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The GM-regulation game – the case of Hungary

RESEARCH ARTICLE

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Abstract

Hungary, this small and open economy with limited natural resources, tries to build its future on creativity and innovation. At the same time, the country has declared in its basic law a categorical prohibition on the application of genetically modified organisms. The aim of this study is to explain the causes of this obvious contradiction. The collection of expert estimations regarding the relative positions and attitudes of different actors has been carried out in the form of face-to-face interviews with 67 stakeholders in the agri-food sector, following a strictly neutral approach, not taking into consideration whether the respondents have taken positions for or against the application of genetically modified crops. In order to define the key actors in the GM regulation debate, their mutual influences and their goals. Based on this information, a quantitative model has been developed to determine the system of interests of different actors and the coalition(s) which develop among them around different goals. The results of the analysis emphasise that a wide coalition of anti-GMO actors has formed, consisting of researchers, NGOs, GM-free certifiers, the media and the parliamentary parties. However, their interests are quite different, as is their natural reluctance to accept new, partially unknown technology. The results of our investigations support the practical applicability of strategic position analysis, supported by modern expert-opinion based quantitative methods. The application of this approach offers a favourable possibility to determine the positions of various actors. Under these conditions, there is an urgent need to change the communication strategy of pro-GMO scientists and other stakeholders and instead of taking a defensive position, pro-active communication should be adopted.

Keywords: innovation, MACTOR model, regulation, social bargaining
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1. Introduction

Several scientific lead thinkers educated in Budapest – John von Neumann, Edward Teller, Leo Szilard, Dennis Gabor, Albert Szent-Györgyi, Theodore von Karman, etc. – were born in Hungary in the decade between 1898 and 1908. They were responsible for some of the twentieth century's most decisive scientific advances (Smil, 2001). However, they had the advantage of emigrating to the USA or UK. Interestingly, their compatriot Karl (Károly) Ereky coined the word 'biotechnology'(Bud, 1989). Ereky proposed a stable science-based solution a century ago because it was his strong conviction that the application of 'agricultural biotechnology' would benefit humanity's food supply (Fári and Kralovánszky, 2006).

The opposition to genetically modified organisms (GMO) is not everywhere as strong as it is in Europe, although it is more common than people tend to think. Proponents of the technique represent scientific rationality and the application of cutting-edge technology which leads to sustainable intensification in agriculture. For opponents, GMOs represent scientific control over nature and have become symbols of industrialization and globalization. Public opposition to GMOs remains strong. Furthermore, concerns about health, environmental, and socioeconomic hazards have resulted in strong public opposition to GMOs (Arthur, 2011; Jayaraman and Jia, 2012; Lewandowsky *et al.*, 2013). Some reports and studies have claimed that GMOs per se badly affect health, the environment, and small farmers in developing countries. Anti-GMO activists continue to refer to these studies. As such, they cloak their arguments under a scientific veil, thus exploiting the cultural authority of science. In this regard, the opposition to GMOs resembles pseudoscience's such as 'scientific' creationism and homeopathy, which mimic science in an attempt to gain respectability (Boudry *et al.*, 2015). At the same time, anti-GMO activists also adopt pseudoscientific tactics to undermine the authority and autonomy of the science that contradicts their claims, for instance by overstating the impact of industry on plant sciences. Considering that public opinion has a significant impact on the development and marketing of GMOs in Europe, it is essential to identify current attitudes toward this biotechnology in different countries, in order to understand public fears and determine potential knowledge gaps (Boccia and Sarnacchiaro, 2015).

The main determinants of restrictive GMO regulation are the absence of comparative advantage in the agricultural sector, a high proportion of the population living in rural areas, stringent environmental regulations and the institutional environment. In addition, in the 'information market' the structure of domestic mass media (public vs private) is an important driver of GMO standards (Vigani and Olper, 2013; Vigani *et al.*, 2012). The human mind comprises intuitions that shape and constrain cultural preferences, and public aversion to GMOs thrives on such preferences. Education can, at least to some extent, moderate the intuitive appeal of negative GMO representations (Blancke *et al.*, 2015). For example, a recent survey revealed that Polish society disapproves of GM foods and demands they be labelled. Generally speaking, the greatest level of scepticism was shown by farmers, medical workers and school teachers, while the greatest enthusiasm was shown by students of medical and life sciences, and researchers/academicians. Most respondents in the survey expressed a desire to improve their knowledge of GMOs and expected school teachers, academicians and researchers to participate in an evidence-based educational process (Rzymski and Królczyk, 2016).

The dissemination of information related to genetic engineering can determine the future decisions of both the policymakers who have to respond to public expectations, and the biotechnology industries whose product success depends on stakeholders' (e.g. farmers) and customers' (consumers) decisions. Several related reasons have been proposed to explain why the EU has introduced such stringent regulations with regard to GM crops compared with other industrialised countries, and hence introduced the basis for the conflict (Punt and Wesseler, 2016). The GM debate is too often conducted in an 'either this or that technology' mode, rather than by recognizing that food security is a combination of all available best approaches. However, GM crops can play an important role in a broader food security strategy (Qaim and Kouser, 2013). According to Amin *et al.* (2014), research findings can serve as a database that will be useful for understanding the social construct of public attitudes towards GM foods in a developing country.

Social acceptance of new technologies in general, and genetically modified plants in particular, has prompted considerable debate and has met with resistance in most societies (Costa-Font *et al.*, 2008; Kuiper *et al.*, 2013; Lusser and Davies, 2013; Scholderer and Verbeke, 2012; Sonka *et al.*, 2000; Tanaka, 2013), but the regulation of GMO is especially strict in Hungary: in 2012 this small Central-European country, which can be characterised by trade openness, i.e. a high level of exports as a proportion of GDP, declared in its Basic Law (Constitution) that '(1) Every person shall have the right to physical and mental health. (2) Hungary shall promote the exercise of the right regarding paragraph (1) through an agriculture free from genetically modified organisms' (Hungary's Constitution, 2011).

In Europe, the lack of public support for GMOs led to a de facto moratorium within the EU on new GM crops from 1999 to 2004, and has steered the development of an extremely strict and expensive regulatory framework as regards the import and cultivation of GM crops. In accordance with the regulation passed by the European Parliament in 2015 (European Parliament and Council, 2015), which amended the previous regulation (European Parliament and Council, 2001), Member States of the EU can decide individually whether or not to implement the cultivation of GM crops. In this issue, Hungary chose to request a full opt-out for its territory in late 2015. GM foods can still be imported and distributed in Hungary, but require mandatory labelling (European Parliament and Council, 2003). The majority of EU member states requested opt-outs from the cultivation of genetically-modified crops for all or part of their territory. What drivers have led the political elite of a country whose national identity includes innovation (Göncz, 2012), and where international success in science and technology plays a very important role (Evans and Kelley, 2002), to set a long-range ban on a new and innovative technology? And in the country where one of the most influential forerunners of the biotech doctrine, the father of the term 'biotechnology' (Bud, 1993), Károly Ereky (1878-1952), was born?

The aim of this study is a systematic analysis of the strategic positions and goals of different actors involved in the GM-regulation debate in Hungary in order to uncover the causes of the extremely rigid legislation regarding the application of GM crops in Hungary. Without a radical re-definition of European and national science and development strategies in a more positive direction, and their inclusion in solutions to global challenges, and the re-shaping of the Common Agricultural Policy in a market-oriented way, there is no chance of changing the current situation in the short term; neither in Hungary, nor in the majority of EU member states. The paper is structured as follows: after the introduction the second section reviews the methodology applied, and the third summarizes the results of interviews with representatives of different stakeholder groups. The fourth section offers a brief summary of the results by using the matrix of alliances and conflicts, and the tactics, objectives and recommendations (MACTOR) method for strategic position analysis. The paper ends with a discussion and conclusions on policies for the scientific community.

2. Methodology

2.1 The MACTOR method for GM policy: players and their goals

We carefully selected 128 papers which are considered important or innovative studies, or comprehensive reviews offering us a wider picture of the adoption of GM food. The basic paradigms of analysis were the concept of strategic planning (Marchesnay, 2004), the institutional economics approach (Allport, 1940; Dacin *et al.*, 2002; Hannan and Freeman, 1984), and principle-agent theory (Eisenhardt, 1989).

The so-called 'French school of strategy' (Marchesnay, 2004) considers the different social systems as an arena, which has different groups of participants (actors) who follow their specific interests. In the opinion of Godet (2000), by an appropriate simplification of the actors and the most characteristic features of their systems of interests, it is possible to analyse the chances of different actors to realize their goals. This method of analysis of social bargaining can be described using the MACTOR model. In the literature this model has been used in different research fields: air transport development, the iron and steel industry, sustainable development, internal motivation and external strategy, public opinion on the development of

nuclear energy, scenario techniques in long range business planning, developing individual infantry weapons, power distribution in the value chain, and the mobile telecommunications market (Bradfield *et al.*, 2005; Camponovo and Pigneur, 2003; Godet, 1976, 1991, 1998a,b, 2000; Godet and Roubelat, 1996; Heger and Rohrbeck, 2012). The effect of the influence of one actor (A) on another (B) can be expressed as a sum of the direct and indirect influences of actor A on actor B.

Based on unstructured interviews, the key actors of the Hungarian legislation system were determined. In the next phase the intensity of mutual direct influences was characterized using a rectangular matrix. By definition the cells of the direct influence rectangular matrix express the estimated level of influence of the corresponding actor in a row on the actor situated in the corresponding column. According to the basic default values of the software, the values in the main diagonal in the matrix are zeros. Indirect influences are calculated by Equations 1, 2 and 3. (Bendahan *et al.*, 2004) offer a good overview of the MACTOR method.

The cells of the matrix – by definition – express the intensity of influence of any actor in a row on any actor in a column on a 0-4 scale, ranging from no influence to total influence. The matrix of direct and indirect influences (MIDI; Equation 1) quantifies the sum of direct and indirect influences for each pair of actors. The cells of the matrix of direct and indirect influences contain a sum of two values: the estimated influence of one actor on another and the sum of second order influences, which have been calculated by summarizing the influence of other actors on the given entity. For example, in relation to actor A and actor B, where actor A is the influencer and B is the influenced (symbolized as: A→B), the intensity of the influence another actor has on B has been summarized together with the influence exerted by A. Of course, the intensity of this influence can be different. In relation of the influence of actor A on B via actor C (symbolically: A→C→B) there are two intensities which will determine the result. The MACTOR algorithm takes the lesser (minimal) intensity of these influences. As a summary: the cells of the matrix of direct and indirect influences contain the sum of one direct and n-2 indirect intensity relations.

$$MIDI_{a,b} = MID_{a,b} + \sum_c(\min(MID_{a,c}, MID_{c,b})) \quad (1)$$

In this way the vector influences (I_a) and dependences (D_a) for each and every actor can be determined by equations (Equation 2) and (Equation 3).

$$I_a = \sum_b(MIDI_{a,b}) - MIDI_{a,a} \quad (2)$$

$$D_a = \sum_b(MIDI_{b,a}) - MIDI_{a,a} \quad (3)$$

On basis of the indicators above a normalized value can be calculated for each of the actors (Equation 4).

$$r_a = \left(\frac{(I_a - MIDI_{a,a})}{\sum_a(I_a)}\right) \times \left(\frac{I_a}{(I_a + D_a)}\right) \quad (4)$$

Applying the vector r_a the matrix of influence-possibilities for each of the actors for different issues can be defined (Equation 5).

The importance of each goal from the point of view of different actors was expressed by the Matrix of Actor-Objective. This was the so-called 1MAO matrix, in which the cells of the matrix contained the attitude of an actor towards a given goal in the form of a positive, 0 or negative sign. In the second phase the 2MAO matrix was determined, which contains the intensity of these attitudes which have been determined for different actors, measured on a -4 +4 scale, where -4 denotes the total negation of the given goal, and +4 denotes total support. The 3MAO matrix also takes into consideration the influence-possibilities of the different actors (Equation 5).

$$3MAO_{a,i} = 2MAO_{a,i} \times r_a \quad (5)$$

This matrix is the basis of most of the analyses proposed by our method, because a number of important values are directly drawn from the 3MAO matrix. The mobilization coefficient (Equation 6) quantifies how much the different actors are involved in the system of interests. The agreement (Equation 7) and disagreement (Equation 8) coefficients indicate how controversial the different issues are for each actor.

$$Mob_a = \sum_i |3MAO_{a,i}| \quad (6)$$

$$Ag_i = \sum_a (3MAO_{a,i}\ (3MAO_{a,i} > 0)) \quad (7)$$

$$Disag_i = \sum_a (3MAO_{a,i}\ (3MAO_{a,i} < 0)) \quad (8)$$

The 3MAO matrix is applied to obtain the convergence matrix (3CAA; Equation 9) and divergence matrix (3DAA; Equation 10). For each actor-pair, these matrices express how much they agree or disagree on different issues.

$$3CAA_{a,b} = \tfrac{1}{2} \sum_i ((|3MAO_{a,i}| + (|3MAO_{b,i}|)\ (3MAO_{a,i} \times 3MAO_{b,i} > 0)) \quad (9)$$

$$3DAA_{a,b} = \tfrac{1}{2} \sum_i ((|3MAO_{a,i}| + (|3MAO_{b,i}|)\ (3MAO_{a,i} \times 3MAO_{b,i} < 0)) \quad (10)$$

The ambivalence coefficient (Equation 11) gives an indication of the expected stability of their potential alliances.

$$3EQ_i = 1 - \left[\frac{(\sum_k \left||3CAA_{ik}| - |3DAA_{ik}|\right|)}{(\sum_k \left||3CAA_{ik}| + |3DAA_{ik}|\right|)}\right] \quad (11)$$

The results of the analysis were evaluated and visualised by correspondence analysis. This multivariate method is appropriate for visualising the relations between actors and goals (Savage *et al.*, 2013).

2.2 Participants and survey methods for policy making

The data collection for the analysis was a multiphase process. In the preparatory phase we carried out a detailed analysis of articles, declarations made by different stakeholders in the GMO-debate and other materials (e.g. minutes of parliamentary sessions). However, the relationship between the abundance of materials and the resources available for research prevented us from carrying out a detailed meta-analysis of resources, so we tried to follow the methodological suggestions of Moher *et al.* (2009). Based on the PRISMA model (Supplementary Methods S1), Figure 1 summarises the most important characteristic features of the literature review (Figure 1). In the second phase, we carried out a detailed analysis of articles, declarations and other materials concerning GMO policy regulation.

The present study employed a self-designed interviews method. Besides analysis of public declarations, face-to-face expert estimations were made with 22 stakeholders in Hungarian GMO-related fields. (We conducted interviews with eight researchers and lecturers from the academic sphere; nine producers from agriculture and the food industry and five experts from the governmental sphere). This series of preliminary (explorative) interviews conducted with the purpose of outlining the set of relevant actors and interests was carried out between 2014 and 2015. The aim of this preliminary interview phase was to outline the most important stakeholder groups and the set of potential objectives of the stakeholders. As a result of these investigations, a conscious, robust and well-manageable set of actors and goals could be created. The protocol of the interviews with experts is presented in Supplementary Methods S2.

Before beginning the face-to-face part of the study, following the guidelines of leading professional associations (American Sociological Association, 1999; Marketing Research Association, 2013; Social Research Association, 2003), the authors analysed the critical ethical aspects of the research. It was unanimously

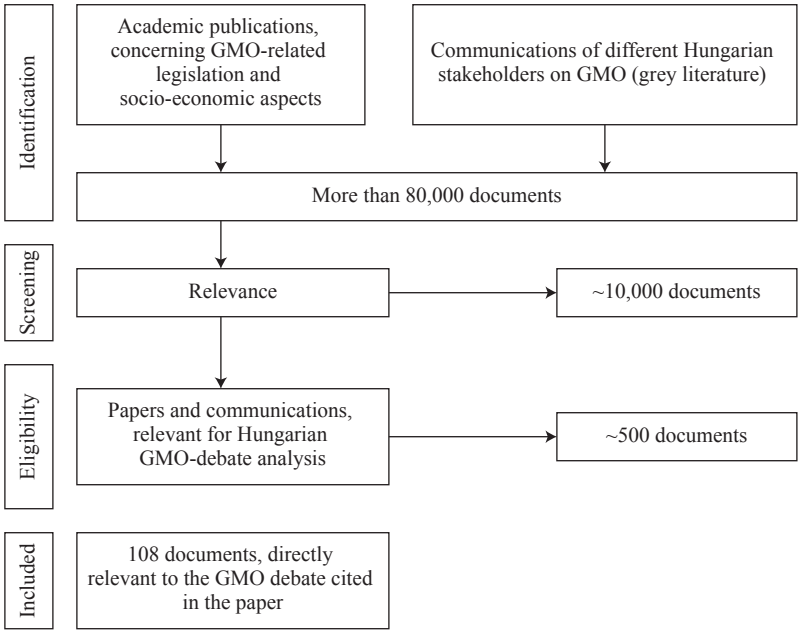

Figure 1. The application of the PRISMA method.

determined that because the study was not funded, there is no conflict of interest. The Ethical Council of the Faculty of Economics and Business, University of Debrecen, which hosts the majority of the authors, has approved the concept and procedure of the research. All of the participants have signed an informed consent form, describing the procedure of research. The interviews were conducted in a separate room, and the respondents were not able to meet each other, neither before, nor after the interviews. The confidentiality of the respondents was maintained appropriately at all stages of the enquiry.

In setting up a pool of experts a specific procedure was followed. We considered experts to be people (1) who have a specific responsibility for decision-making in GMO-related questions in any sector of the food chain, from the creation of biological materials to consumers; (2) who have proven their specific knowledge in a GMO-related field by the publication of high-quality peer reviewed papers on topics related to the GMO-debate; (3) who have been especially active in professional social debates concerning GMO-regulation in printed and electronic media. The attitude of experts towards GMO has not been taken into consideration, neither in the choice of the experts, nor in the interview phase.

The list of potential participants was collected on the basis of intensive research of publications, membership-lists of professional organisations and the personal recommendation of other experts. In Hungary the professional community is relatively small, which is why the potential circle of respondents was cross-checked by members of the authors' academic or professional community.

In summary, the names of 397 experts were collected. In the next phase experts were selected who supposedly – in the opinion of at least two members of the author's community – have a more 'holistic' approach to GMO issues, without taking into consideration whether their attitude to the GMO question was pro or contra. In this way 145 experts were selected. 97 respondents expressed their willingness to participate in the research. Due to time and financial constraints 67 expert-interviews were carried out, all of them face-to-face.

The quantification of the intensity of actor-actor influences, as well as the actor-objective relations developed in an evolving manner. As we experienced, filling out the input matrices in the form of MS Excel worksheets for research was a very time-consuming process, often causing conflict because it was very difficult to achieve a general common interpretation of different scales. That is why a semi-structured interview was

used (Lindlof and Taylor, 2011). The conversion of the verbal estimations was carried out during the report phase, with the help of the researchers. The only task of the researchers was to help to interpret the different scales. This quantification technique proved to be an efficient practical method for achieving consistency in input data for analysis.

The most important socio-economic indicators of the respondents are summarised in Table 1. It should be emphasised that with this type of analysis we cannot follow the well-established logic of survey-type opinion research methods, because (1) representativeness as a basic postulate of this type of research is not applicable since it is impossible to define the 'population', (2) the length of the interviews does not allow us to have a high enough number of respondents to carry out a statistical analysis of the results. At the same time, this research concept seemed to be useful for analysis of the GMO-related actors, their goals and what is at stake regarding the potential benefits of current GMOs.

In the design of the panel of respondents our aim was not to achieve representativeness, because – as a consequence of the wide and diverse sets of stakeholders – this would be impossible. The high proportion of specialists working in higher education and academic research offered a favourable opportunity to obtain the information from specialists with a broad overview and a perspective on the area analysed.

Table 1. Basic characteristics of respondents enrolled in the study. All results are shown as percentages.

Characteristics of respondents (n=67)	**Share of respondents**
Gender	
Women	27
Men	73
Type of qualification	
Agriculture	67
Other natural science (e.g. chemistry, biochemistry)	7
Engineering	4
Economics	15
Social sciences (e.g. politic science, law)	7
Academic background	
At least PhD	82
Master's degree (MSc, MA)	18
Field of activity	
Higher education	47
Scientific research	16
Agricultural production	16
Food processing	8
Food trade	6
Policy analysis, legislation, politics	7
Professional experience (years)[1]	
0-5	22
6-20	15
>20	63

[1] Professional experience represents years after completing graduate studies.

3. Key actors and their strategic goals in Hungarian GM acceptance and legislation

It is well documented that legislation in general (Burstein and Linton, 2002), and GMO-legislation in particular (Doh and Guay, 2006), is the result of a complex social bargaining system. In order to understand these processes in the first phase of investigations we identified the key actors of these process. In this phase we built heavily on the literature, but the exhaustiveness of the list of actors, as well as their significance was discussed and checked in the preliminary interview phase.

3.1 The European Union

The historic development and the current situation of EU legislation on GM plants have been analysed in detail in several works (Morris and Spillane, 2010; Von Kries and Winter, 2012). In the opinion of Davison (2010) 'the European anti-science attitude reaches the highest levels of the EU bureaucracy'. According to Masip *et al.* (2013), the EU policy 'has been developed in pursuit of brave goals', but what has emerged in the field of agricultural regulation is 'a fragmented, contradictory, and unworkable legislative framework'. Ramessar *et al.* (2010) pointed out that the current EU coexistence procedure is 'arbitrary and scientifically unjustifiable'. In explaining EU decision-making regarding GM regulation, the classic right-left political ideology scheme can be excluded (Navah *et al.*, 2013). Lynch and Vogel (2001) stated that the GM-related European politics and policies are 'often politicized, highly contentious and characterized by a suspicion of science and mistrust of both government and industry'. Moore (2001) noticed that the inclusion of genetic modification in the negotiations on free trade agreements is an old EU strategy because the European Union – emphasising the importance of the defence of the environment and consumers' interests – tries to obtain additional benefits for another product in trade negotiations. Authorization for GM crop cultivation in Hungary has become a highly charged political topic (Balázs *et al.*, 2011).

3.2 The Hungarian parliamentary parties

Each of the respondents highlighted the fact that the state can be considered a decisive player in GM acceptance and regulation. This fact is especially important in the case of Hungary, where a considerable element of the media is under the control of the government (Sedelmeier, 2014). In the last six years Hungarian politics has been dominated by centre-right political parties, Fidesz – Magyar Polgári Szövetség – Kereszténydemokrata Néppárt (the Alliance of Young Democrats – the Hungarian Civic Alliance – the Christian Democratic People's Party). Szabó (2011) drew attention to the fact that elements of populism have gained momentum during recent decades in the politics of FIDESZ-MPSZ. The most important elements of this are the following: (1) an anti-establishment, anti-elite orientation; (2) siding with 'civil society' and rural communities against the 'cosmopolitan Social-Liberal parties and their allies'; (3) strong rhetoric against the International Monetary Fund, the World Bank and global multinational companies. The most important political rival is the extreme right party 'Jobbik', whose political slogan is: 'Hungary belongs to Hungarians'. A strong accent on the 'defence of national interests' against the 'multinational biotech companies' can be very easily integrated into the rhetoric of the above mentioned parties. Under these conditions there is no political force with the political will and determination to open a new front for GM technologies.

3.3 The academic community

The application of natural sciences for the modernisation of the agro-food sector has considerable traditions in Hungary. The word 'biotechnology' was coined in 1917 by a Hungarian engineer, Karl Ereky (Bud, 1989, 1993). Ereky spent a lifetime in the realisation of his vision of a new era of technology based upon a combination of biochemistry and biology (Fári and Kralovánszky, 2006). Later, under the shadow of fascism, Albert Szent-Györgyi achieved considerable results in the field of biochemistry (2009), acknowledged by the Nobel Prize awarded in 1937. The Hungarian school of modern biology and biochemistry has been able to produce results acknowledged worldwide, even in the period of Soviet-dominance determined by the Lysenko and Michurin epoch (Pollock, 1955). Numerous prominent foreign scientists in the field of biotechnology

and molecular genetics were encouraged to work at the biological sciences centre in Szeged (Anonymus, 1971). Since then, several Hungarian scientists have achieved considerable results in the field of genetics and biotechnology (Demont *et al.*, 2005), but as a consequence of the lack of governmental resources for the continuation of biotechnology-related research, most of them have given up their GMO research, or left Hungary. Some sophisticated Hungarian GMO plant research laboratories have ceased operation.

3.4 Non-governmental organisations

In the last two and a half decades an active and independent civil society has not developed. According to (Gerő and Kopper, 2013), this phenomenon can be explained by the fact that 'party politics pervades every aspect of political life, undermining the autonomy of civil actors, treating them as a 'fan club' of parties rather than cooperating and consultative partners'. Under these conditions the professional level of Non-governmental organisations (NGOs) – as in the majority of post-socialist countries – is rather weak (Svidronova *et al.*, 2016). Given this lack of professional, genuinely independent NGOs, there is a wide space for organisations which present themselves as the independent, committed defenders of consumers' interests. As in other spheres of international NGO activity, it is very hard to determine the real political background and financial resources of these organisations (Císař, 2010; Harbulot, 2013).

3.5 Organic producers

Organic agriculture is firmly rooted in an ideology (Trewavas, 2001) which does not accept GM products, based on two weak arguments questioning the safety of food derived from GM crops and highlighting the threat of genetic contamination (Ceccarelli, 2014). Smyth *et al.* (2015) noted that GM crops have helped boost demand for organic products. There are fewer than 2000 farms in Hungary which can declare themselves to be organic producers, and the area under organic production has constantly decreased in the last few decades – to no more than 130 thousand hectares, or less than 3% of Hungary's arable land (Hungarian Central Statistical Office, 2015). At the same time, the increase in organic production is a strategic goal of the Hungarian government (Balázs, 2012). The ideology of organic farming is very close to the agricultural policy guidelines of the current Hungarian government, which is why this – basically marginal – community is able to multiply its influence on political decision making.

3.6 Biotechnology companies

Theoretically, the increasing concentration and economic power of biotechnology companies (Bonny, 2014) offers them a growing possibility to increase their political pressure on Hungarian decision makers. The positive effects of the application of biotechnological innovations on increasing the efficiency of Hungarian agriculture are well documented (Demont *et al.*, 2005; Dillen *et al.*, 2010; Kruppa, 2011). Taking into consideration the instability and unpredictability of the legal environment, the leading international biotechnology companies are somewhat reluctant to promote their products and services.

3.7 Consumers

The introduction of the new regulations on the commercialisation of GM crops and the labelling of GM food (European Parliament and Council, 2001) appears to have done little to allay the European public's anxieties about agri-food biotechnology (Gaskell *et al.*, 2006). In 2010 on average, a slim majority of 54% of Europeans agreed that GM food is not good for them or their families. Country variations were considerable, and 56% of respondents in Hungary hold this view (European Commission, 2010). Traditionally, the scientific and academic professions enjoy relatively high prestige in Hungary. This can account for the fact that, according to a Europe-wide survey carried out in 2005 (European Commission, 2005), Hungary has the highest proportion of respondents (76%) who supported the statement that scientific and technological decisions should be based primarily on the advice of experts regarding the risks and benefits involved. The average for the EU-25 was just 66%. In contrast to Hungary, in neighbouring Austria just 52% of respondents accepted this statement.

As became apparent from earlier examples (such as GMO and irradiation), the advantages that a new processing technology has to offer do not necessarily guarantee the success of a product in the market place (Nielsen *et al.*, 2009). There is a need to understand what consumers want, and want to avoid, with respect to GMO foods, as well as the consumer characteristics associated with concern for GMOs (Baker and Burnham, 2001). There are few research studies based on modelling consumer willingness to buy products which contain genetically modified genetic ingredients. One of the most comprehensive has shown, on the basis of a conjoint analysis, that consumers will accept genetically modified products if they offer some advantage (e.g. lower price, longer shelf life) (Lakner, 2006). The lower price of products seems to be an extremely important factor in Hungary, because 26.3% of the population is affected by poverty or social exclusion (Hungarian Central Statistical Office, 2016a). The share of the population living under the subsistence level was 14.5% in 2015. Food and non-alcoholic beverages make up nearly one quarter (24.5%) of household expenditure, which is why the price of food is a decisive factor in the standard of living of Hungarian households (Fodor and Horn, 2015).

3.8 Media

After 1990 international media enterprises acquired large parts of the Hungarian market (Gulyás, 1998). As in most Central European countries, tabloids are extremely popular in Hungary. Unlike the Western European tabloids, they carry a considerable amount of public information, but presented in a sensational and over-simplistic style (Tzankoff, 2002). This media focuses on scandals (Putnam, 1995; Thomson, 2000). One potential topic is GM foods and their supposed dangers to health. Fokas (2008) has demonstrated that even the 'serious' national newspapers are increasingly open towards sensations and 'scandals'. The putative risks of GM is a popular topic for the media, which is able to increase its audience by featuring this subject. The role of the media in the GMO-debate is an extremely complex issue. In his review Vigani (2017) highlights that (1) the information from environmental groups and scientists is often considered more reliable than other sources of information; (2) the public attitudes to GMOs are often negative, (3) the marginal value of an item of 'bad news' is higher than an item of 'good news'. The public is poorly informed on many important issues because information is imperfect. Information provision is assumed to be neutral; however, most information is not provided by institutions but by organizations selecting certain information (McCluskey and Swinnen, 2004). The opposition of European activist groups and some European consumers sparked media attention around the world. These concerns and the growing use of these crops have brought about regulatory changes to address their special characteristics and risks (Sonka *et al.*, 2000). The drastically contradictory views of pro and anti-GMO camps expressed in media debates have also helped to generate a general sense of misinformation and confusion, even in France (Kuntz, 2014).

3.9 Anti-GM researchers

Mark Lynas points out that the activities and views of anti-GM groups have been more influential than scientific facts in shaping government policy and that this situation is unacceptable (Lynas, 2013).The Hungarian academic community is highly divided in its views on GMO. This is the main reason we differentiate the members of the academic community according to their attitude towards the GMO issue. This seems to be a simplified solution but offers more insight than lumping the academic sphere together into one group. Moreover, although the anti-GM scientific community is rather heterogeneous, they share one common feature: the only internationally well-known biochemist in this group is Árpád Pusztai, whose results in the field of GM research (Ewen and Pusztai, 1999) caused considerable controversy in 1988 (Enserink, 1999). According to Harper (2004), Pusztai's visit to Hungary evoked both patriotic pride among some scientists in the Hungarian scientific community, and at the same time support for Pusztai as a scientific authority. His image as a refugee from the Communist regime in 1956 contributed to his credibility. Anti-GM researchers have been receiving considerable research support for studies designed to analyse any potential negative environmental effects of GM plants, and for the development of new methods of GM detection.

3.10 GM-free certifiers

GM crops currently represent the bulk of the international trade in maize, soybean and canola. This constitutes the main challenge for the supply of identity-preserved (IP) non-GM crops. Segregation of non-GM IP crops involves costs at every step of the supply chain, and the price premiums for these products are increasing. Furthermore, non-GM IP crops require stricter controls along the supply chain, third party certification, and a stronger commitment of all the parties involved (Tillie *et al.*, 2012). The detection, segregation, and separation during the handling of GM products creates a market for a wide, and continuously deepening range of services and products (laboratory equipment, tests, external auditing). There are different estimations of GM-free testing costs in the literature. According to Menrad, the testing costs for GM-free raw materials are 9.39 €/t for sugar in Germany, and 1.86 €/t in Denmark (Menrad *et al.*, 2009). There is a large number of species, GMOs, and food products, which is why GM-detection is labour- as well as knowledge intensive, and has high costs (Holst-Jensen *et al.*, 2012). The additional costs incurred to ensure coexistence results in price increases ranging from 7.4% to 13.8%, compared to non-GM food products (Gabriel and Menrad, 2015).

3.11 Traditional plant breeders/geneticists

The anti-GM climate creates favourable conditions for projects aiming at the development of new varieties involving plants which have relatively unfavourable agro-ecological conditions for production. This offers a market for traditional plant breeders/geneticists. A striking example of this is the 'Donau-Soya' project (Krön and Bittner, 2015). The producer price of soya in Hungary has been 25% higher on average over the last five years compared to prices in the world's largest soya producers, the USA and Brazil. The question arises as to whether the non-GM soybean market in the EU will continue growing or will experience a contraction due to difficulties in supply availability and the resulting high premium. The evolution of this market will depend on its ability to secure the supply of non-GM soybean from Brazil at affordable prices and the search for alternative suppliers. The success of both options will determine the future of the non-GM markets in the EU (Tillie and Rodríguez-Cerezo, 2015).

3.12 Market-oriented agricultural producers

Hungarian agriculture is dominated by relatively large scale producers and very small farms. There is a strong, significant correlation between the yield and the profitability of production. At the same time, the yields are relatively low in Hungarian agriculture. Between 2009 and 2013 the average yield in Hungary was lower than the European average by 13% for maize, and by 8% for wheat (Hungarian Central Statistical Office, 2015). Soybean production in Hungary is able to cover only a small proportion of consumption. A further, specific problem of Hungarian agriculture is the negative consequences of climate change. It is well-documented that Hungary is extremely vulnerable to decreasing precipitation. Under these conditions, the introduction of new, drought-tolerant varieties seems to be a key issue. Given these conditions, it is obvious that the majority of market-oriented agricultural producers are *per se* interested in increasing yields. Direct and indirect subsidies from the EU made up 36.5% of the gross income of Hungarian agricultural producers in 2015 (Hungarian Central Statistical Office, 2016b). This was more than enough to cover the lack of efficiency and productivity (Quiroga *et al.*, 2017). From 2020 the Common Agricultural Policy will drastically change (Nazzaro and Marotta, 2016). A possible consequence of this will be a drastic reduction in agricultural support. This fact further enhances the importance of increasing efficiency.

3.13 Food industry and trade

Interestingly, neither the Hungarian food industry, nor the food retail sector has taken an active part in the debates on GM crops. According to survey participants, this fact can be explained by the rather unfavourable position of these branches in the economy: in the last ten years the level of registered capital in the Hungarian food industry has decreased by 50% as a consequence of a slow re-structuring process. In addition, the Hungarian middle-class has been shrinking, and numerous regulatory measures have been introduced

(centralised sale of tobacco products, compulsory closing of shops on Sundays). The results of our interviews did not support the statement formulated by Apel (2010) highlighting that food companies have substantial financial interests in opposing agricultural biotechnology. On the contrary, the Hungarian food industry focuses mainly on the domestic market where the main driver is the relatively low consumer price of food products.

4. Results

In the first phase of our investigations we used unstructured interviews to set up a set of actors and their potential goals. In the second phase we applied a structured interview to collect estimations. Using the results of extensive (unstructured, face to face) interviews, we determined the set of key actors (Table 2), and the set of strategic goals which were determined for one or more actors (Table 3). To avoid any ambiguity or preconception, the actors in the research were mentioned in alphabetical order of their abbreviation. The same applies in the tables, too.

Table 2. Relevant actors in the Hungarian GM game.[1]

Actor	Abbreviation
Academic community	ACAD
Anti-GM scientific researchers	ANTIGMSCI
Anti-GM NGOs	ANTIGMNGO
Biotechnology companies	BIOTECH
Consumers	CONS
European Union	EU
GM-control suppliers	GMCONT
Hungarian political elite	HUPOL
Market-oriented agricultural producers	AGR
Media	TABLOID
Organic producers	ORG
Traditional plant breeders	TRADSEL

[1] Altogether 12 actors have been identified. Arguably, their number could be increased, but this would jeopardise the operability of the research.

Table 3. Set of key strategic goals in the Hungarian GM game.

Elements of strategic goals	Abbreviation
Increasing consumers' welfare through cheaper foods	WELF
Maximising votes by 'defending the national interest' rhetoric	VOTE
Maximising the profit in agricultural production	AGROPR
Maximising the audience	AUDMAX
Maximising the profit in agricultural production by GM free communication	GMFREEPR
Market creation for scientific research with anti-GM attitudes	ANTIGMSCI
Market creation for GM-detection instruments and laboratories	GMFREEAUD
Sale of GM seeds	GMSEEDS
Seed production based on traditional technologies	TRADSEED
Maximising public attention by anti-GM declarations	ANTIGMPROP
Development of GM plants and technologies	BIOTECHDEV
Increasing the inclusiveness of Hungary in the international scientific community	INT
Decreasing chemicals in the environment and in food	CHEMDECR
Decreasing the environmental burden caused by abuse of agro-chemicals	ENVFOOD
Production of functional food	FUNCFOOD

When preparing Table 2 and 3, only the most important issues were taken into consideration in order to concentrate participants' attention on the key issues. Even so, a relatively high number of actors and goals emerged. The overwhelming majority of our colleagues agreed that if we had further increased the number of actors or goals, this could have jeopardised the practical realisation of the project, because the participants could 'get lost' in the evaluation of the positions of different actors.

Altogether fifteen different goals were identified. This set of goals seemed to be the upper limit for practical handling. Profit maximisation in agricultural production is calculated by using the price difference for GM-free and non-GM identity preserved crops. It is well known that one of the main arguments of anti-GM rhetoric is the 'non-naturalness' (Wunderlich and Gatto, 2015) and 'unsafe' nature (Scott *et al.*, 2016) of these products. This is why, theoretically, the purchase of safe products can be included in the set of actors' potential goals because this is especially important for consumers. The willingness of consumers to buy safe products has been considered as a natural, *per se* condition, which is why we have included these arguments in the set of strategic goals. The protocol of expert interviews is summarised in Supplementary Methods S2.

The matrix of direct influences is summarized in Table 4. The cells of the matrix indicate the influence of the actor in the row on the corresponding actor in the column.

The dependence and independence of actors are measured on relative scales. Obviously, the highest levels of influence are enjoyed by the political (and legislative) forces: the Hungarian political elite and the European Union. Consumers, as well as agricultural entrepreneurs who seek to modernise, occupy a subordinated level in this bargain, with a relatively low level of influence and high level of dependence. Unlike biotechnology firms, they do not have the opportunity to quit the game.

Table 4. Analysis of actors' positions and strategies using the MACTOR[1] method.[2,3]

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
EU: 1	0	3	2	0	1	3	2	2	0	1	3	3	2
HUPOL: 2	2	0	4	2	3	3	3	3	2	3	3	4	4
ACAD: 3	1	1	0	0	0	0	0	1	0	0	0	0	0
NONGMNGO: 4	1	1	0	0	1	0	2	3	0	0	0	1	0
ORGPROD: 5	1	1	0	1	0	0	1	1	0	0	0	0	1
BIOTECH: 6	1	0	1	0	0	0	1	1	0	0	0	0	0
CONS: 7	1	1	0	0	1	0	0	0	0	0	2	2	0
MEDIA: 8	1	2	0	0	0	0	4	0	0	0	3	3	0
ANTIGMSCI: 9	1	1	0	3	1	0	0	1	0	0	0	0	0
GMCONT: 10	1	1	0	0	1	0	0	1	0	0	3	3	0
MODAGR: 11	1	1	1	0	0	0	1	1	0	0	0	1	1
FOOD: 12	1	1	1	0	1	0	3	1	0	0	3	0	0
PLANTSEL: 13	0	1	0	0	1	0	0	0	0	0	1	0	0

[1] Matrix of alliances and conflicts, and the tactics, objectives and recommendations.

[2] The headers of the columns are the same as the title of each row.

[3] Obviously, there are considerable differences between the bargaining positions of different actors.

Analysing the direct influence and dependence rate of actors (Figure 2) based on Table 3, it is obvious that the influence-dependence structures of the EU and the Hungarian political elite do not show considerable differences. A wide range of actors have some influence on Hungarian political decision makers, but the level of intensity is relatively low. This fact mirrors the low level of debating culture in Hungarian society, unlike, for example, in the United Kingdom, where in 2003 the 'GM nation?' debate took place, which – with all its controversies (Pidgeon *et al.*, 2005; Rowe *et al.*, 2005) – at least tried to create a platform for the exchange of opinions (Horlick-Jones *et al.*, 2006). The intense lobby activity of multinational biotechnology firms is a natural way of expressing and asserting their interests (Coen, 1997), but in the current Hungarian political climate most of the respondents considered the possibilities available to multinational firms to influence political decision makers in Hungary to be extremely limited because, in the opinion of the majority of respondents, the sheer fact of meeting representatives of these firms is considered politically compromising. The academic sphere has a rather high dependence on the political elite because the resources for basic research have been highly centralised (Hennen and Nierling, 2014). 'Organic' is a buzzword in Hungary (Koszegi, 2014), which is why the influence of well-organised and assertive organic producers is much more intense than could be deduced from the size of this producer group.

By analysing the net force of different actors based on Equation 4 (Figure 3), the high level of influence of the Hungarian political elite, the European Union and the anti-GM NGOs, and the marginal position of the academic sphere, is obvious. The r values of dependence have been calculated on the basis of Equation 4. Obviously, the science- and market-oriented participants in the bargaining play a marginal role in the game.

The media is considerably influenced by the government (Bajomi-Lázár, 2013), but there are numerous market-based enterprises which are relatively independent from direct political influence (Hanretty, 2014). The relatively high level of independence (put in another way: the lack of control) of anti-GM scientists and quality control organisations offer them a favourable position to influence the public, and in this way to create a market for their ideology, products and services. In a free, market oriented economy, market-oriented agricultural enterprises are the engines of development (Pasour, 1990), but the expert estimations indicate a somewhat dependent position for this element of society.

The set of actors' potential objectives (Table 3) consists of a relatively high number (12) of these objectives (Table 5). Four objectives out of 12 can be associated with just one author. This fact makes it difficult to form a coalition. At the same time, there are two goals (ANTIGMPR and GMDETPRIFI) which categorically divide the stakeholders' concerns. With some goals a relatively wide coalition can be forged; these include increasing welfare, decreasing the chemical burden on the environment and enhancing the functional characteristics of food products.

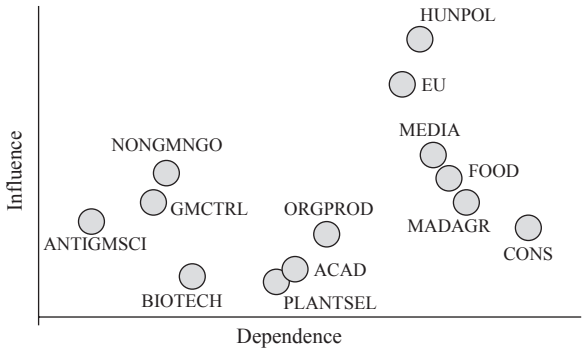

Figure 2. Direct influence and dependence of actors.

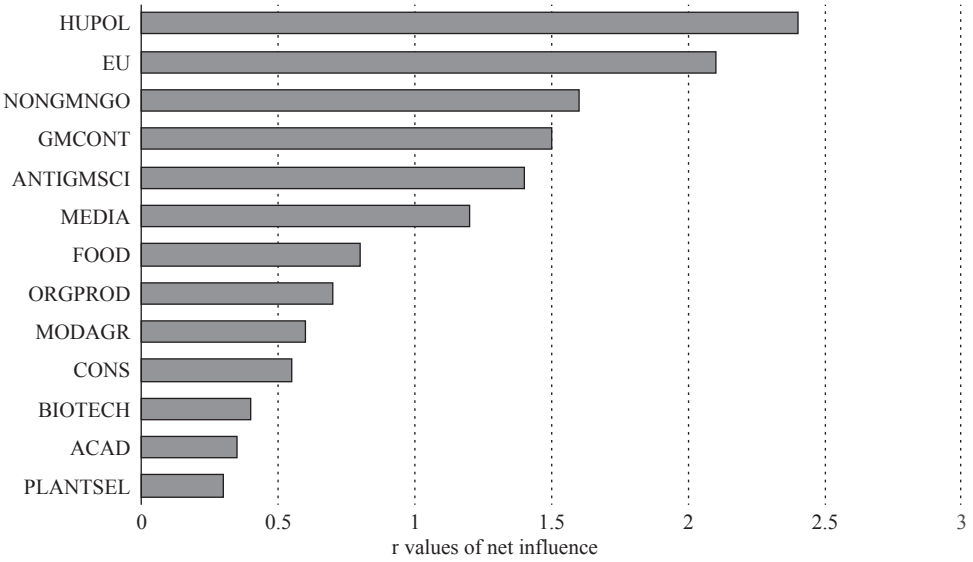

Figure 3. Bargaining position based on net influence of different actors.

Table 5. Actor-goal matrix (actors' attitudes to different goals are expressed on a -4 to +4 scale).[1]

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
ACAD	-2	0	4	0	4	0	0	0	4	0	0	0	0
ANTIGMSCI	4	0	0	0	0	0	0	0	0	0	0	0	0
BIOTECH	0	0	3	0	3	0	0	4	0	0	0	0	0
CONS	0	0	0	1	4	0	0	0	0	0	0	0	4
EU	3	0	1	1	2	0	0	0	1	0	0	0	2
FOOD	0	0	3	1	4	-1	1	0	2	0	0	0	3
GMCONT	4	0	0	0	0	4	0	0	0	0	0	0	0
HUPOL	4	0	1	3	1	0	0	0	2	3	0	4	4
MEDIA	2	4	0	0	0	0	0	0	0	0	0	0	0
MODAGR	0	0	3	3	2	-3	2	0	0	2	4	0	1
NONGMNGO	4	4	0	3	0	0	0	0	0	1	0	0	0
ORGPROD	4	0	0	0	0	0	4	0	0	2	0	0	1
PLANTSEL	0	0	0	0	0	0	0	0	0	4	0	0	0

[1] 1 = ANTIGMRP; 2 = AUD; 3 = BIOTDEV; 4 = CHEMDECR; 5 = FUNCTIONAL; 6 = GMDETPROFI; 7 = GMFREEPROF; 8 = GMSEEDS; 9 = INT; 10 = NOGSEED; 11 = PROFIT; 12 = VOTE; 13 = WELFARE.

Interestingly, a considerable number of respondents did not accept the often-heard argument that selling GM-free products brings a higher profit margin. According to their argument, the low level of organisation of the international trade in agricultural and food products, and the low capital endowments of producers are much more important obstacles than the lack of GM.

There are considerable differences between the interests of the goals of different actors. Some goals (e.g. profit, or vote maximisation) are only important for some actors, but the achievement of these is vital for them.

Analysing the weighted level of support for different goals based on Equation 6, it is obvious that the highest level of mobilisation force is generated by anti-GM propaganda (ANTIGMPR). This fact can be explained by four arguments:

1. Some actors are directly interested in anti-GM campaigns because this is the legitimising basis for their existence (e.g. anti-GM NGO's).
2. The media is highly motivated to transmit any news which could serve the growing audience.
3. The political elites try to utilise the 'rally round the flag' effect. This is well documented in political sociology (Gelpi, 2017; Neustadt, 1960), and its essence is summarised through the example of the US political system by (Flores-Macías and Kreps, 2017; Polsby, 1964): 'inevitably, the popular response to a President during an international crisis is favourable, regardless of the wisdom of the policies he pursues'. In the opinion of (Mueller, 1970) the 'rally point' must be associated with a problem which (a) is international, (b) involves the nation, and (c) is specific, dramatic and sharply focussed. The GM problems can satisfy these criteria to a considerable degree, which is why the elite is happy to utilise this effect in boosting its popularity. A vicious circle begins: to maximise the 'rally round the flag' effect the risk of GM should be emphasised. Consumers in the EU oppose GM foods, although scientists and official institutions claim these products are safe. Imperfect information is blamed for consumers being poorly informed. This problem may be solved by providing more information since most information is not provided by institutions but by organizations with an incentive to select certain information (McCluskey and Swinnen, 2004). Tabloidizing by the mainstream media influences the effects of anti-GM NGOs and scientists. The circle is closed when policy makers, a considerable number of scientists, the media and the political elite are able to create and maintain a monster able to serve their goals.
4. As has been demonstrated above, all of the actors involved in this circular causality have a high level of influence (Figure 2).

The correspondence analysis between actors and goals (Figure 4) highlights a close relationship between academics, modern agricultural producers, and the food industry, as well as biotechnology companies which can be attached to this group of actors (A), but there is also a close, interest-based relationship between anti-GM scientists, the media, and enterprises offering GM detection technologies and quality control systems (B). A third, characteristic group is the political sphere, based on vote maximization (C).

Correspondence analysis is an extremely useful tool to demonstrate the relative positions of actors and goals. Obviously, consumers (and their welfare) are 'orphans' in this field of science and politics. The market-and profit-oriented actors have relatively compact clusters, as opposed to the relatively homogenous group of

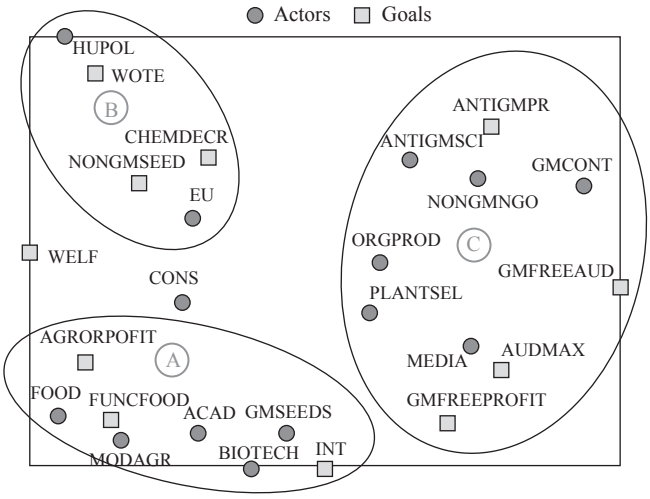

Figure 4. Results of correspondence analysis of actors' and goals' sets.

actors and interests based around an anti-GM attitude. This situation is capable of blocking development for a long time.

5. Conclusions and discussion

Based on our analysis, it is obvious that there are three specific clusters of actors and goals. One cluster (A) can be characterised as pro-GMO actors and their goals. This embraces biotech companies, profit-oriented agricultural enterprises, food industrial companies and the academic sphere. Their goals are well-identifiable economic factors and contributions to the health of the population. The B cluster has just two actors: the Hungarian government and the EU. This situation clearly highlights the separation between politics and professionalism. It is very important to see that consumers and their welfare are marginal actors and considerations in this game for influence and voters. It can be stated that the current biotechnology landscape does not offer a long-term solution based on the real interests of consumers. The cluster of anti-GMO actors and their goals (C) is much more heterogonous because, besides the actors whose individual interest is related to non-GM activities, we can also find the media in Group C, whose most important aim is to maximise their audience. The majority of the Hungarian media is state-controlled and the rest private. However, the practical influence of the private media is much more significant with a larger audience compared to the state-controlled media and that is why the Media appears in Group C. The basic direction of changes should reshape the decision making procedure of the EU in a direction involving increasing scientific flexibility and the ability to put decision-making on a sound footing, since there is an extremely strong pressure on the EU to contribute much more to global problems (e.g. climate change, the fight against poverty).

Here we also encounter the organic producers. It is worth highlighting that the area of land cultivated by organic methods has been stagnating in Hungary since 2005. This fact indicates that in spite of one of the strictest GM regulations in the world, Hungarian eco-producers have not been able to achieve a considerable increase in land area. For example, in Spain, with its more liberal GM regulation (Vigani *et al.*, 2012), the proportion of land under organic production is four times higher than in Hungary. It can be concluded that the presence of anti-GM regulation cannot be considered a necessary precondition of the success of organic production.

As a conclusion of our investigations it can be observed that a rather specific alliance of different forces against the latest methods of biotechnology has been created. This alliance is built on aversion to new technologies and is in harmony with the general policy of the current Hungarian government, which emphasises the food sovereignty of Hungary. This feeling is further fuelled by the anti-globalisation rhetoric of the governing Hungarian political elite (Enyedi, 2016), which over the last few months has acquired a new impetus, because other nationalistic parties from the neighbouring countries have joined their voices to this chorus. In the spring of 2017 the political leaders of East-Central European states declared that they do not want to be the 'rubbish-bin' of Europe (http://tinyurl.com/yd4krvow).

The strong coalition between anti-GM forces and the political- and media elites seems to be strong enough to freeze the current situation for quite a long time. But even under these conditions some hard questions still remain to be answered. The most important are the following:

- Based on sociological research, the 'so-called' middle class in Hungary has shrunk by one million people (Binelli *et al.*, 2015). It is not clear how the constantly increasing low-income element of the population can be supplied with safe and high-quality food without GMO, especially in the case of meat produced by non-GM soymeal. As a consequence of climate change, the agro-ecological potential of Hungary will decrease quite rapidly, mainly due to decreasing precipitation (Li *et al.*, 2017). It is hard to predict how Hungarian agriculture will be able to cope with this new concern.
- Hungary is eager to participate in the international food trade. How can the competitiveness of food production be maintained with increasing feed prices? Over the last few decades Hungarian researchers have achieved some internationally respected results in the field of plant biotechnology

(Ricroch *et al.*, 2016). Under these conditions, how is it possible to maintain the human resources required for biotechnology? How can we prevent a brain-drain from this field of science in Hungary?

- The decreasing production intensity of Hungarian agriculture offers considerable environmental benefits; however, the abandonment of agricultural land in some regions causes considerable environmental and ecologic problems (De Weger *et al.*, 2016). One of the most evident indicators of this phenomenon is the increasing number of areas infested with ragweed (*Ambrosia artemisiifolia*), a plant which leads to a deterioration in the quality of life in Hungary where the number of registered hay-fever patients increased from 10 000 in 1990 to 309 000 in 2012 (Hungarian Central Statistical Office, 2015).

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Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2017.0065.

Methods S1. Prisma model.
Methods S2. Protocol of interviews with experts.

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