Sustainable rural development: what is the role of the agri-food sector?
MARTIN PETRICK, GERTRUD BUCHENRIEDER (eds., 2007)
Studies on the Agricultural and Food Sector in Central and Eastern Europe, Vol. 39, Halle (Saale), IAMO.

ANTICIPATED IMPACTS OF GMO INTRODUCTION ON FARM PROFITABILITY IN POLAND

MARIUSZ MACIEJCZAK, ADAM WAS*

ABSTRACT

The paper takes one significant element of agriculture production – the use of genetically modified organisms (GMO) – and considers it in relation to the overall profitability of agriculture in Poland. In so doing, the paper aims to examine Polish farmers' opportunity costs of being non-GM, were they free to use GMO. Specifically, the paper asks if, under *ceteris paribus* conditions, the use of GMO plants in Polish farms would influence their economic results. To answer this question, the scientific and theoretical assumption that GMO cultivation is permitted in Poland has been applied. The approach combines experience of the new biotech-based system of agricultural production with a modelling system that builds up and aggregates the impacts of individual farm responses under actual and assumed situations.

Key words: GMO, coexistence, farm profitability, farm model, Polish agriculture.

1 INTRODUCTION

Growing concerns are observable in Poland over the coexistence of genetically modified organisms (GMO) and non-modified organisms - both conventional and organic (non-GM). So far, GMO use is restricted in Poland. According to official data provided by the responsible authorities, currently there are no GMO cultivations in Poland (THE SCOPE …, 2007). The use of GMO feeds is permitted, but under a special moratorium. However, since September 2004, the European Commission permitted, under strict conditions, GMO varieties to be grown in the European Union (EU). Poland, as an EU member state, asked for a temporary prohibition, citing the need to strengthen existing laws on GMO plant cultivation (PRESS RELEASE..., 2005). Lifting this prohibition was recently considered in the amended Legal act on genetically modified organisms (PROPOSAL OF AMENDMENT …, 2007). But according to the position paper of the Polish government, the cultivation of GMO crops should be extremely limited or even excluded. Thus, the regulations proposed in the amendment provide a

* Warsaw Agricultural University – SGGW, Nowoursynowska Str. 166, 02-787 Warsaw, Poland, E-mail: mariusz_maciejczak@sggw.pl , adam_was@sggw.pl.

chance for minimising the risk connected to mixing plants' reproductive material, or the cross-pollination of GM and non-GM plants. It also enables the introduction of appropriate control measures (THE SCOPE…, 2007).

Nonetheless, there is much opposition at various levels to the introduction of GMO crops. As an example, all 16 Polish provinces have already announced that they aim for a total ban of GMO crops (GMO FREE ZONES..., 2007). On the other hand, there are many supporters of GMO use in Polish agriculture. These advocates claim that biotech-based agriculture could significantly increase yields and reduce costs; they also claim that it has many other positive impacts which could strengthen the competitiveness of Polish agriculture, as well as that of particular farms (TWARDOWSKI, 2007). In the most recent survey on the public perception of biotechnology, more than 50% of Poles are in favour of scientific research using biotechnology and genetic engineering in the production and processing of food. However, 65% of respondents are afraid that GMO in food products might have a negative impact on the environment and human health (PUBLIC PERCEPTION…, 2005).

It should be noted that agriculture is an open process, which means that perfect segregation of the various agricultural production types, namely conventional, organic or based on genetically modified organisms, is not possible in practice. When considering the different aspects of GMO and non-GM systems, it must be taken into account that in the EU, no form of agriculture should be excluded and the ability to maintain different agricultural production is considered as a prerequisite for providing a high degree of consumer choice (COMMISSION RECOMMENDATION, 2003).

Thus, to cope with the emerging GM challenge, which is either prohibition or implementation of GMO in Polish agriculture, biotechnology development policies of the EU, as well as the general trends of agricultural development, where biotech-based systems are expanding rapidly, should be taken into account (BROOKES and BARFOOT, 2006); naturally, the opinion of the Poles should also be considered. From the economic point of view, the total ban of GMO might directly influence the performance of Polish agriculture (ANIOL and BROOKES; 2005), as well as the existence of a black market for GMO in Poland (ZAKOWSKA-BIEMANS and MACIEJCZAK, 2005).

The approach applied in this paper combines the (very short) experience of the new biotech-based system of agricultural production with a modelling system that builds up and aggregates the impacts of individual farm responses under actual and assumed situations. As such, it is possible to gain an understanding of the likely movement in incomes for a variety of assumptions, together with changes in the balance of enterprises by farm type and in the aggregate, assuming farmers strive for, or are forced to adopt through competition, profit-maximising strategies. The results provide an indication of the impact of GMO application on the performance of Polish agriculture, including the importance of different GMO crops on the maintenance and prosperity of different farm types. The employed comparative static approach does show the degree to which one significant element of agriculture production – the use of genetically modified organisms - could influence the sector.

2 THE MODEL

In preparing this paper, an exhaustive investigation has been completed comparing the situations of 252 representative farms, with introduced or constrained GMO crops, using a linear programming optimisation technique. The model was constructed as an Excel spreadsheet and solved with the Solver function. The applied farm model uses over 80 decision variables and over 200 constraints. Each of the farm models optimise Net Farm Income (NFI) in a comparative static approach. A set of balances has been incorporated into the model to secure internal integrity of the results. The most important of these are rotational ties for crops. A animal feed nutrient balance is obtained whereby the model optimises the use of fodder and calculates the necessary supply of concentrates. The balance of animal places with buildings available is also included. By using the standards adapted to the technologies implemented in the modelled farms, the relationship between the labour force and tractors is achieved.

All parameters of the calculation were fed into the model in a disaggregated form. These included: farm enterprises with associated yields and input requirements, product prices, input costs, costs of land lease and production quotas, services, seasonal and permanent employment, and other financial burdens of the farms. It is also possible to program in any type and amount of payment from the Common Agricultural Policy (CAP).

2.1 Farm types

The set of 252 farm types are representative of some 90% of the agricultural area in Poland; they have been assembled using statistical and FADN[1] data as well as expert knowledge. The farm types have been classified according to the following criteria:

- intensity of production: intensive and extensive;
- soil quality: good, medium and poor soils;
- enterprise types: cattle, pig, arable, mixed;
- size: (6 groups of arable farms, 8 groups of cattle and pig farms, 20 groups of mixed farms, assuming different sizes and also different proportions of pigs and cattle).

[1] Farm Data Accountancy Network of EU.

After calculating the optimal results for every farm type model in every scenario, the results were multiplied using the number of each type of farm in the total Polish farm population.

2.2 Scenarios

Two time horizons, which take into account the short-term (2006) and medium-term (2013) perspective, were assumed. For each time horizon, two scenarios were created: "non-GMO", which assumes restrictions for GMO crop development, and "GMO", which assumes unlimited coexistence of GMO and non-GMO crops, i.e., no buffer zones. In "GMO" scenarios, the availability of basic GMO crops like Roundup Ready wheat, rapeseed, corn for grain, maize for silage and sugar beets has been assumed. The run of the calibrated model for 2006 served as a reference scenario (non-GMO situation) for solutions generated for "GMO 2006". This was done in order to explore the potential effects on financial performance of farms applying GMO. The run of the "non-GMO 2013" model was used as a reference for the future "GMO 2013" model in order to examine the influence of upcoming CAP changes regarding the GMO issue. Thanks to such assumptions, the model also reflected expected changes in agricultural policy, especially the level of support in line with the phasing-in of the current SAPS[2] payment scheme, as well as forecasted changes in prices and costs (MAJEWSKI ET. AL, 2006). In the medium-term perspective, adjustments in production structure have been assumed, while the short time perspective has been constrained to preserve current status. However, the analysis does not consider dynamic changes between 2006 and 2013, due to overall difficulties in distinguishing the single impact of introducing GMO crops from the impact of agricultural policy.

3 RESULTS

Calculated farm model results were aggregated to obtain estimates for the whole of Polish agriculture, as well as particular farm groups. The results have been compared separately for the short- and medium-term perspective. To examine the potential influence of GMO crops, a comparison of farm types has been made according to various intensities of production, specialisation and soil quality. In both time horizons, the introduction of GMO crops has a positive influence for Net Farm Income. However, the effects are not evenly distributed among farms.

3.1 Impact in the year 2006

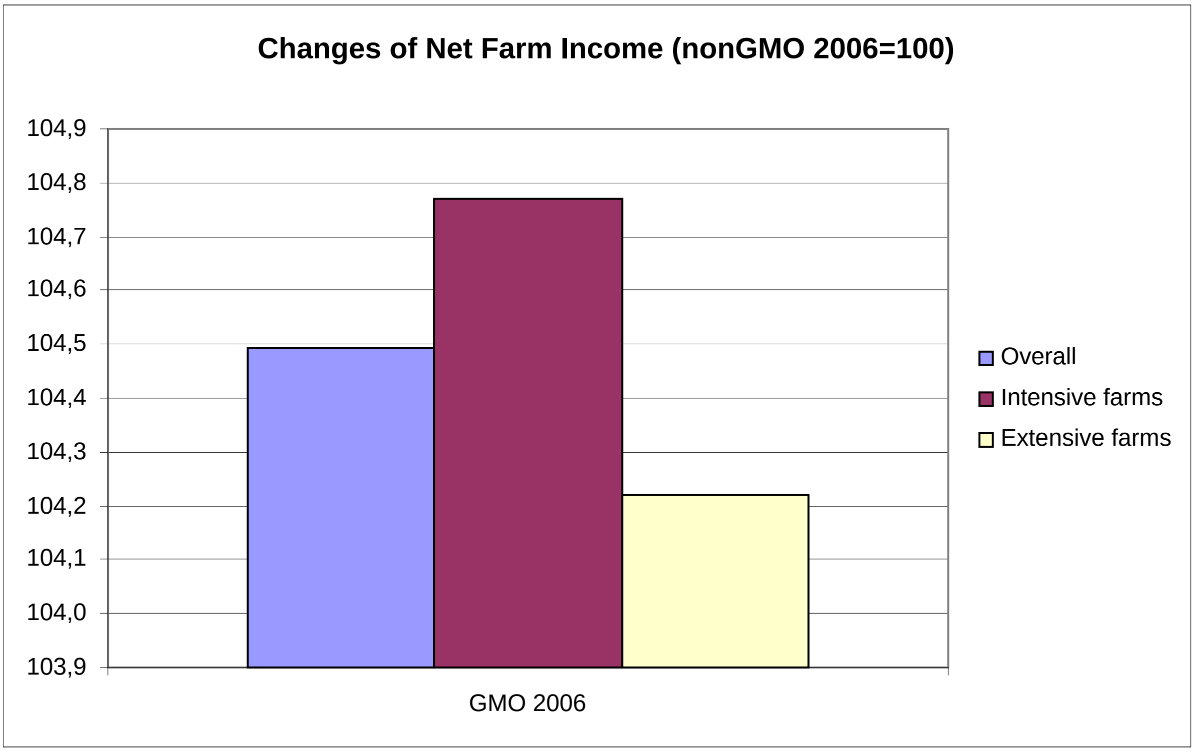
The increase of overall Net Farm Income due to the introduction of five GMO "Roundup Ready" crops in 2006 reached 4.5%. This proved, therefore, the

---

[2] Single Area Payment Scheme – direct payment scheme applied in most of EU New Member States.

potential of new biotechnologies. Although the calculated models show differences in growth rate between intensive and extensive farms, those differences are rather small (Figure 1).

Figure 1: Potential income effects of GMO crop introduction for 2006 by intensity of production.

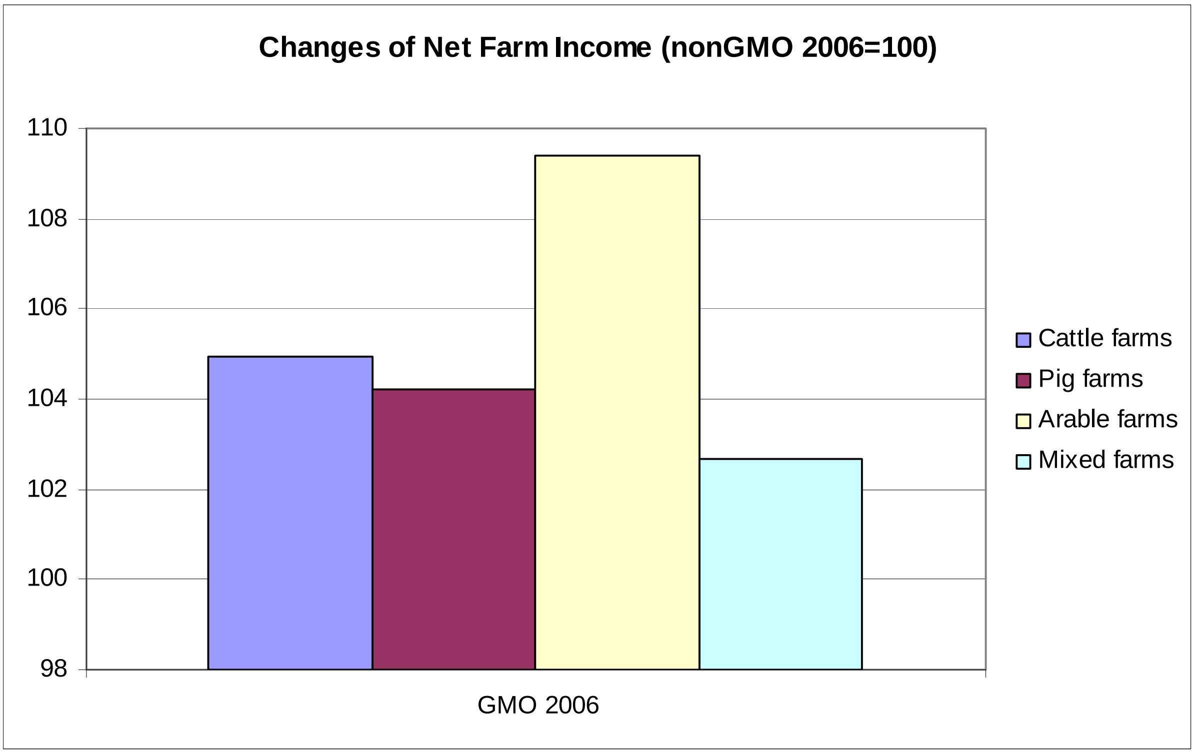


Source: authors' calculation.

The model results show much stronger differentiation in the economic effects of GMO implementation in the case of farm specialisation.

The highest increase of NFI is observed in the case of arable farms. This could be explained by a higher share of crop production in total production, which might be influenced by GMO crops. Farm types that specialised in animal production also gained from the introduction of GMO, but due to a limited share of crop production in the production structure, the NFI increase is lower. The slightly better situation of cattle farms could be explained by utilising the potential of GMO fodder maize. Low profits on the side of mixed farms are caused by the relatively smallest share of crop production in terms of income creation (Figure 2).

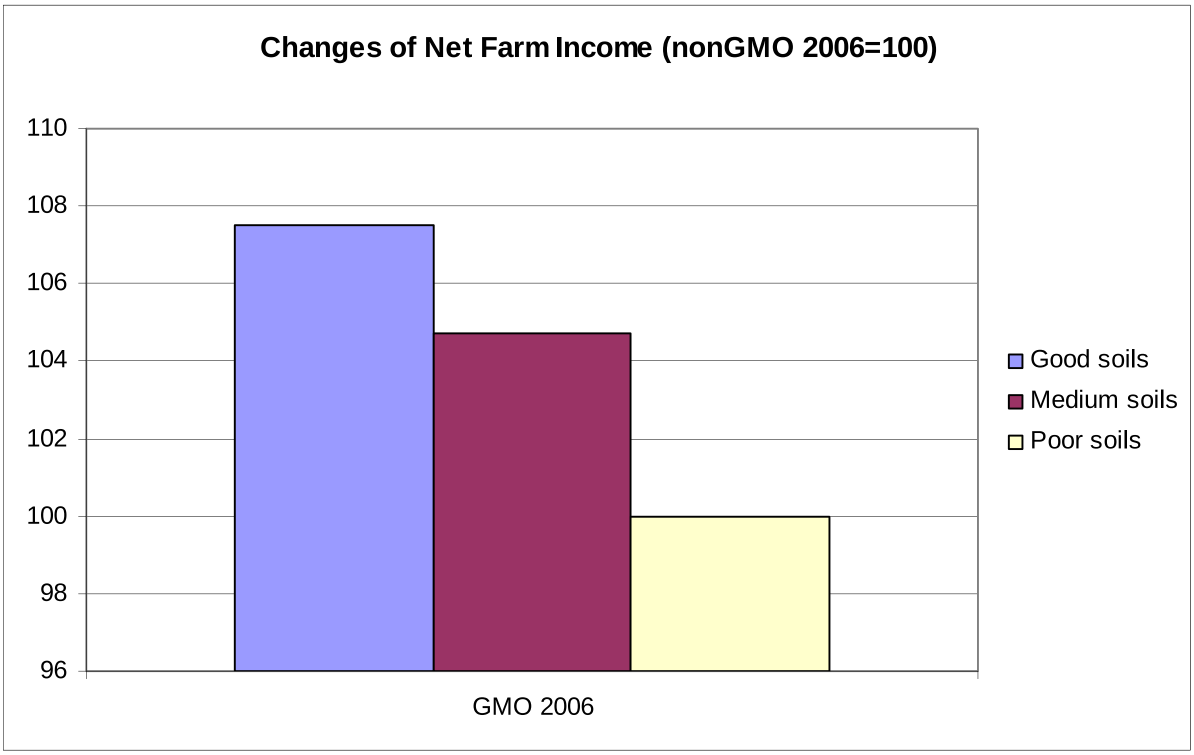
Figure 2: Potential income effects of GMO crop introduction for 2006 by specialisation.



Source: authors' calculation.

Results of the model calculated for farm types differentiated by soil quality show essential disparities in the economic effects of introducing GMO. Models of farms located on the best soils show the possibility of highest NFI growth due to GMO application. On the contrary, models of farms on poor soils do not show any benefits from possibly acquiring modified species. Looking at a set of currently available modified species, this phenomenon can be easily explained. Most GMO species require rich or medium soils for optimal growth. Limited yield growth potential, together with the relatively high costs of new technology do not create favourable conditions for applying GMO crops on poor soils (Figure 3).

Figure 3: Potential income effects of introducing GMO crops for 2006 by soil type.



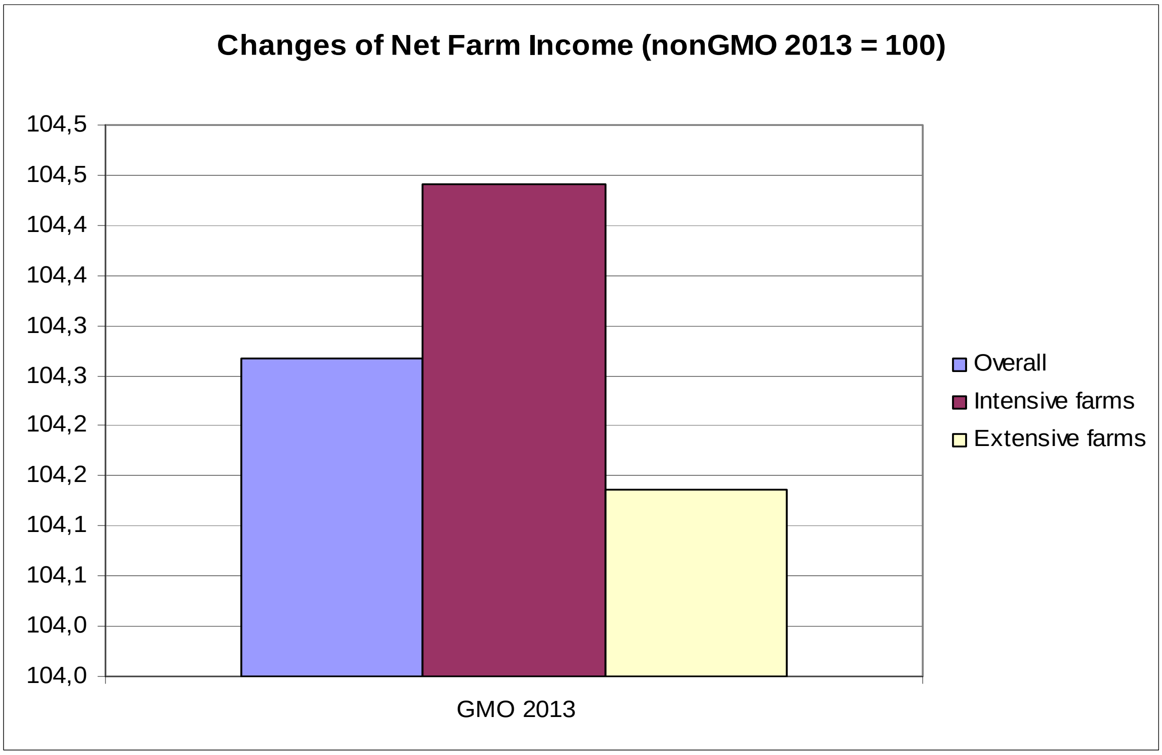
Source: authors' calculation.

3.2 Impact in 2013

The results of models for 2013 confirm the outcomes of scenarios for 2006. The assumed introduction of full rates for the SAPS payment scheme and forecasted worsening of trade-off conditions in agriculture had no influence on the economic effects caused by implementing GMO crops. The observed relative gains are slightly smaller than in 2006. This could be explained by the increase of overall income due to increasing direct payment rates. (Figure 4-6).

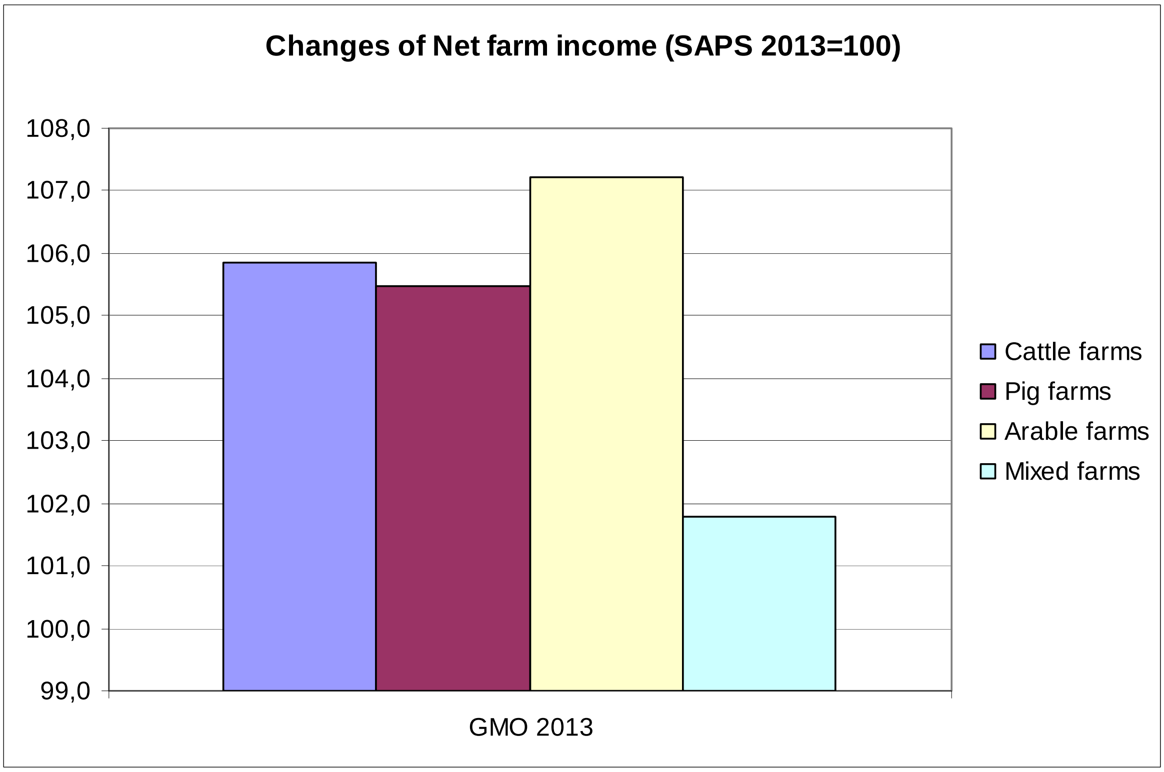
Further, relaxing some rotational constrains do not change relative NFI gains resulting from GMO application. Optimisation of the cropping structure, which leads to increased shares of corn and rapeseed at other cereals' expense (Figure 7) does not change the relationship between GMO and non-GMO species. In all farm types analysed in both time horizons, the relative income increase due to GMO introduction is hardly the same.

Figure 4: Potential income effects of GMO crops introduction for year 2013 by intensity of production.



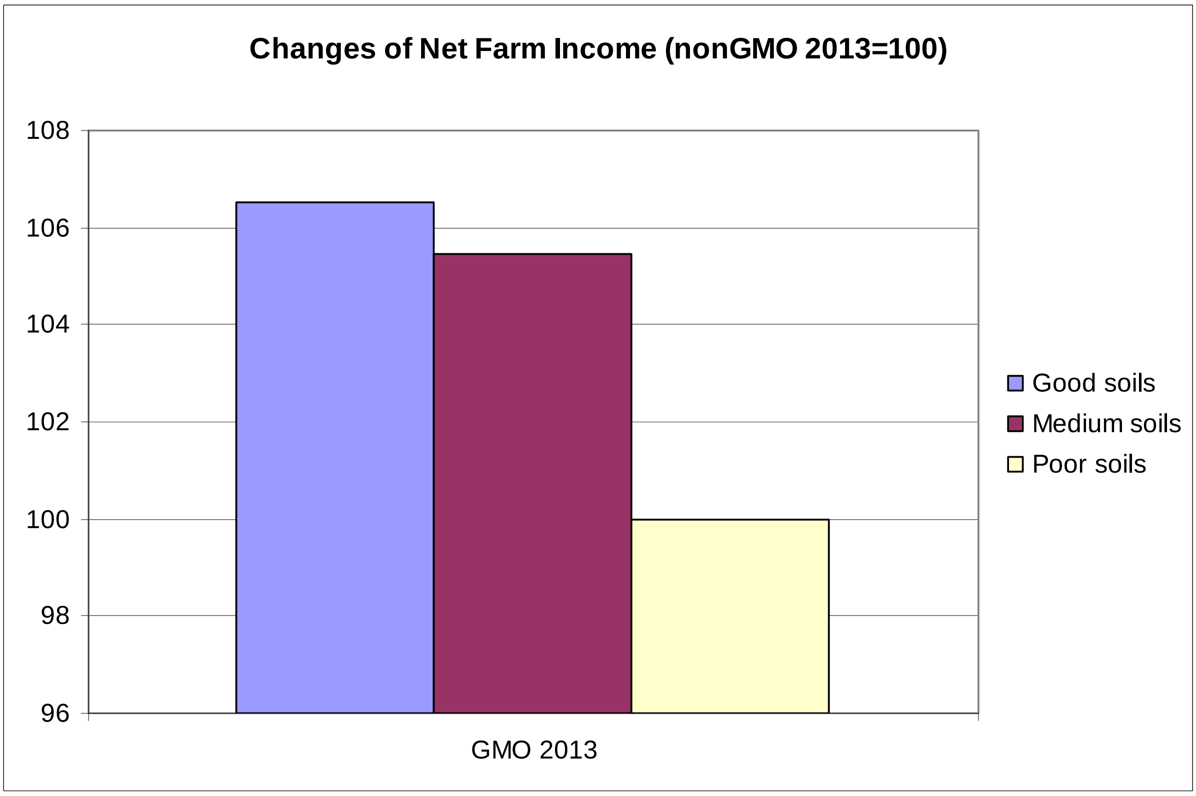
Source: authors' calculation.

Figure 5: Potential income effects of GMO crops introduction for year 2013 by specialisation.



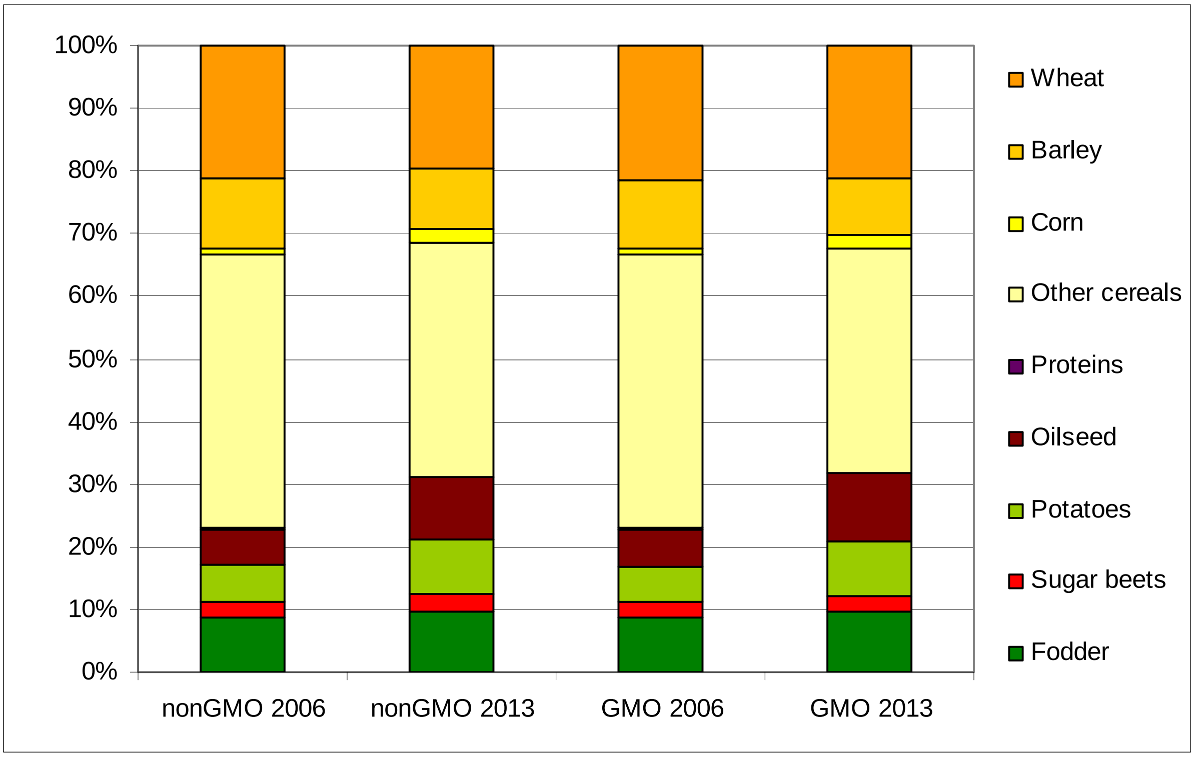
Source: authors' calculation.

Figure 6: Potential income effects of GMO crops introduction for 2013 by soil type.



Source: authors' calculation.

Figure 7: Cropping structure for GMO and non-GMO scenarios



Source: authors' calculation.

4 CONCLUSIONS

The paper took one significant element of agriculture production – the use of genetically modified organisms – and considered it in relation to a single factor – the overall profitability of agriculture in Poland. This was carried out under strict scientific rigor and under the theoretical assumption that GMO cultivation is permitted in Poland without any coexistence limitations. The authors aimed to discover whether, under *ceteris paribus* conditions, the use of GMO plants in Polish farms would have an influence on their economic results. The applied comparative static approach of an optimisation technique provided an opportunity to build up and aggregate the impacts of individual farm responses under actual and assumed situations, respectively, for 2006 and 2013.

The modelling results show that GMO crops would have an influence on the economic performance of Polish farms. It has been proven that from an economic point of view, the possibility of using GMO crops is likely to cause an increase of Net Farm Income. Nonetheless, it should be noted that this impact is not very crucial. The average farm income given the unrestricted availability of GMO technology is only 4.5% higher compared to the GMO-free strategy. The obtained results for 2006 show that in the short-term perspective, the effect of introducing GMO will be greater, due to a generally lower income level. In the medium-term perspective presented for 2013, which assumed changes in agricultural policy as well as adjustment in crop structure, the GMO effect of economic profitability for Polish farms is lower due to an overall NFI increase; this is the result of CAP phasing-in.

However, the influence of GMO on Polish farm profitability depends significantly on the intensity of production, soil conditions, and the type of production. These three factors are connected to the character of plant production. Firstly, in both the short- and medium-term perspectives, intensive farms obtain a higher income from introducing GMO compared to those which perform more extensively. Secondly, as GMO plants are more effective on good soil, farms that operate in such conditions will report higher income from GMO introduction than those with poor soil. Finally, the impact on the type of production can be described with apprehension. The more general approach shows that farms specialising in plant production report higher profitability than those with animal production. This is related to a higher share of crop production in income creation, which is highly influenced by GMO technology. The lowest income increase was found on mixed farms, which is due to their relatively smaller share of crop production in income creation. Taking into account only farms specialised in animal production, introducing GMO crops contributes more for cattle farms in comparison to pig farms. This is due to the possibility of acquiring GMO fodder maize.

As a final remark, it should be stressed that this analysis has only taken into account the effect of introducing GMO on the economic performance of Polish farms. As such, it shows that the opportunity costs of being GMO-free for an average farm is equal to approximately 4.5% of its NFI. However, it is important to bear in mind that other issues, be they social, environmental, health or ethical in nature, are of equal importance for the emerging challenge of possible GMO implementation in Polish agriculture. In academic elaborations, only one of these issues can be analysed at a time, but one should remember that only examining all of them can provide a comprehensive view that might be a coherent guide for further development. Therefore, there is an urgent need to perform exhaustive studies to answer further arising questions.

REFERENCES

ANIOL A., BROOKES G. (2005): The farm level impact of using GM agronomic traits in Polish arable crops. Brookes West, Dorchester.

BROOKES G., BARFOOT P. (2006): GM Crops: The First Ten Years - Global Socio-economic and Environmental Impacts. P.G. Economics, Dorchester.

Commission Recommendation of 23 July 2003 on guidelines for the development of national strategies and best practices to ensure the co-existence of genetically modified crops with conventional and organic farming. Brussels.

GMO free zones in Poland. ICPP International Coalition for Protection of Polish Countryside, http://icppc.pl/pl/gmo/; read on 14.03.2007.

MAJEWKI E., DALTON G., WAS A. (2006): Anticipated impacts of decoupling on the pattern of production in Poland. Proceedings of the 93rd seminar of the EAAE "Impacts of Decoupling and Cross Compliance on Agriculture in Enlarged EU". 22-23 September 2006. VUZE-EAAE, Prague.

Press release of 23.03.2005 (2005). Polish Press Agency base on Ministry of Agriculture and Rural Development (MARD), Warsaw.

Proposal of amendment of Legal act of 22 June 2001 on genetically modified organisms accepted by the Council of Ministers of Poland and send to the Parliament on 02 February 2007. Warsaw.

Public perception of biotechnology – 2005. The survey executed by the TNS OBOP for Institute of Plant Breeding in Radzikow on a representative sample of Poles (1005 respondents above 15 years old, held in January 2005). TBS OBOP, Warsaw.

The scope and implementation of Legal act on genetically modified organisms as at February 2007. Ministry of Environment of Poland, Warsaw.

TWARDOWSKI T. (2007): GMO-three colors. Biotechnology as a base for bio-economy of the future. Proceedings of the conference "GMO a chance for Polish agriculture? Facts and myths" 15 February 2007. Office of Analyzis of Senate of Poland, Warsaw.

ZAKOWSKA-BIEMANS S., MACIEJCZAK M. (2005): GMO and non GM coexistence implications in Poland as a New Member State of EU. Proceedings of Second International Conference on Co-Existence between GM and nonGM agricultural based supply chains. 14-15 November 2005. Agropolis Productions, Montpellier.