technologies based on closely related scientific knowledge – biotechnology – is justified by the controversy that has arisen out of transgenic plants being used for food, which is consistent with the literature review discussed earlier. Eating is a necessary risk, thus one that is involuntary, broad, and unknown. However, using biotechnology for drug production has a potential benefit that is tacitly understood by the public, especially people who are more knowledgeable about science and technology, which seems to be the case for respondents of this survey. The same type of opinions were found by Soares (2003).

## 5.2 Trust in Information Sources

The results obtained from the survey concerning the question of trust in information sources are presented in Table 1.

**Table 1 Percentage of Confidence in Sources of Scientific Information**

| Kind of Source | Scientists | International Governmental Organization | NGO | Physicians | Government | Private Companies | Media | Teachers |
|---|---|---|---|---|---|---|---|---|
| % | 77.0 | 41.0 | 38.5 | 35.0 | 29.0 | 16.0 | 14.0 | 45.6 |

Source: Online Survey (2010)

The results obtained from the survey show that the respondents have more confidence in information provided by scientists and teachers (research and educational institutions). The percentage is much higher when compared to the confidence shown in Organizations, Nongovernmental Organizations (NGOs), the government, and the media. This supports the literature that shows that, in Brazil, scientific production in the field of agriculture is seen as being linked to public institutions. Information is more reliable when it is supplied by scientists and experts.

Furthermore, survey results showed that the forms of media or individuals that respondents "most hear speak about transgenic plants and biosafety" are: 1) NGOs; 2) TV and magazines; 3) scientists and specialists, which clearly is the opposite order of confidence as for sources of information. That is, those offering the most information are not the people and/or source that is most trusted by the general public, and often the researcher is the indirect source of information to the public via the news media.[7]

Furnival and Pinheiro (2008) showed that the scientific community is seen as a credible source of information, which supports the results found in the online survey. Other surveys have also shown the high level of confidence in Brazilian science and scientists (VOGT, POLINO, 2003). Another online survey with over 21,000 respondents from 18 countries, including Brazil, conducted by the journals Nature and Scientific American8, published in September 2010, indicates that the credibility of science and scientists is high.

For the survey topic, the work of Costa-Font et al. (2008) can be very useful because it indicates that the process by which individuals acquire knowledge depends on the confidence and security that they have in the sources of information. It also notes that trust depends on the individual values that filter the information. If confidence is an indicator of social health, if confidence is to be preserved by institutions,

[7] The Biotechnology Information Council (CIB) in Brazil adopts an ingenious strategy to match scientists (as advisors) and media experts, what fits perfectly the results of the online survey.
[8] Available at http://www.revistapesquisa.fapesp.br/index.php?art=6744&bd=2&pg=1&lg.

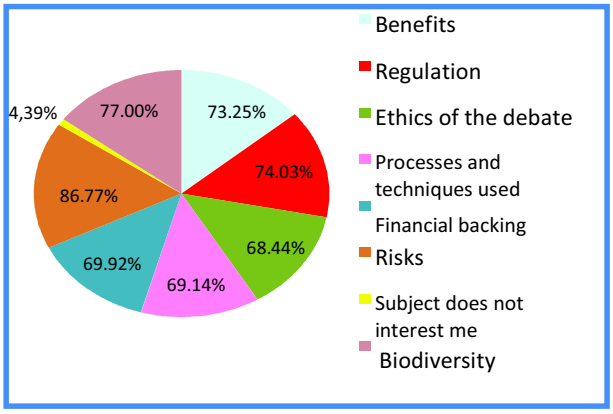
and if the respondents point to the scientist as the largest beneficiary of their confidence on the issue of the biosafety of transgenic plants, then researchers from the field must take on the responsibility of fostering discussion on the subject.

## 5.3 Perceptions on Information and Discussion

Based on the responses obtained, one can state that the scientific information on transgenic plants: it is not clear (73%), is conflicting (72%) and insufficient (85%). The analysis of this data requires very deep knowledge of the contexts in which the responses were obtained and of theory about the risks and benefits presented in the overview included in the introduction (STARR, 1969; SLOVIC, 2000). Such discussions are underway within the research group, and certainly will be supplemented when other results, especially those from the interviews, are completed.

At this point, we could now put these questions to the reader: why would someone from the city need to be sympathetic to farming techniques that, as far as they know, do not offer any direct benefits? Would someone living in a rural area have the same views on the subject as someone living in a city? The list of topics mentioned by the respondents and the percentage of the total they represent is show as a graph in Figure 3. From that list, "risk," followed by "biodiversity," “regulation,” and "benefits" stand out as the topics with the highest percentages.

Figura 2 **Topics about which more information is needed** (and the percentage of the total respondents they represent).




Source: Online Survey

Therefore, examining the responses submitted, the communication strategy will be directed primarily towards information on risk science, the concept of biodiversity, explaining national and international regulations on biosafety and also those about the benefits of using transgenic techniques. The other topics may be presented and included in communications products, especially to

supplement the prioritized topics.Communications products are already being developed, especially on topics that are independent of the results of the technical components of the LAC-Biosafety project. They should contribute to facilitating access to scientific information and promote discussion and autonomy of choice.

## 5.4 Group Attitudes towards GM

One strategy to summarize the results of the online survey is to carry an correspondence analysis (ACM) to generate groups of respondents and identify the main questions that had contributed to the inertia of "factorial plans" according to the methodology described in the section above. The questions used in the ACM are presented in the ANNEX I. The three principal dimensions of the ACM were used as criteria for classification by cluster analysis. The results obtained by the ACM are described below:

Dimension 1 (28% of the total inertia): the categories that most assist in classifying this dimension are: *a positive or negative attitude towards transgenic plants and genetically modified organisms*, *optimism or pessimism regarding the use of transgenic plants to produce medicine or food*, *agreement or disagreement regarding safety for the environment and human health*, *ethics, and using transgenic plants to produce medicines or food*. In other words, the result confirms that the public perception on transgenic crops gives a crucial contribution the inertia of the most important axe.

Dimension 2 (16% of total inertia): the categories that most assist in classifying this category are: *neutrality with regards to transgenic plants and genetically modified organisms* and *lack of information (do not know) to evaluate whether the use of transgenic plants to produce food or medicines is safe for human health and the environment*.

Dimension 3 (5% of the total inertia): the categories that most assist in classifying this category are: *negative or neutral attitudes towards biotechnology*, *biosafety, and genetic engineering* and *knowledge regarding the use of transgenic plants to produce medicines.*

It is clear that what differentiate ACM axes is: a) concerns or hope on agricultural biotechnology *versus* neutrality and/or lack of knowledge; b) other views *versus* negative or neutral opinions on biotechnology.

Using the coordinates of each questionnaire for each of these three dimensions as criteria for classification, five groups were selected by cluster analysis. The variability among the identified groups represented 78% of the total variability of the dimensions and the description of their mean responses identified some relatively consistent patterns in the population:

- **Group 1** - extremely positive attitude (219 individuals, 15% of the total): over 90% positive responses towards the terms "biotechnology," "biosafety," "transgenic plants,"

"GMO," and "genetic engineering". Almost all respondents also described themselves as knowledgeable about the use of transgenic plants for food and medicine production are optimistic about these practices and believe that they are safe for the environment and human health and are ethically acceptable;

- **Group 2** - positive attitude (307 individuals, 21% of the total): although the majority present a positive attitude towards the terms "biotechnology," "biosafety," "transgenic plants," "GMO," and "genetic engineering," a considerable portion of the respondents in this group describe themselves as not knowledgeable about the use of transgenic plants to produce medicines (40%) and are undecided about the risks transgenic plants present to the environment and human health (between 25% and 45%);
- **Group 3** - intermediate attitude (211 individuals, 15% of the total): although they tend to present a positive attitude towards the terms "biotechnology," "biosafety," and "genetic engineering" (75% or more), this group is neutral with regard to the terms "transgenic plants" and "GM" (46%). This group shows the highest percentage of a lack of knowledge regarding the use of transgenic plants for the production of medicines (62%) and food (18%). They tend to be undecided about the safety and ethics of using transgenic plants for the production of food or medicines;
- **Group 4** - negative attitude (159 individuals, 11% of the total): although 70% or more have a positive attitude towards the terms "biotechnology," "biosafety," and "genetic engineering," 39% had a negative attitude towards the terms "transgenic plants" and "GMO". This group is also characterized by a lack of knowledge surrounding the use of transgenic plants to produce medicines (62%) and their opinions with respect to such use.
- **Group 5** - extremely negative attitude (543 individuals, 38% of the total): this group presents the highest percentage of negative responses for the terms "biotechnology," "biosafety," "transgenic plants," "GMO," and "genetic engineering" (between 19% and 85%). This group is pessimistic about the use of transgenic plants for the production of medicines (59%) and, above all, food (94%), believing that it poses risks to human health and the environment.

Table 2 describes the groups according to social (gender and age) and occupational (profession) characteristics. Firstly, there is a higher prevalence of men in the group with the most positive attitude towards GM (group 1) in particular. Women, however, tend to be concentrated in the intermediate groups, especially groups 3 and 4. That is, while women tend to have a more moderate attitude towards the use of transgenics, men tend to take more extreme positions, particularly in showing positive attitudes. In terms of age, the most striking observation is the relative concentration of people over 44 years of age in the

group with the most positive attitudes towards GM. Young people (under the age of 25) tend to be concentrated in the group with negative attitudes towards GM (group 4).

The respondents' professions suggest that people who have jobs requiring a college degree tend to have extremely positive attitudes towards GM while students were more associated with a negative attitude (group 4). Overall, the results suggest that extremely positive attitudes towards GM are most closely associated with men working jobs requiring a college degree who are over 34 years of age. Negative attitudes (group 4) are associated with women, young people under the age of 25, and students.

**Table 2 Socio-occupational Composition of the Groups**

| Feature | Groups | | | | | Total |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| n | 219 | 307 | 211 | 159 | 543 | 1.439 |
| % | 15 | 21 | 15 | 11 | 38 | 100 |
| Gender (% column) | | | | | | |
| Female | 35 | 47 | 57 | 53 | 43 | 46 |
| Male | 65 | 53 | 43 | 47 | 57 | 54 |
| | | | $\chi^2$=27,0*** | | | |
| Age (% column) | | | | | | |
| < 25 years old | 14 | 27 | 17 | 28 | 22 | 22 |
| 25 a 34 | 32 | 35 | 37 | 30 | 35 | 34 |
| 35 a 44 | 20 | 15 | 22 | 18 | 18 | 18 |
| > 44 years old | 34 | 22 | 23 | 23 | 26 | 25 |
| | | | $\chi^2$=27,7** | | | |
| Professions (% column) | | | | | | |
| Managers | 4 | 3 | 5 | 1 | 5 | 4 |
| Professional (superior degree) | 76 | 65 | 60 | 64 | 64 | 65 |
| Technicians | 2 | 6 | 6 | 5 | 5 | 5 |
| Services | 4 | 5 | 10 | 4 | 8 | 7 |
| Non qualified workers | 2 | 1 | 1 | 1 | 2 | 1 |
| Students | 12 | 17 | 15 | 24 | 13 | 15 |
| Retired | 0 | 2 | 3 | 2 | 3 | 2 |
| | | | $\chi^2$=49,4** | | | |

Source: Online Survey

*** Significant at 0,1% level by $\chi^2$; ** Significant at 1%; * Significant at 5%;

There were also significant relationships between the groups' responses and the level of confidence in and knowledge of institutions that inform the public and monitor GMOs in Brazil (Table 3). For example, positive attitudes are directly linked to confidence in the government, scientists, experts, and private companies as providers of information on transgenic plants. In other words, the percentage of people who rely on these institutions tends to be higher in groups with more positive attitudes towards GMOs. On the other hand, respondents with more negative attitudes towards GMOs tend to rely more on information provided by NGOs.

Another important result of the survey refers to people's knowledge of a commission responsible for the safety clearance of GMOs in Brazil. The highest percentage of people who claim to know about a national commission, as well as the people who actually know the name of the institution, is observed in the group with the most positive attitudes about GMOs. The lower percentages tend to concentrate in the intermediate groups, where there is a higher prevalence of people undecided about their opinion of GMOs.

**Table 3– Composition of Groups By Level of Confidence and Knowledge of Institutions**

| Feature | Groups | | | | | Total | $\chi^2$ |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | |
| **Reliable source of information about what is transgenic plants** (%) | | | | | | | |
| Government | 42 | 39 | 27 | 28 | 19 | 29 | 61.4*** |
| NGO | 14 | 28 | 35 | 38 | 57 | 39 | 146.8*** |
| Experts (scientists) | 95 | 95 | 89 | 76 | 55 | 77 | 263.3*** |
| Corporations | 37 | 25 | 13 | 11 | 5 | 16 | 146.7*** |
| **Reliable source of information about biosafety** (%) | | | | | | | |
| Government | 45 | 36 | 25 | 23 | 22 | 25 | 115.1*** |
| NGO | 13 | 24 | 33 | 38 | 56 | 37 | 163.5*** |
| Experts (scientists) | 96 | 94 | 85 | 73 | 51 | 74 | 283.3*** |
| Corporations | 37 | 20 | 12 | 9 | 1 | 13 | 191.7*** |
| **Know exists Commission approving / disapproving the release of GMOs in Brazil**? (%) | | | | | | | |
| Yes | 88 | 73 | 52 | 60 | 75 | 72 | 83.6*** |
| Do you know the name of the Commission? (%) | | | | | | | |
| Yes | 74 | 52 | 32 | 36 | 59 | 53 | 101.6*** |

Source: Online Survey

*** Significant at 0,1% by $\chi^2$; ** Significant a 1%; * Significant a 5%;

## *6. Final Remarks*

The approach used in the LAC-Biosafety project is just one small example of a plan to build a communication channel, and certainly others should be created. Surveys, questionnaires, and interviews aimed at studying public awareness and communication patterns regarding a particular technology are useful if they precede the deployment of the technology by the government. Communication from the perspective of the general public that is affected by technology builds communication for development. It is an attempt to explain science and scientific viewpoints, to contribute to the debate and increase confidence, clarity, and transparency necessary for the sustainable strengthening of public awareness and opinion from the perspective of introducing technological innovation.

As shown previously, the results discussed in this article come from a sample from an online survey conducted from February to July 2010 for the LAC Biosafety project and its initiatives in Brazil. Thus, it is not possible to draw any definitive conclusions, affirmations, or interpretations based on the context of the survey but instead learn lessons and gain knowledge. The main caveat is due to the informational bias generated by the strategy of applying the questionnaire by internet. This does not, however, invalidate any of the findings.

The more important result of the analysis is: GMOs are in the spotlight, it means, they are the main source of disagreement between respondents, not biotechnology in general (see the questions on ANNEX I). The fact that CTNBIO is now working better than it did five years ago do not authorize policy makers to disregard people who are against transgenic crops**.** The results of the online survey shows that about 50% of the people declared themselves at some extend against on biotechnology and GM crops, mostly the latter, and part of them are informed on these subjects.

The results of ACM analysis are very akin to the literature and mostly with the results achieved by Borges, Silveira and Ojima (2010), who worked with experts, not with general public. The role of knowledge is as important as the positions in favor or against transgenic crops to generate contrasts between respondents. The two groups in favor of biotechnology and mostly to transgenic crops are composed by male, senior e well informed people. They trust in experts as source of information, even to grab information about biosafety. On the other hand, the group of respondents who are against GM crops (G4/5) are younger, have a higher proportion of students and fewer top-level professionals. They are a little bit less informed than group of people who are in favor of GM, and part of them relies on NGOs for information about GM and biotechnology. The existence of groups made up predominantly of women that are neutral or admits to having little information about biotechnology points to the need for a strategy

focused on this people. The importance that people give to scientists has shown the need to have a sound strategy of communication that combines media resources with qualified and accessible knowledge.

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## *Annex I*

### Questions from the questionnaire used in ACM (correspondence Analysis)

| Section | Question | Response |
|---|---|---|
| Attitudes towards GM | What is your attitude towards biotechnology? | Positive, Negative, or Neutral |
| | What is your attitude towards biosafety? | Positive, Negative, or Neutral |
| | What is your attitude towards transgenic plants? | Positive, Negative, or Neutral |
| | What is your attitude towards genetically modified organisms? | Positive, Negative, or Neutral |
| | What is your attitude towards genetic engineering? | Positive, Negative, or Neutral |
| GM in Medicine | On using transgenic plants to produce medicine: | Familiar or Unfamiliar |
| | On using transgenic plants to produce medicine: | Optimistic, Pessimistic, or Undecided |
| | Using transgenic plants to produce medicine is safe for the environment: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce medicine is safe for human health: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce medicine is dangerous to the environment: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce medicine is dangerous to human health: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce medicine is ethically acceptable: | Agree, Disagree, or Don't Know |
| GM in Food Production | On using transgenic plants to produce food: | Familiar or Unfamiliar |
| | On using transgenic plants to produce food: | Optimistic, Pessimistic, or Undecided |
| | Using transgenic plants to produce food is safe for the environment: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce food is safe for human health: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce food is dangerous to the environment: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce food is dangerous to human health: | Agree, Disagree, or Don't Know |
| | Using transgenic plants to produce food is ethically acceptable: | Agree, Disagree, or Don't Know |