

## Anticipated Impacts of GMO Introduction on Production Pattern In Poland

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**Abstract**— The paper takes one significant element of the agriculture production – use of genetically modified organisms (GMO) – and considers it in relation to the production pattern in Polish farms. It asks if under the *ceteris paribus* conditions the use of GMO plants in Polish farms will have influence on the cropping structure. To answer this question only a scientific and theoretical assumption has been applied that GMO cultivation is permitted without restrictions in Poland. The approach combines both the very short experience of the new biotech based system of agricultural production and a modeling, which builds up and aggregates the impacts of individual farm responses under assumed situations.

**Keywords**— GMO, cropping structure, farm model, Polish agriculture.

### I. INTRODUCTION

Growing concerns are observable in Poland over the use of genetically modified organisms (GMO). Although the European Commission permitted under strict conditions GMO varieties to be grown in the European Union (EU), Poland wish to prohibit GMO plant cultivation. According to the official registers there are no GM plants cultivated in Poland [6]. This is due to the effective legal act on GMO of 2001, which prohibits GMO commercial cultivations. In 2007, an amendment to this law, which allows farming of GM varieties under specific conditions, was prepared. However, this amendment haven't come in force yet. Nonetheless, different sources [1] mention Poland as a seventh EU Member State where Bt maize is commercially grown, with the area of ca. 300 ha in 2006. Use of GMO feeds is permitted, but under a special moratorium until the year 2012. As in other European countries, in Poland there is ongoing discussion at different levels concerning the introduction of GMO crops. Most recent survey on the public perception shows that ca. half of Polish society does not agree for introduction GMO cultivations [5]. However it needs to 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.

### II. DATA AND METHODS

In this paper an exhaustive investigation has been completed comparing the situations on representative farms, with introduced or constrained GMO crops using a linear programming optimization technique. The model have been constructed in Excel spreadsheet and solved with the Solver function. The applied farm model uses over 80 decision variables and over 200 constraints. Each of farm models optimize Net Farm Income 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 are rotational ties for crops. An animal feed nutrient balance is obtained whereby the model optimizes 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 modeled farms, the relationships between the labour force and tractors is achieved too. All the parameters of the calculation are fed into the model in a disaggregated form including the farm enterprises with associated yields and input requirements, product prices, input costs, cost of land lease and production quotas, services, seasonal and permanent employment and other financial burdens of the farms. There is also the option to program in any type and amount of payments from the Common Agricultural Policy. The set of 252 farm types are representative of some 90% of the agricultural area in Poland, divided according to different intensity of production, different specialization and soil quality. They have been assembled using statistical and FADN data and expert knowledge. After calculating the optimal results for every farm type model in every scenario the results have been multiplied up using the number of each type of farm in the total Polish farm population.

Calculated farm models results were aggregated to obtain estimates for the whole of Polish agriculture as well as particular groups of farms. The model has been calibrated for the year 2006. There have been assumed two basic scenarios: NON-GMO and GMO, which take into account

the perspectives for the year 2013. GMO scenario assumes introduction of genetically modified wheat, corn (grain and fodder), rapeseed and sugar beets. The input data for the GMO crops has been estimated based on Brooks and Aniol [2] and PG Economics [4]. NON-GMO scenario served as a reference to explore the potential effects on cropping pattern of farms applying GMO. Thanks to such assumptions the model could include also changes in agricultural policy, especially the level of support, as well as forecasted changes in prices and costs [3]. In the long term perspective adjustments of production structure have been assumed.

### III. RESULTS

Calculated farm models results were aggregated to obtain estimates for the whole of Polish agriculture as well as particular groups of farms. To examine potential influence of GMO crops comparisons have been made between NON-GMO and GMO. The paper points out three main issues connected with introduction of GMO crops:

1. Cropping pattern in analyzed scenarios.
2. Structure of GMO crops in GMO scenario.
3. Share of GMO varieties within considered crops.

Results of the research have shown that introduction of GMO crops might have influence on the cropping structure in Poland (Fig. 1). The highest increase could be noted in case of rapeseed, which share in total area grows by 3 percentage points. from 7,3 to 10,3 percent.

1. However the highest relative increase could be observed in case of corn, which cropping area has grown in GMO scenario by 41,3% comparing to NON-GMO situation. Similarly the area of sugar beets tends to be higher in GMO scenario by 26%. Nevertheless it needs to be mentioned that due to assumed Sugar Market Reform the share of sugar beets in total area is decreasing, when compared with the base situation in the year 2006.

2. With regard to cereals some decrease could be observed, however in relative terms only barley area is changing in noticeable way, while in case of wheat and other cereals the changes are rather minor.

3. The share of GMO crops in total cropping area could reach 25 percent (Fig. 2). Taking into account the structure of GMO crops in GMO scenario the highest percentage is observable concerning rapeseed (9,83%), wheat (8,41%) and corn for grains (3,94%). While sugar beets and fodder maize owns minor share. Although the sugar beets' share in the total GMO crops' area is rather limited it needs to be noted that the GMO technology might be an important issue for the Polish sugar sector. As shown on the figure 3 all non GMO varieties of sugar beets have been replaced by the GMO counterparts. Almost the same situation could be observed in case of corn and rapeseed. Due to high share in cropping structure wheat is grown often neither on the best soils nor in the most intensive way, while only best management practices could guarantee the highest gains from new technology. Such situation is even more obvious in case of fodder maize. It takes only a small share in fodder crops, which usually are grown on worse soils and in less intensive way comparing to commercial crops.

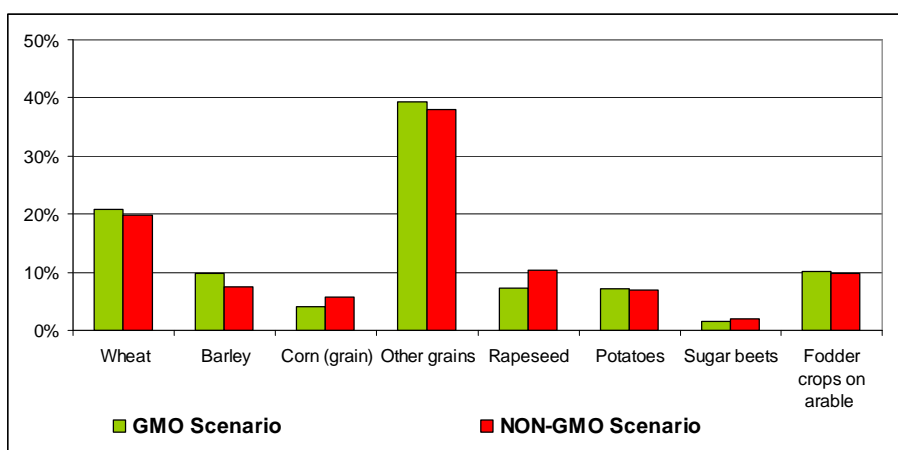


Fig. 1. Cropping pattern in analyzed scenarios for the year 2013.

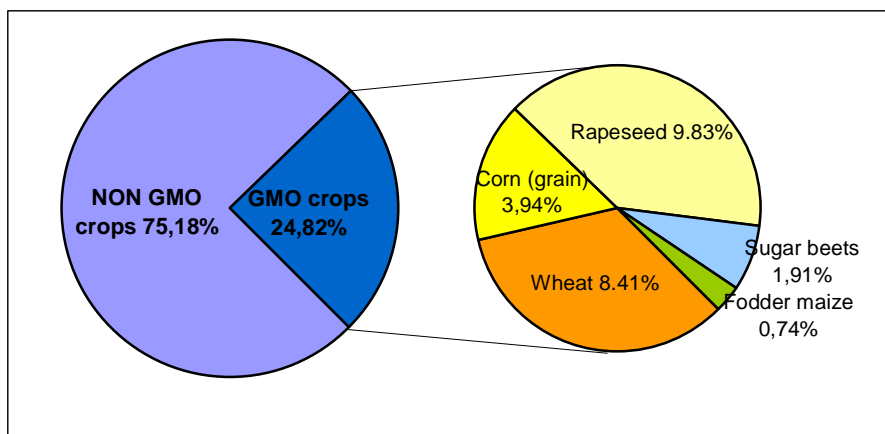


Fig. 2. Structure of GMO crops in GMO scenario for the year 2013.

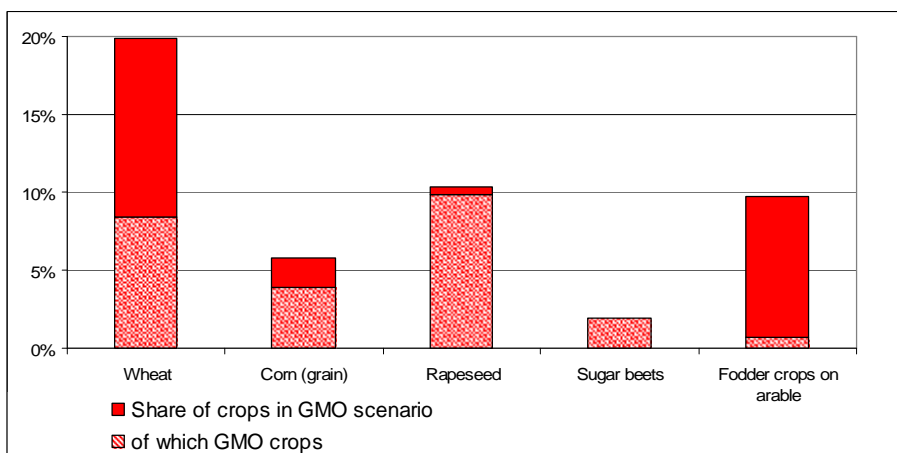


Fig. 3 Share of GMO varieties within considered crops.

#### IV. CONCLUSIONS

The executed analysis shown that implementation of GMO crops might have influence on the cropping structure in Poland. Introduction of new technology favors rapeseed, corn and sugar beets. Among GMO crops also wheat owns the remarkable share. However the importance of GMO technology for particular crop is not fully reflected by the share of its GMO varieties in total cropping area. There needs to be taken into account the share of GMO varieties within single crop. In case of sugar beets all its non GMO varieties have been replaced by the GMO counterparts. Almost the same situation could be observed in case of corn and rapeseed. Due to soil and technology requirements

those crops are very often grown in the intensive way on good soils in Poland. Here the possible gains from new technology are relatively high. However with regard to wheat the diffusion of GMO technology is not so obvious. While wheat is also grown in Poland on not the best soils. Thus one might argue that GMO varieties will replace the non-GMO counterparts in Poland only on the best soils and in most intensive farms.

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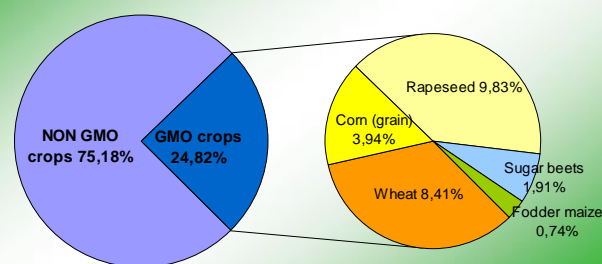
# ANTICIPATED IMPACTS OF GMO INTRODUCTION ON PRODUCTION PATTERN IN POLAND

## Objectives of the analysis

Will GMO introduction influence the production pattern of Polish farms?

- To build up and aggregate the impacts of individual farm responses to GMO introduction.
- To compare nonGMO and GMO cropping pattern in medium term perspective (year 2013).

## STRUCTURE OF GMO CROPS IN GMO SCENARIO FOR THE YEAR 2013

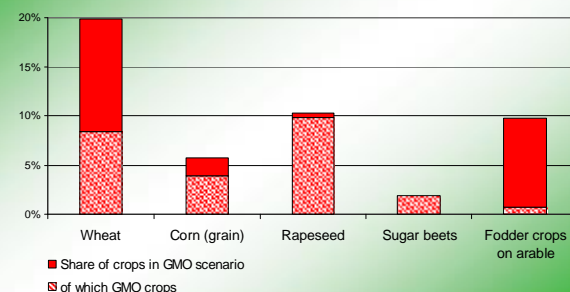


## Methodology

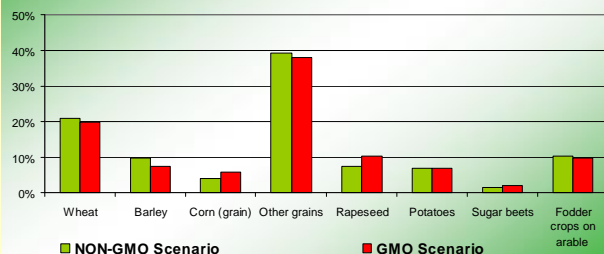
Assumption: CETERIS PARIBUS		Policy options	
		Non GMO	GMO
Time horizon	Short term 2006	2006 nonGMO model calibration	
	Medium term 2013	2013 nonGMO	2013 GMO

- LP optimisation model – Net Farm Income as the objective function
- 80 decision variables, 200 constraints
- Excel with Solver function
- 252 farm types representing approximately 90% of the sector aggregated on the basis of share in population of farms

## SHARE OF GMO VARIETIES WITHIN CONSIDERED CROPS



## CROPPING PATTERN IN ANALYZED SCENARIOS FOR THE YEAR 2013



## Conclusions

- GMO crops might have an influence on production pattern of Polish farms.
- The new technology favors mainly rapeseed, corn and sugar beets, but also wheat owns a remarkable share.
- In case of sugar beets, corn and rapeseed nearly all nonGMO varieties have been replaced by the GMO ones. Here the possible gains from the new technology are relatively high, because these crops are very often grown in an intensive way on good soils in Poland.
- With regard to wheat the diffusion of GMO technology is not so obvious, while it is also grown in Poland on wide range of soils.

GMO varieties would replace the non-GMO's in Poland on the best soils and in the intensive farms.