Economic Arguments for Establishing Free Zones from Genetically Modified (GM) Rape in Latvia
Ekonomiskais pamatojums brīvo zonu izveidošanai no ģenētiski modificēta rapša (ĢM) Latvijā

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Abstract. Free biological zone is a definite part of the state territory where possible growing of GM cultivated plants become economically unprofitable after the fulfilment of state norms and/or cause real threat of worsening (losses) of natural circumstances for other farming subjects as well as for sustainable development of environment, and for animals and human health. The necessity of forming the free zones can be economically based. Farms in the free biological zones would be state protected from threat of GM agricultural cultivated plants which could be caused by genetically modified pollution. It would increase trust in the processors of the produced agricultural production – the producers of foodstuffs – to suppliers creating certitude in no presence of genetically modified organisms in the obtained raw materials of agricultural character. Producers and consumers of foodstuffs are ready to pay higher price for this assurance. The identified subjects of potential losses in case of growing GM cultivated plants are biological farms, rapeseed crop growing farms, seed farmers for rapeseed crop or some other member of mustard family, and apiculture farms. Mathematical and demonstrative graphic models are elaborated for the economic basis of the free zones.
Key words: GM rapeseed crops, free zones.

Introduction

For Latvian manufacturers of farm produce when they meet with global challenges, the new EU approaches to the reforms related to manufacturing of the farm produce, and with the increase of the global pressure of competitiveness, the growth of GM cultivated plants is becoming urgent in the territory of Latvia.

The biologically free zones were established (BZ) to solve the problems arisen in the world. Initially, they appeared in Canada and the USA but somewhat later in the European countries as well as where the GM corn was raised (Angevin, 2006). The reason for establishing free zones is the existing uncertainty about the effect of biologically modified cultivated plants and organisms on the sustainable development of environment and human health within a longer period of time.

The primary task of the free zones is to protect the environment from uncontrolled dissemination of GM cultivated plants. Farms operating in the free biological zones are kept nationally protected from the threat inflicted by GM agricultural crops (Hirzinger, Monrad, 2006). It increases confidence from the part of the agricultural processors-food manufacturers towards the suppliers generating conviction that the purchased agricultural raw material is without the presence of genetically modified organisms. For this conviction, the food processors and the final consumers willingly pay more. Thus, mutually favourable pre-conditions are created for economic activities which enhance appearing of free zones. Tourists give preference to territories where GM crops are not grown as well.

The free biological zone can be defined in the following way: "The free biological zone – a definite part of the state territory where the possible growing of GM cultivated plants becomes economically unfavourable in fulfilling the requirements set by the laws and regulations and/or it can create a real threat of worsening (losing) of the natural conditions of manufacturing to other subjects of

the economic activities as well as to the sustainable environmental development, to health of animals and humans."

Effectively and purposefully cooperating with state institutions, municipalities can develop a flexible approach in establishing free zones incorporating territories where growing GM plants can incur losses to subjects of the economic activities in the countryside and can make harm to the sustainable development of the environment (Sondergaard et al., 2006). The state has to forecast the opportunity of establishing such a zone at the national and cross-border level as well.

The hypothesis of the research. An accidental and uncontrollable GM dissemination can inflict losses to separate types of economic management and their concurrent coexistence with GM cultivated plants is impossible if their isolated existence is not ensured, i.e., free zones are not established.

The aim of the research is to develop methods for estimation of the economic justification for establishing free zones from GM cultivated plants.

Methods

When dealing with growing cultivated plants, harvesting, transportation and technologies of primary processing and costs in diverse systems of manufacturing agricultural produce, we pass to the subject of the research and the data are processed applying corresponding statistical and descriptive methods. As a result, different estimation indices are obtained to attain the aim of the research and to fulfil the assignments. Conclusions are made by analysing the results of estimations. Proposals are moved forward on the basis of the conclusions applying synthesis, logical and historical approaches and other applicable methods for justification of free zones in their development phase.

Developing the economic justification for establishing free zones, several assumptions and restrictions are imposed. The most significant are as follows:

1) it is assumed that the growers of GM cultivated plants will comply with laws and regulations set by the legislation and will fulfil all the requirements in relation to the protective zones, establishing the buffer zone at the sides of the fields and in relation to cleaning machinery, etc.;
2) the growers of GM cultivated plants will be capable to come on terms with owners of the near farms on distribution of field crops taking into account the requirements for crop rotation;
3) the growers of GM cultivated plants will provide sowings of GM cultivated plants and their economic activities against the threat of uncontrolled dissemination of GM cultivated plants and the biologic contamination of the soil;
4) the growers of GM cultivated plants will cover losses inflicted upon the conventional and biologic farms by growing, harvesting and/or storing and transporting GM cultivated plants;
5) in the economic justification, the potential losses and/or additional payments are included which can arise to other subjects of the economic activities in the countryside;
6) in the economic justification, the potential additional incomes are included which may arise when growing GM cultivated plants and the potential additional expenditures which are related to fulfilment of the requirements set by laws and regulations in relation to eliminating the uncontrolled dissemination of GM cultivated plants and to threat insurance of the economic activities.

Evaluating the restrictions and assumptions incorporated in establishing free zones, it is to be taken into account that they are constantly occurring in the rapidly changing political, economic, social, scientific and technological environment. Therefore, information updating is required (Enabling the Coexistence .., 2005).

In the conditions of Latvia, growing of GM cultivated plants is connected with the possible decrease of the production cost due to the direct costs on the one hand but before making a decision to grow GM cultivated plants, the farm has to elicit the requirements set by laws and regulations for the activities to be carried in order to reduce possibilities of lawless and inevitable dissemination of GM cultivated plants on the other hand. Fulfilment of the requirements set by laws and regulations will be related with certain costs in the period of cultivating the soil before sowing, the phase of growing cultivated plants as well as within harvesting of the grown produce, primary processing and marketing. In comparing and estimating costs, a definite technology of crop management, harvesting and primary processing and its close relation with the technology of growing, harvesting and primary processing of grains of the corresponding GM cultivated plants are to be taken into account. Thus, the cost elements of growing, harvesting and primary processing of cultivated plants will be found which will decrease or increase the costs.

Results

To clarify profitability of growing GM cultivated plants or non-profitability in the conditions of Latvia, the most important economic aspects to be encountered by the potential growers of GM cultivated plants will be further discussed. The general condition of the economic profitability for growing GM cultivated plants can be shown by means of the following inequality:

$$(\sum TRN_{GM} : PL_{GM}) \geq (\sum TRN_{KKA} : PL_{KKA}, \quad (1)$$

where

$\sum TRN_{GM}$ – total net income in the case of growing GM cultivated plants;

$\sum TRN_{KKA}$ – total net income in the case of growing conventional cultivated plants;

PL_{GM} – the area for growing GM cultivated plants;

PL_{KKA} – the area for growing conventional (genetically unmodified) cultivated plants.

The economic condition for growing GM cultivated plants taking into account the inequality 1 can be defined in the following way: "Growing GM cultivated plants in a definite territory becomes favourable if the net income obtained by the grower of GM cultivated plants per one unit of area does not exceed the net income per one unit of area in the case of growing the conventional cultivated plants."

In the case of growing GM cultivated plants, the total net income per one unit of area:

$$\sum TRN^{GM}_{PLV} = (\sum TR_{GM} - \sum TC_{GM}) : PL_{GM}, \quad (2)$$

where

$\sum TRN^{GM}_{PLV}$ – total net income per one unit of area in the case of growing GM cultivated plants;

$\sum TR_{GM}$ – total income obtained from the whole sowing area of GM cultivated plants;

$\sum TC_{GM}$ – total costs for growing, harvesting, primary processing and marketing of GM cultivated plants;

PL_{GM} – the growing area for GM cultivated plants.

It is important to include differences in income and costs compared to the conventional cultivated plants in the economic justification for growing GM cultivated plants. Therefore, peculiarities of costs and incomes in growing GM cultivated plants will be further described. In the event of growing GM cultivated plants, it is important to identify all the costs which can considerably differ from the costs of growing conventional cultivated plants. The total costs can be shown by means of the following equation:

$$TC_{GM} = \sum C^{GM}_{SMA} + \sum C^{GM}_{P} + \sum C^{GM}_{V} + \sum C^{GM}_{PP}, \quad (3)$$

where

TC_{GM} – costs for growing, harvesting, primary processing and marketing GM cultivated plants;

C^{GM}_{SMA} – costs for the seeds, fertilizers, plant protection measures of GM cultivated plants;

C^{GM}_{P} – service costs for growing GM cultivated plants;

C^{GM}_{V} – general costs for growing GM cultivated plants;

C^{GM}_{PP} – additional costs for growing GM cultivated plants related to observing requirements set by the laws and regulations.

To estimate costs for the seeds, fertilizers and plant protection measures of growing GM rape per one unit of area, the following equation is used:

$$C^{GMR}_{SMA} = \frac{(Q^{GM}_{S} \times P^{GM}_{S}) + \sum C^{GM}_{MM} + \sum C^{GM}_{AAL}}{\sum PL^{GM}}, \quad (4)$$

where

C^{GMR}_{SMA} – specific expenses for the seeds, fertilizers and plant protection measures of growing rape;

Q^{GM}_{S} – the amount of seeds of GM cultivated plants per ha;

P^{GM}_{S} – the price for the seeds of GM cultivated plants;

C^{GM}_{MM} – the amount of fertilizers required per one unit of area for growing GM cultivated plants;

C^{GM}_{AAL} – the costs required for plant protection measures in growing GM cultivated plants;

$\sum PL^{GM}$ – the area for growing GM cultivated plants.

It is important to note that the comparison of the costs for the seeds, fertilizers and plant protection measures of GM cultivated plants and genetically unmodified cultivated plants can make the following differences:

a) the price of GM cultivated plants can be on 20-30% higher compared to the seeds of the conventional cultivated plants. It means that the seed prices are raised due to growing of GM cultivated plants which are expensive;
b) for sowings grown in similar agro-climatic conditions, the amount of used fertilizers will not change. Wherewith, there are no differences in relation to fertilizer costs between GM and conventional cultivated plants;
c) the specific expenses per one unit of area, for plant protection measures in growing GM cultivated plants decreases compared to the expenses for plant protection measures in growing conventional cultivated plants.

It means that the costs for growing GM cultivated plants decrease per ha for the reason of the new properties obtained by means of modification to resist definite diseases, pests and ability to bear treatment by herbicides. Certain differences exist in services as well if comparing services and their costs needed for growing GM cultivated plants and conventional ones. These differences are shown in the following equation:

$$C_P^{GM} = \sum CP_{ASS}^{GM} - \Delta CP_{AAL}^{GM} + \sum CP_{NSA}^{GM} + \Delta \sum C_{MMZ}^{GM} \quad , (5)$$

where

C_P^{GM} – service costs needed for growing, harvesting and primary processing of GM cultivated plants;

$\sum CP_{ASS}^{GM}$ – service costs for cultivation of the soil before sowing of GM cultivated plants and sowing;

ΔCP_{AAL}^{GM} – decrease of service costs for plant protection measures;

$\sum CP_{NSA}^{GM}$ – service costs for harvesting and primary processing of GM cultivated plants;

$\Delta \sum C_{MMZ}^{GM}$ – service costs for the machinery needed for growing, transportation and primary processing of GM cultivated plants as well as for washing the machinery.

As it is evident, in equation 5 two deltas are included – one with a positive sign, while the other with a negative one. It gives a chance to get a clearer idea of the cost comparison result for the services used in the production of GM cultivated plants and the conventional ones. The positive delta increases service costs for growing GM rape – machinery used in growing, transporting the seeds and harvest as well as primary processing of GM cultivated plants and cleaning agricultural machinery. But the negative delta decreases the service costs used for plant protection measures of GM cultivated plants. In the research, the general costs for growing GM cultivated plants are equalised to the general costs for growing genetically unmodified cultivated plants except the costs related to the fulfilment of the activities set by the laws and regulations for the growers of GM cultivated plants to reduce dissemination of uncontrolled GM cultivated plants.

The most important cost increase in the event of growing GM rape in the territory of Latvia compared to the genetically unmodified cultivation of rape is related to the activities which are to be carried out by the growers of GM rape to decrease the threat of the surrounding environment and other subjects of the economic management as a result of the dissemination of uncontrolled genetically modified cultivated plants. Within the framework of the research, these costs are defined as extra costs in relation to implementation of the requirements set by the laws and regulations. To state the above costs, the following equation is offered:

$$\sum C_{PP} = \sum C_{PP}^{GM} + \sum C_{PP}^{VI}, \quad (6)$$

where

$\sum C_{PP}$ – total extra costs in the event of growing GM cultivated plants;

$\sum C_{PP}^{GM}$ – extra costs for a farm growing GM cultivated plants which arise in relation to the fulfilment of requirements set by laws and regulations;

$\sum C_{PP}^{VI}$ – extra costs of the state institutions which arise in relation to the fulfilment of requirements set by the laws and regulations.

Extra costs which arise in a farm growing GM cultivated plants to fulfil requirements set by the laws and regulations for eliminating dissemination of uncontrolled genetically modified cultivated plants are estimated taking into account the following equation:

$$C_{PP}^{GM} = C_{INF}^{GM} + \sum C_{PM}^{GM} + \sum C_{LA}^{GM} + \sum C_{DK}^{GM} + \sum C_{PA}^{GM} + \sum C_{VI}^{GM} + C_{APD}^{GM} + NP_{INF}^{GM} + C_{CI}^{GM} \quad , \quad (7)$$

where

C_{PP}^{GM} – extra costs related to the fulfilment of requirements set by the laws and regulations for growing GM cultivated plants on the farm;

C^{GM}_{INF} – extra costs to coordinate growing costs for the prospective growing of GM cultivated plants;

C^{GM}_{PM} – the packaging and marking costs for the harvest of GM cultivated plants;

C^{GM}_{PM} – costs for the laboratory analyses to control the uncontrolled dissemination of GM cultivated plants;

C^{GM}_{DK} – extra costs for processing documentation reflecting growing, harvesting, primary processing and preparation of GM cultivated plants for sale;

C^{GM}_{PA} – extra costs for training of the personnel of farms which desire to grow GM cultivated plants;

C^{GM}_{VI} – extra costs of the state institutions related to the fulfilment of the supervisory and control process set by the laws and regulations to fulfil the requirements set by the laws and regulations for growing GM cultivated plants;

C^{GM}_{APD} – insurance costs for sowings of GM cultivated plants;

NP^{GM}_{BFJ} – the lost income from the area which is used for establishing the buffer zone around the fields where GM cultivated plants are grown;

C^{GM}_{CI} – other costs related to the fulfilment of other requirements set by the laws and regulations for farms growing GM cultivated plants.

In estimating extra costs, the grower of GM cultivated plants has to take into account the packaging and marking costs of GM cultivated plants. Mutually agreeing, the grower can attribute these costs to the wholesale dealer of GM cultivated plants. But in such case, the grower of GM cultivated plants has to consider a lower sales price. It means that it will be necessary for the grower of GM cultivated plants to pay for packaging and marking of the harvest due to the decrease of the sales revenues. In the formation of sales revenues in farms growing GM cultivated plants, the most essential factor is the sales price of the grown harvest and the following aspects are to be taken into account in creating it:

a) potentially low price – the forecasted sales price of the harvest for GM cultivated plants can be at least 10-15% lower than the sales price for the conventional cultivated plants and the experience of farms growing GM cultivated plants in other countries give evidence of that;
b) the use opportunities – the sales price of the harvest for GM cultivated plants to a great extent depends on the use opportunities set for the final output;
c) the impact on the environment – the impact of the respective GM cultivated plant on the environment, health of animals and people;
d) to a certain extent the sales price is affected by the regulations set in the EU countries for marking GM cultivated plants.

The sales revenues of the farm when selling the grown harvest of GM cultivated plants can be expressed by the following equation:

$$TR_{GM} = (Q_{GM} \text{ x } P) \times K_{iz} \times K_v \times K_m \times K_n, \qquad (8)$$

where

TR_{GM} – income from the harvest of GM cultivated plants;

Q – the amount of sold GM cultivated plants;

P – sales price for GM cultivated plants;

K_{iz} – the correction coefficient for the sales price which depends on the type of using GM cultivated plants in manufacturing a definite final output;

K_v – the correction coefficient for the sales price which depends on the impact of a certain modification of cultivated plants on the environment, health of animals and people;

K_m – the correction coefficient of the sales price related to the fulfilment of the requirements for marking GM cultivated plants;

K_n – the correction coefficient of the sales price related to other factors affecting dissemination of GM cultivated plants.

According to equation 8, the economic content is not unequivocal. Separate factors can reduce sales revenues from the harvest of GM cultivated plants, while the others can increase them. In addition, it is to be taken into account that the society and scientists are uncertain of the effect of GM cultivated plants on the diversity of species and the sustainable development of the environment. It means that the law makers and the potential growers of these cultivated plants have to observe in their activities not only the principle "the polluter pays" but also the precautionary principle in eliminating the threat of an uncontrolled spread of GM cultivated plants (Džeroski et al., 2006).

The scientific research in improving properties of cultivated plants and the sphere of using GM products can drastically affect both growing costs of GM cultural plants and sales revenues. Being in such uncertainty conditions in relation to the prospective

growing of GM cultivated plants in the territory of Latvia, in creating free zones in Latvia; it is more useful to use the economic methods. It means that additional requirements for eliminating the threat of an uncontrolled dissemination of GM cultivated plants should be forecasted in the laws and regulations, and their implementation for the prospective grower being in the free zone, will increase operating costs, thus growing GM cultivated plants in this territory will become unfavourable compared to other alternatives available for the use of natural resources.

The definition of free zones offers the opportunity to apply the following basic principles:

a) the principle of the economic profitability. It means that in the free zones additional requirements are set for eliminating the uncontrolled dissemination of GM cultivated plants which increase operating costs for the prospective grower of GM cultivated plants;

b) the principle of the administrative ban. This principle envisages the opportunity that the state can set the ban in definite territories to grow GM cultivated plants taking into account the prospective threat and the prospective losses for other subjects of the economic activities in the countryside.

Every of the above principles have certain priorities and drawbacks. Their comparison is depicted in Table 1.

The positive and negative aspects for evaluating the principles of establishing the free zone shown in Table 1 may help the state institutions to take a decision on the tactical ways which are directed to eliminating an uncontrolled dissemination of GM cultivated plants and maintaining of the natural advantages of the state in growing cultivated plants which are used for manufacturing foodstuffs and non-food products with a high value added.

Developing the economic justification for establishing economically free zones, the applied mathematical model can be expressed by the equation system in the following way:

$$\frac{\sum TR_{GM}}{\sum PL_{GM}} - \frac{\sum TC_{GM} + \Delta C_{GM}^{PRP} + \sum EC_{GM}^{SB}}{\sum PL_{GM}} \le \frac{\sum TR_{KKA}}{\sum PL_{KKA}} - \frac{\sum TC_{KKA}}{\sum PL_{KKA}}, \quad (9)$$

$$\frac{\sum TR_{GM}}{\sum R_{GM}} - \frac{\sum TC_{GM} + \Delta C_{GM}^{PRP} + \sum EC_{GM}^{SB}}{\sum R_{GM}} \le \frac{\sum TR_{KKA}}{\sum R_{KKA}} - \frac{\sum TC_{KKA}}{\sum R_{KKA}}, \quad (10)$$

Table 1

Comparison of the Free zones (FZ) forming principles

Principle of forming FZ	Positive aspects	Negative aspects
Principles of economic profitability	– based on the principle of alternative costs and rational behaviour of market members; – diminishes threats of illegal growing of GM cultivated plants;	– in addition to the determination of preventive enterprises for diminishing threats of illegal dissemination of GM cultivated plants it can be also eliminated by the EU norms regarding the issue; – determining preventive enterprises, it is necessary to calculate their sales costs; – profitability of preventive enterprises can be influenced by different agro climate circumstances in the regions of the state; – effectively working farms can gain sufficient profitability sufficient profitability by growing GM cultivated plants also in Free zones.
Principle of administrative prohibition	– economic calculations on possible costs of preventive enterprises are not necessary; – principle of rational behaviour and alternative costs.	– based on legal consciousness, moral and material responsibility of the market members in case of inobservance of the prohibition that would not be an obstacle in particular cases to grow GM cultivated plants also in the free zones if it was economically profitable; – state institutions need additional resources to ensure the implementation of the prohibition; – prohibition to grow GM cultivated plants in the free zones can be in conflict with the EU norms with all the following consequences.

where

$\sum TR_{GM}$ – total income for farms where GM cultivated plants are grown;

$\sum TC_{GM}$ – total costs for growing GM cultivated plants;

$\sum PL_{GM}$ – the total area for GM cultivated plants;

ΔC_{GM}^{PRP} – extra costs for the grower of GM cultivated plants in relation to the preventive measures set by the laws and regulations for eliminating the threat of dissemination of GM cultivated plants;

$\sum EC_{GM}^{SB}$ – extra costs for the society (the state, other subjects of the economic activities and households) which arise if GM cultivated plants are grown in the country;

TR_{KKA} – total income from a farm growing a conventional cultivated plant as the alternative to the GM cultivated plant;

TC_{KKA} – total costs when growing a conventional cultivated plant as an alternative to the GM cultivated plant;

PL_{KKA} – the area for the conventional cultivated plant grown as an alternative to the GM cultivated plant;

R_{KKA} – weight of the harvest for the conventional cultivated plant grown as an alternative to the GM cultivated plant;

R_{GM} – weight of the harvest for GM cultivated plants.

The economic content of inequalities 9 and 10 shows that as a result of growing GM cultivated plants in the territory of the free zone, the obtained net income on a weight unit of the area and the grown harvest will be lower than the net income of the respective conventional cultivated plant per a weigh unit of the grown area and the harvest. Thus, the possibility of the grown harvest to change upon the effect of the agro-climatic conditions and other outer factors is included in the developed mathematical model.

From the point of view of the sustainable development of the society and the environment, it can be concluded that growing GM cultivated plants can be favourable for the state and society only in the case if the specific income (income per one unit of area) of growing GM cultivated plants is higher than the direct and indirect costs arising for the grower himself as well as for the near farms and other subjects of the society in carrying out the preventive and corrective measures to eliminate and/or decrease dissemination of uncontrolled GM cultivated plants, and to decrease the threat of the biological contamination. In addition, in this case it is assumed that the principle of the free choice is observed. It means that the farms which choose to grow GM cultivated plants will not cause any burden for the economic environment and extra costs for farms which will operate according to the technologies of the conventional and biological agriculture, or will recompense the arisen extra costs and the inflicted losses as a result of an uncontrolled dissemination of GM cultivated plants.

Growing GM cultivated plants causes losses to other subjects of the economic activities in the countryside and causes extra costs for state institutions in whose competency is to carry out preventive measures at the state level to eliminate and/or to decrease an uncontrolled dissemination of GM cultivated plants. The content of extra costs for other economic subjects in the countryside and state institutions can be revealed by the following mathematical equation:

$$\sum EC_{GM}^{SB} = \sum EC_{BL} + \sum EC_{KL} + \sum EZ_{LU} + \sum EC_{VI}, \quad (11)$$

where

$\sum EC_{GM}^{SB}$ – additional costs for the society in the event of growing GM cultivated plants;

$\sum EC_{BL}$ – additional costs for biological farms related to the preventive measures to decrease and/or to eliminate threat which might be caused by the growers of GM cultivated plants;

$\sum EC_{KL}$ – additional costs for conventional farms related to the preventive measures which might be caused by the preventive measures to decrease and/or to eliminate the threat which might be caused by the growers of GM cultivated plants;

$\sum EZ_{LU}$ – additional losses in the form of the lost income for other countryside businesses which provide services related to tourism, relaxation, health rehabilitation and similar businesses which raise their competitiveness through the advantages of the natural environment of Latvia;

$\sum EC_{VI}$ – total expenses of the state institutions related to the preventive measures to decrease and/or to eliminate threat which might be caused by the growers of GM cultivated plants.

The global practice witnesses that the preventive measures (measures directed to elimination of

threats and/or their decrease) are economically more favourable, cost less than the corrective measures-measures related to starting of threats and elimination of the caused results (Frank, 2004). The results of the economic justification for the free zones have to give the reply to the question whether the potential gain of the society giving access to growing GM cultural plants in the territory of Latvia will be higher and will be able to compensate the extra costs to the manufacturers of GM cultivated plants themselves and will no harm the biological and conventional farms.

The graphical model developed for the economic justification of establishing free zones is envisaged for the comparison of operating costs in the case of growing GM cultivated plants and conventional cultivated plants. Besides, the graphical model gives the opportunity to estimate the minimum area for the farms so as the harvest income covers the expenses. To get a fuller insight of the graphical model used in the economic justification for establishing economically free zones, initially the model used in estimating costs and incomes for the conventional cultivated plants in relation to the sown area which can be used in developing the economic justification for establishing free zones is shown. The graphical model is shown in Figure 1.

By using the graphical model shown in Figure 1, it is possible to state the profitability of growing the conventional cultivated plants as the alternative to the GM cultivated plants and its connection with the sowing area. For the purpose of the model, the total costs of growing, harvesting, primary processing and sales of the respective cultivated plants are divided in the following parts:

$$\sum TC_{KKA} = \sum FC_{KKA} + \sum VC_{KKA}, \quad (12)$$

where

TC_{KKA} – total costs for growing, harvesting, primary processing and sales of the respective conventional cultivated plants;

$\sum FC_{KKA}$ – fixed costs for growing, harvesting, primary processing and sales of the conventional cultivated plants;

$\sum VC_{KKA}$ – variable costs for growing, harvesting, primary processing and sales of the conventional cultivated plants.

Within the framework of developing the economic justification of the free zones, the variable costs are defined in the following way: the variable costs in growing, harvesting, primary processing and sales of the conventional cultivated plant are the costs which are variable if the sowing area of the respective cultivated plant is increased on one hectare. The variable costs contain the following costs:

– sowing costs;
– costs related to fertilizers and plant protection measures;
– service costs needed for growing, harvesting, primary processing and sales of the respective cultivated plant if the farm does not perform this work themselves;
– other similar costs directly related to manufacturing a definite agricultural produce.

The fixed costs unlike the variable costs do not vary if the sowing area of the respective cultivated plant is increased within the limits of the available resources.

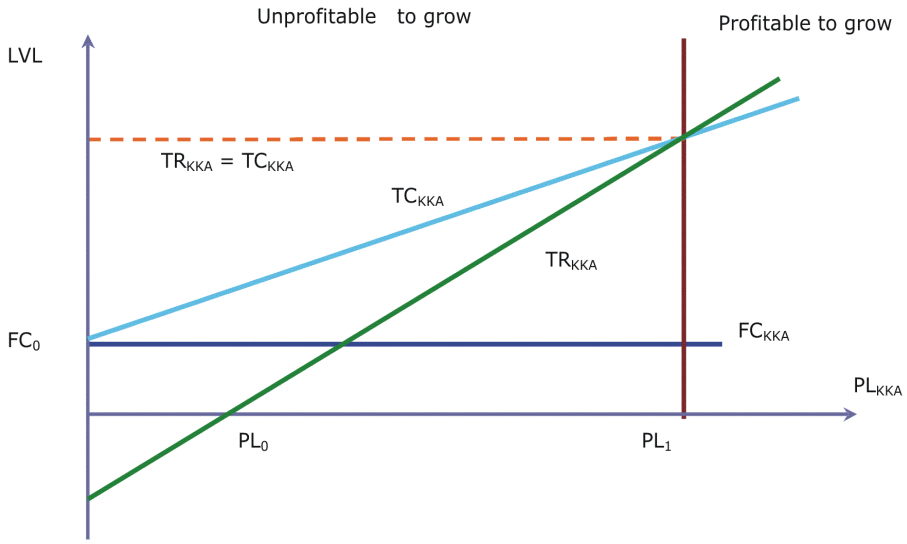

Fig. 1. The model of economic basis for conventional rapeseed crop growing.

The following costs are included in the group of the fixed costs:

– depreciation expenses for the fixed assets on the farm;
– farm management expenses;
– other similar expenses related to the operation of all the farms in manufacturing different types of agricultural produce.

In the evaluation of expenses and incomes for growing the conventional cultivated plants, the applicable model is described by the following lines and points:

a) the fixed costs are shown by the lower horizontal line and the respective symbol as they are not variable if the sowing area changes;
b) the variable costs included in the total costs are shown by a rising line which starts at the point FC0;
c) the line describing the income starts by a negative value as the field income, if the cultivated plants are not grown and other economic activities are not carried out, will be negative, i.e., losses will be incurred;
d) the point PL_0 describes the minimum area at which the incomes can cover the fixed costs;
e) the point PL_0 describes the minimum area which provides such sales income which can cover the variable and fixed costs;
f) by increasing the sowing area which is larger than PL_0, it becomes profitable to grow the respective cultivated plant.

Evaluating the expenses and incomes for growing the conventional cultivated plants, the applicable graphical model gives the opportunity to determine the minimum area for growing the respective cultivated plant at which the farm can cover all the operating costs and can start operating with profit. The graphical model used for the development of the economic justification of the free zones is given in Figure 2.

The indices of the economic profitability for growing the conventional cultivated plant as the alternative to the GM cultivated plant are shown by a broken line. The graphical model for the economic justification of establishing free zones shown in Figure 2, gives the opportunity to state different significant indices which can be later used in evaluating the economic profitability for growing GM cultivated plants compared to the alternative conventional cultivated plants. Wherewith, economically grounded information is obtained on the preventive measures to be carried out and of the required extra costs so as growing GM cultivated plants will not be profitable in the established free zones. The most significant elements of the model shown in Figure 2 are as follows:

a) the increase of the fixed costs ΔTC_{GM}. It is related to the additional resources used for implementing the

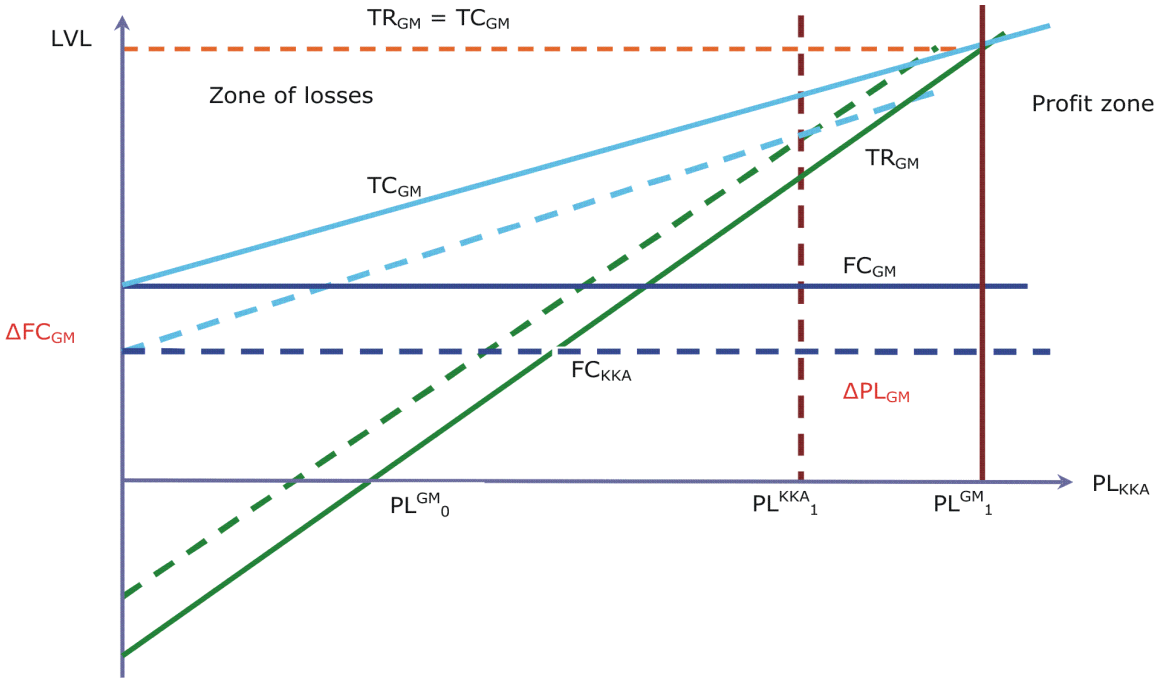

Fig. 2. The determination model of economic basis for forming of the Free zones.

preventive measures set by the laws and regulations;

b) due to the properties obtained as a result of modification of cultivated plants, the variable costs for GM cultivated plants will decrease. In the graphical model, it is shown by the diverse directions of the lines for the total costs of growing GM cultivated plants- the line of the total costs for growing GM cultivated plants is not parallel but slightly more sloping compared to the line for the total costs of the conventional cultivated plants;

c) the economic condition for establishing the free zone is related to a higher increase of extra costs compared to the decrease in costs which can be obtained applying the new properties of the modified cultivated plant;

d) by increase of the total costs, the area increases which is needed to cover the fixed costs to PL^{GM}_{0}. It means that in the case of growing GM cultivated plants, a larger area shall be sown in order to cover only the variable costs and, wherewith, all the costs. In other words, a larger area is needed to make growing of GM cultivated plants more profitable;

e) to cover all the operating costs in the event of growing GM cultivated plants, the minimum area corresponds to PL^{GM}_{1}, which in the event of establishing free zones will be larger than the area PL^{KKA}_{1}, which is needed for covering costs needed to grow conventional cultivated plants;

f) the model shows that growing GM cultivated plants in the free zones can become more profitable than growing alternative conventional cultivated plants only in huge areas.

The described method for the economic justification of establishing free zones is applicable when it is needed to protect a territory from the threat inflicted by GM cultivated plants which can cause fundamental threat to other subjects of the economic activities. It is useful to do such estimations after developing the respective laws and regulations, and taking into account properties of the cultivated plant.

It is possible to comparatively evaluate districts and regions of Latvia to find more or less endangered territories in the country. Such approach can decrease time for developing the economic justification for the free zones and for taking management decisions in relation to the opportunities of growing GM in one of the regions of the country. Different indices related to the threat of disseminating GM cultivated plants are used for the evaluation of the regions. These indices are shown in Table 2.

As shown by the information provided in Table 2, the selected absolute and comparative indices are mutually linked. However all the indices are linked with fundamental threat for other manufacturers of the agricultural produce in the countryside.

To combine the indices shown in Table 2 for the evaluation of the most endangered regions, at first, the regions are ranked in growing order according to every index. As a result, 10 charts are obtained with the absolute index and the rank for the respective index. Every of the evaluation criteria shown in Table 2 get a definite weight to use the obtained rank indices for evaluating the threat. The weight values are shown in Table 3.

As it is shown by the information depicted in the table a variable weight is set to evaluate more precisely the potential threat and the possible losses in the event of the threat for the indices used in evaluating districts. The highest weight in the group of the absolute indices is assigned to the land for the biological farming – 0.4 or 40% of the absolute value

Table 2

Indicators used in the regional evaluation

Absolute indicators	Comparative indicators
Number of organic farms in region	Proportion of organic farms in total number of farms in a region
Utilised agricultural areas of organic farms	Proportion of utilised agricultural areas of organic farms in total usable UAA in a region
Endangered areas in biological farms	Proportion of endangered area in total area of utilised agricultural areas of organic farms
Areas of rapeseed crop in all farms	Proportion of areas of rapeseed crop in all farms in total usable UAA in a region;
Number of beehive of bees in all the farms of a region	Number of beehive of bees in all farms per 1000 ha of usable UAA.

Table 3

Weight of indicators used in evaluation of regions

Absolute indicators		Comparative indicators	
Contents of indicator	Weight	Contents of indicator	Weight
Number of organic farms in a region	0.15	Proportion of organic farms in the total number of farms in a region	0.1
Utilised agricultural areas of organic farms	0.4	Proportion of utilised agricultural areas of organic farms in the total usable UAA in a region	0.45
Endangered areas in organic farms	0.1	Proportion of endangered area in the total area of utilised agricultural areas of organic farms	0.1
Areas of rapeseed crop in all farms	0.1	Proportion of areas of rapeseed crop in all farms in the total usable UAA in a region	0.05
Number of beehives of bees in all the farms of a region	0.25	Number of beehives of bees in all farms per 1000 ha of usable UAA.	0.3
Total	1.00	Total	1.00

of all the indices effect. It is related to a greater threat for dissemination of GM cultivated plants to the biological farms with a larger area of management. The smallest weight in this group of indices is left for the endangered areas of the biological farms and rape sowings in all the farms. Such weight is set taking into account the following aspects:

– comparatively small area of the endangered biological farms which deal with the endangered cultivated plant;
– the existing differences in the agro-climatic conditions between the districts growing rape;
– the existing differences between the districts in using the grown rapeseeds for manufacturing a definite final output.

In the group of the comparative indices, the highest value is assigned to the specific weight of the agricultural land available for the biological farms from the total used district of agricultural land – 0.45. The weight for this index can be explained by the increase of threat in districts where both the absolutely and relatively larger areas are managed by the biological farms. The lowest value in this group is set for the specific weight of the biological farms of the total number of the farms in the district – 0.1, for the specific weight of the rapeseed sowing area from all the farms of the total agricultural lands – 0.05, and the specific weight of the endangered area from all the agricultural land available for the biological farms – 0.1. For the assigned rate weight, the following explanation is given:

– the variable size of the biological farms in the districts which are considered as an indirect factor intensifying the threat;
– the specific weight of rape sowings in several districts is not considered to be an essential argument intensifying the threat and the potential losses as comparatively good alternative opportunities exist to sell the rape with the presence of GMO;
– comparatively small peculiar weight of the endangered areas on the biological farms is considered to be an insignificant threat intensifying factor.

Using the above indices and the weight of their impact on the endangered subjects in the countryside, every district gets definite points which are used for comparative evaluation of the districts in relation to the dissemination threat of GM cultivated plants. The application of the described method enabled to evaluate every district in a definite territorial region and country on the whole. The districts were grouped into the following 3 parts: districts with a strong threat/essential losses can arise for the subjects of the economic activities, districts with a medium threat, and districts with a low level of threat.

As it is seen in Table 4, the group of the endangered districts to a great extent includes districts which have received the evaluation starting from 34.8 points for Preiļi district to 42.4 points for Cēsis district. The difference in points does not form full 8 points or 19% of the value of the highest result. None of Kurzeme districts is included in the group of the most endangered districts. In the group of less endangered districts, all 8 districts are included where the threat is evaluated from 9.3 points for Jelgava district in Zemgale region to 21.4 points for Tukums district in Riga region.

Table 4

Indicators for the evaluation of common regional risk

Evaluation of regional risk		Most endangered regions	
Region	Points	Region	Points
Aizkraukle	37.95	Cēsis	42.4
Alūksne	30.70	Limbaži	42.1
Balvi	30.25	Madona	38.5
Bauska	12.50	Aizkraukle	38.0
Cēsis	42.35	Valka	37.9
Daugavpils	30.05	Preiļi	34.8
Dobele	12.30	Talsi	32.8
Gulbene	25.35	Liepāja	31.6
Jelgava	9.25	Alūksne	30.7
Jēkabpils	26.20	Balvi	30.3
Krāslavas	28.50	Daugavpils	30.1
Kuldīga	28.35	Saldus	29.9
Liepāja	31.55	Krāslava	28.5
Limbaži	42.05	Kuldīga	28.4
Ludza	18.25	Ventspils	28.0
Madona	38.50	Jēkabpils	26.2
Ogre	15.95	Valmiera	26.2
Preiļi	34.80	Gulbene	25.4
Rēzekne	21.15	Tukums	21.4
Rīga	10.60	Rēzekne	21.2
Saldus	29.85	Ludza	18.3
Talsi	32.80	Ogre	16.0
Tukums	21.40	Bauska	12.5
Valka	37.90	Dobele	12.3
Valmiera	26.20	Rīga	10.6
Ventspils	27.95	Jelgava	9.3

It is important to note that the districts of Bauska, Dobele and Jelgava find themselves in a very similar situation which points to the high competitiveness of the districts for an intensive manufacturing of the agricultural produce with wide prospects to use the scale effect.

Conclusions

1. The evaluation of the threat level for the districts can provide valuable information to the concerned persons on establishing free zones and developing the economic justification for a definite territory of the country.
2. The information and conclusions can be useful for making government decisions in the respective state institutions.
3. When starting to grow GM rape, the prospective free zones are to be established in the Districts of Cēsis, Limbaži, Madona, Aizkraukle, Valka, and Preiļi.

References

1. Angevin, F., Colbach, N., Meynard, J.M. (2006) Analysis of necessary adjustments of farming practices. In: Bock A.K. (editor). *Scenarios for coexistence of genetically modified, conventional and organic crops in European agriculture.* Technical Report Series of the Joint Research Center of the European Commission, EUR 20394 EN, 128 pp.
2. Džeroski, S., Pascher, K., Grabbher, G. (2006) Analysing the effect of field characteristics on

gene flow between oilseeds rape varieties and volunteers with regression trees. *Proceedings of Second European Conference "Co-existence between GM and non-GM based agriculture supply chains*", *14-15 November 2005*. Agropolis Productions, Paris**,** 207-212.
3. Frank, R. (2004) Effective GMO Risk Management. In: *Asia Pacific Food Industry,* January/February, 56-58.
4. Hirzinger, T., Monrad, K. (2006) Effects of the Regulation (EC) No. 1829/2003 and 1830/2003 on the German Food Industry. *Proceedings of Second European Conference "Co-existence between GM and non-GM based agriculture supply chains*", *14-15 November 2005*. Agropolis Productions, Paris, 125-129.
5. Sondergaard, J., Pedersen, S.M., Gylling, M. (2006) Danish perception of GM-crops. *Proceedings of Second European Conference "Co-existence between GM and non-GM based agriculture supply chains*", *14-15 November 2005*. Agropolis Productions, Paris, 135-139.
6. *Enabling the Coexistence of genetically Modified Crops and Conventional and Organic Farming in Finland*. (2005) Mid-Term Report. Ministry of Agriculture and Forestry, Finland, Helsinki, 88 pp.

Anotācija

Brīvā bioloģiskā zona ir noteikta valsts teritorijas daļa, kurā iespējamā ĢM kultūraugu audzēšana kļūst ekonomiski neizdevīga, izpildot valsts normatīvajos aktos noteiktās prasības un/vai var radīt reālus ražošanas dabisko apstākļu pasliktināšanās (zaudējumu) draudus citiem saimnieciskās darbības subjektiem, kā arī apkārtējās vides ilgtspējīgai attīstībai, dzīvnieku un cilvēku veselībai. Brīvo zonu izveidošanas nepieciešamību var ekonomiski pamatot. Brīvajās bioloģiskajās zonās strādājošās lauku saimniecības būtu valstiski aizsargāti no ĢM lauksaimniecības kultūraugu apdraudējuma, ko var izraisīt ģenētiski modificētais piesārņojums. Tas palielinātu saražoto lauksaimniecības produktu pārstrādātāju – pārtikas preču ražotāju uzticību piegādātājiem, radot pārliecību, ka iepirktajām lauksaimniecības rakstura izejvielām nav konstatējama ģenētiski modificēto organismu klātbūtne. Par šo pārliecību pārtikas produktu ražotāji un gala produktu patērētāji labprāt maksā lielāku cenu. Identificētie potenciālo zaudējumu subjekti ĢM kultūraugu audzēšanas gadījumā ir bioloģiskās lauku saimniecības, lauku saimniecības, kurās tiek audzēts rapsis, sēklkopības lauku saimniecības, kurās audzē rapsi vai citu krustziežu sēklu,saimniecības, kurās audzē bites. Izstrādāti matemātiskie un uzskatāmi grafiskie modeļi brīvo zonu ekonomiskā pamatojuma izstrādei.