Economic Aspects of Growing Genetically Modified (GM) Rapeseed in Latvia
Ģenētiski modificēta(ĢM) rapša audzēšanas ekonomiskie aspekti Latvijā

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Abstract. Growing of GM cultivated plants can be economically profitable for the following reasons: opportunity to gain more harvest due to the resistance to conventional diseases and pests characteristic to cultivated plants as well as opportunity to decrease costs for the use of plant protection means. Although presently there are no commercially available diseases resistant GM cultivated plants, yet only cultivated plants that are resistant to particular pests and mainly tolerant to common herbicides. Gene flow among GM herbicide tolerant plants can have important organising, economic and legal impacts on farmers due to considerably high additional costs for growing GM rapeseed crop. Farmers may incur the following costs: informational costs to avoid dissemination of GM products in sowings of other farms; costs of elimination of distribution of GM plants during their pre-processing, storage and transportation; costs for marking GM products on their presence in the corresponding item; costs of laboratory sampling and analyses; additional expenses for personnel training; expenses of maintenance of the state supervising departments; and expenses for insurance of sowings of GM cultivated plants. Growing of GM cultivated plants becomes profitable in a set territory if the net income gained by the planter of GM cultivated plants per unit of area exceeds the net income per unit of area in the case of growing conventional cultivated plants.
Key words: GM rapeseed crops, economic arguments.

Introduction

The rapid development of biotechnology offers new technologies for growing cultivated plants, and one of them is growing GM cultivated plants (Mesean, Angevin, 2006). Various genetic modifications of plants are capable to raise quality and productivity of plants, to enable technologies for processing cultivated plants, and to eliminate noxious organisms. However, together with the positive gains, by decreasing expenses required for growing plants of genetically modified sowings, growing of such plants causes problems as well. An uncontrolled dissemination of genes is observed from some genetically modified cultivated plants, thus breaking the competitiveness of the natural plant community as well as depleting the eco-system by growing congenial cultivated plants in huge areas. The genes are disseminated by the pollinators-insects and the wind if the cultivated plant has kindred wild plants in nature (Beckie et al., 2003). According to the data obtained by Canadian researchers (Knispel et al., 2007), in the Western part of Canada, an uncontrolled dissemination of the rape genes tolerant to herbicides (HT) was observed everywhere but the HT rape populations were most widely met at the sides of roads and railways. It is to be particularly noted that hazardousness of this process is stated as in nature the rape generation is found with multiple tolerance against three groups of herbicides – glyphosphate, glyphosinate as well as against the herbicides of the imidasolinon group. Within two years of the research, it is found that the maternal plants with one HT feature give descendants with the above multiple tolerance. According to the opinion of Canadian researchers, the process is practically unmanageable, and dissemination cannot be forecasted. Therefore, it causes a risk for the conventional and biological agriculture. On certain conditions, the uncontrolled dissemination of genes might affect the apicultural and biological managements, and the decrease of seed farming in Latvia (Turka, 2007; Turka, Ruža, 2007).

On the one hand growing of cultivated plants in the conditions of Latvia is connected with a possible decrease of operating costs; while on the other hand the farm before making a decision on growing GM cultivated plants has to elicit the requirements for the activities to be carried out set by the laws and regulations in order to decrease the possibility of spontaneous dissemination of GM cultivated plants. The fulfilment of requirements set by the laws and regulations will be followed by certain expenses within the period of soil cultivation before sowing, in the phase of growing the cultivated plants as well as in harvesting, primary processing and sales of the grown produce.

The hypothesis of the research. The cultivated plants obtained by the gene engineering with their main feature to be tolerant only to herbicides of the general effect, is not only a gain for agriculture, but they can also generate certain management, monitoring and ecologic problems. Growing GM winter and summer rape in Latvia may possibly cause economic losses to the neighbourhood farms.

The aim of the research is to obtain more detailed information on the profitability or losses of growing GM rape in the regions of Latvia by carrying out analysis of the economic conditions and evaluation at the micro level.

Materials and Methods

The costs for growing conventional and GM rape are estimated during the research.

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. Calculatation has been done by the authors using information by Certificate Enterprise of Association of Biological farms and Ministry of Agriculture of Latvia. The general condition of the economic profitability for growing GM cultivated plants can be shown by means of the following inequality:

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

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

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

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:

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

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_V^{GM} – general costs for growing GM cultivated plants;

C_{PP}^{GM} – 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:

$$C_{SMA}^{GMR} = \frac{(Q_S^{GM} \times P_S^{GM}) + \sum C_{MM}^{GM} + \sum C_{AAL}^{GM}}{\sum PL^{GM}}, \quad (4)$$

where

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

Q_S^{GMR} – the amount of seeds of GM cultivated plants per ha;

P_S^{GMR} – the price for the seeds of GM cultivated plants;

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

C_{AAL}^{GMR} – 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 growing expenses per ha for growing GM cultivated plants decrease due to the new properties to resist definite diseases, pests obtained through modification and capability to bear treatment by herbicides.

Certain differences also exist in services compared to the services and their costs required for growing GM cultivated plants and conventional cultivated plants as well. These differences are included 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} – costs for growing, harvesting and primary processing of GM cultivated plants;

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

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

$\sum CP_{NSA}^{GM}$ – service costs for harvesting and pre-treatment of seeds 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.

The total costs in growing GM cultivated plants are equalled to the total costs for growing genetically unmodified cultivated plants, excluding the costs related to the fulfilment of activities set by the corresponding laws and regulations for the growers of GM cultivated plants to decrease an uncontrolled dissemination of 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.

In estimating 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 additional costs in the event of growing GM cultivated plants;

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

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

Additional 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:

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

where

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

C_{INF}^{GM} – dissemination of additional information on cost coordination for the possible growing of GM cultivated plants;

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

C_{LA}^{GM} – costs for the laboratory analyses to control an uncontrolled dissemination of GM cultivated plants;

C_{DK}^{GM} – additional costs for processing documentation reflecting growing, harvesting, primary processing and preparation of GM cultivated plants for sales;

C_{PA}^{GM} – additional training costs for farms desiring to grow GM cultivated plants;

C_{VI}^{GM} – additional costs of the state institutions related to the fulfilment of supervision and control process set by the laws and regulations on the fulfilment of the requirements set by the laws and regulations on growing GM cultivated plants;

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

NP_{BFJ}^{GM} – the lost income from the area which is used to establish the buffer belt around the fields where GM cultivated plants are grown;

C_{CI}^{GM} – other costs related to the fulfilment of other requirements not given here for a farm which grows GM cultivated plants.

Determining additional costs, the grower of GM cultivated plants has to take into account the necessity for packaging and marking GM cultivated plants. Mutually agreeing, the grower can attribute these costs to the wholesaler of GM cultivated plants. But in such case, the grower of GM cultivated plants has to consider upon a lower sales price. It means that with the decrease of the sales revenues, the grower of genetically modified plants will have to decrease packaging and marking costs of the grown harvest.

The question remains open on attributing the additional costs in full amount to the grower of GM cultivated plants. According to the principle of the economic fairness and the principle "the polluter pays", all additional costs should be attributed to the farm which desires to grow the GM rape including the additional costs of the state institutions to control the fulfilment of requirements set by the respective laws and regulations. It means that the grower of GM cultivated plants in his expenses should include all additional costs arising on the farms which do not grow GM cultivated plants, if the farm where GM cultivated plants are grown has worsened the management conditions, and the nonconformity of the grown harvest with the requirements for obtaining the highest sales revenues causing GM plant threat and/or allowing an uncontrolled dissemination of uncontrolled GM cultivated plants.

The fulfilment of requirements set by the laws and regulations on growing GM cultivated plants and manufacturing food products using the GM raw material is attributed to additional costs. Presently it is impossible to determine the amount of these costs in Latvia as there is no experience accumulated in this country. Though other EU countries deal with GM products and certain experience is accumulated which enables to estimate additional costs related to the presence of GM products in the process of manufacturing.

The condition of the economic profitability for GM cultivated plants based on sales revenues and

costs per one unit of area or the amount unit of the harvest was described above. Attributing incomes and expenses to the growing area of GM cultivated plants or the weight of harvest is related to the fact that the harvest is affected by both the internal factors depending on the farm and the external factors not depending on the farm, for instance, the climatic conditions.

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 selling the harvest of GM cultivated plants can be expressed by the following equation:

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

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 sales price which depends on the type of using GM cultivated plants set for manufacturing a definite output;

K_v – the correction coefficient for sales price which depends on the impact of cultivated plants of a definite modification on the environment, animal and human health;

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

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

Results

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.

The comparatively poor experience of the society on the use of GM cultivated plants and their output shall be considered when evaluating the potential income in selling the harvest of GM cultivated plants. The researches related to improving properties of cultivated plants and in the sphere of using GM products can essentially affect both costs for growing GM cultivated plants and sales revenues. The following subjects of the economic activities in the countryside are included in the evaluation of the potential direct losses as a result of an uncontrolled dissemination of GM cultivated plants:

a) the potential losses, primarily, are attributed to the biological farms growing the cultivated plants threatened by the uncontrolled dissemination of GM cultivated plants;
b) the potential losses attributed to the centres of seed farming and research which augment high-rate quality seed material in their territory and provide the needed seed material for cultivated plants of the mustard family in cooperation with the neighbourhood farms;
c) the potential losses are attributed to any agricultural farm where cultivated plants endangered by an uncontrolled dissemination of GM cultivated plants are grown;
d) the potential losses attributed to the farms dealing with apiculture;
e) the potential losses attributed to the farms and enterprises dealing with rural tourism and providing health rehabilitation services as well.

The lost part due to the dissemination of GM cultivated plants is set for the endangered objects by means of the expertise method. The opinion of specialists on the amount of losses for the subjects of the threat is shown in Table 1.

Table 1

Experts' view on the amount of losses

Subjects of risk	Endangered branch	Amount of losses
Organic farms	Organic farming, certification, support	Not less than 7-10% of the gained income
Seeds cultivation farms	Branch of seeds cultivation	Essential losses, even to 100%, if seeds of biologically endangered cultivated plants are grown
Farms growing rape seed	Growing of rape seed	Not less than 25-30% of the gained income
Apiculture farms	Apiculture	Not less than 50-70% of the gained income
Farms of rural tourism and health improvement	Rural tourism, medical services	Not less than 7-10% of the gained income

The amount of potential losses depicted in the table is estimated considering information available by the specialists on the properties obtained by GM cultivated plants and their impact on the environment, animal and human health in the vegetation period and in the form of a ready product. The amount of potential losses will be adjusted if supplementary and more complete information on the properties of GM cultivated plants and their environmental impact is at the disposal of the society. In addition, the actual opportunities are to be considered to receive new lines of GM cultivated plants which might have different impact on other cultivated plants, environment, animal and human health.

Potential Losses to the Bological Farms

During recent years biological agriculture is rapidly developing. The number of biological farms certified in 2007 as well as the farms standing as candidates for receiving the certificates and the area of the agricultural land for these farms are considered when estimating the number of the endangered farms and the area for the agricultural land of these farms. Therefore, the number of the endangered farms exceeds 4.8 thousand and their land – over 16.4 thousand ha. Even presently more than 3 thousand biological farms deal with cultivation of plant-growing produce and more than 150 farms are engaged in the biological apiculture. Many farms cultivate nectar plants, develop growing of herbal teas, and field plant teas, develop environmental and health services in all the regions (Vanags, 2007).

The state programme for developing biological agriculture for the period from 2007 to 2013 is directed towards improving the qualitative properties of the produced product and increasing the value added for the produce in the system of biological agriculture. The programme envisages enhancing the material and technical basis of the farms, to favour the vertical and horizontal development of cooperation for processing the products and delivering them to the consumer. The support rendered by the LAP is envisaged for implementing the set assignments. It is envisaged to develop special programmes of training, show farms, and to develop the biological seed farming.

In Latvia, suitable conditions are created for manufacturing biological produce with a high value added. It is an important natural priority of Latvia in the global cross-country competition which enables Latvia to enter the world by own exclusive biological produce with a high value added. The above mentioned gives evidence that 10% of the income included in the estimation of the potential losses are considered to be the minimum potential losses which might arise as a result of an uncontrolled dissemination of genetically modified organisms both for individual farmers and the country on the whole, and it is forecasted that the specific weights of losses can increase up to 15-20% in the near years. The results of the estimated potential losses for the biological farms in the regions of Latvia are shown in Table 2.

Only the certified biological farms and their agricultural lands are used in the loss estimation included in the table. It ensures precision of the obtained results and increases its application in making decisions. The total estimated sum of the potential losses exceeds LVL 2 million. The highest amount of losses is attributed to Vidzeme region – LVL 487 thousand or 24.3% where the largest areas are biologically managed. In accordance with the increase in prices for the agricultural produce, in 2007 the average income per ha in the regions is fluctuating from LVL 90 in Latgale region to LVL 170 in Riga region, where better opportunities to grow vegetables and to sell the manufactured biological produce for a higher price are possible. Wherewith, in Riga region, the potential losses for the biological farms reach LVL 360 thousand and make 16.8% of the total losses of the biological farms in the country. Similar potential losses are possible in Zemgale region – LVL 340 thousand. Although, in Latgale region the

Table 2

Potential losses of organic farms in case of uncontrolled distribution of GMO

Region	Calculation of losses, year 2007		
	UAA of organic farms, ha	average income, LVL ha^{-1}	potential losses =10%, thousand LVL
Vidzeme	44 264	110	486.9
Kurzeme	32 452	140	454.3
Latgale	44 595	90	401.4
Zemgale	22 462	150	336.9
Pierīga	21 227	170	360.9
Total/the country	165 000	132	2040.4

Table 3

Potential losses for rapeseed growing farms

Region	Calculation of losses, year 2007			
	area of rapeseed, ha	average income, LVL ha^{-1}	lost part, %	potential losses, thousand LVL
Vidzeme	14 600	700	30	3066
Kurzeme	13 800	900	20	2484
Latgale	9800	500	30	1470
Zemgale	43 700	900	5	1967
Pierīga	9300	700	10	651
Total/the country	91 200	–	–	9638

land for the biological farms 2 times exceeds the area of the biological farms in Zemgale region.

Potential Losses for the Farms Growing the Rape

Due to the favourable market conjuncture, the country support, and the constant increase of the purchase price, the area of rape sowings rapidly increases. In the period from 2000, they have increased more than ten times. This increase is stipulated by widening of the rape usage-in food as well as for the renewable energy resource in bio-fuel and utilization of the rape shoots in fodder. The rape areas are directly subjected to the hazardous impact of genetically modified organisms in the event of uncontrolled dissemination. For the growers of the rape, the potential losses are estimated considering the region where the rape is grown and the opportunities to grow the genetically modified rape in this region. For every region, an individual loss coefficient is used.

The information on the results of estimation is shown in Table 3.

The estimation of the potential losses in Table 3 is based on the assumption that in the event of invasion of genetically modified organisms, the usage of the rape seeds in food will essentially decrease. Therefore, the rape seeds with the presence of the GMO, will be sold for the production of bio-fuel which will decrease the sales price of the produce. In addition, the rape cakes with the biological contamination will not be applicable in fodder. Therefore, it is assumed that the real threat inflicted by GM cultivated plants can decrease income for the rape growers at least by 30%. Wherewith, the region is considered where the farm of the potential rape grower is located.

As it is evident from the figures given in Table 3, the total losses exceed LVL 9.6 million. The highest losses are attributed to Vidzeme region-slightly over LVL 3 million or 33.8%. Considerably high losses are possible to be encountered in Kurzeme region as well – LVL 2.5 million or 24.1%. While in Riga region the potential losses for the farms growing the rape make only LVL 600 thousand, growers of the rape orientate themselves, mainly, to manufacturing bio-fuel, except Limbaži district.

Due to the agro-climatic conditions in Latgale region, the rape seed grown in the biological and conventional systems of farms can be used in food production; while sowing of the rape is mainly done

for agro-technical purposes – as one of the cultivated plants in the crop rotation. Therefore, in this region, rape sowings are not widely spread and total potential losses make only LVL 1.5 million or 15.9% of the total losses for the farms growing rape seeds.

Potential Losses for the Apiculture Farms

The favourable climatic conditions and the established traditions favour a rapid increase of bee families in the countryside of Latvia. In accordance with the information provided by the association of bee growers, the beehives are found in small amounts almost in every farmstead of Latvian countryside. The urban population and households of the city outskirts like bees as well.

Within the recent year, the number of the beehive families has increased from 43 to 62 thousand families in the beginning of 2007. Over 150 biological farms deal with apiculture which set even higher requirements for quality of the manufactured produce. In the event of genetically modified organisms, in exceeding the permissible level of contamination, serious problems might appear with sales of the manufactured produce at prices acceptable to apiarists. Consulting the apiculture specialists, it is assumed that the sales price for honey with the presence of GMO will decrease on a half, at least. The estimation results of the potential losses are shown in Table 4.

As it is evident from the results of estimation for the potential losses, the forecasted amount of losses for apiculture farms nearly reach LVL 2.5 million, out of which the majority – LVL 726 thousand or 29.5% refer to Kurzeme region and LVL 583 thousand or 23.7% to Vidzeme region. Considerably lower losses are possible to incur in Riga region – LVL 400 thousand. In Latgale region relatively low losses can be observed as well – LVL 370 thousand or 15% of all the losses for the apicultural farms. It is related to considerably tiny number of bees per one unit of the agricultural land area.

Evaluating the losses incurred upon the bee farms, it is to be considered that the bees act as active vectors of GM organisms in the environment. Therefore, the forecasted losses may increase taking into account the damage incurred upon the environment.

Potential Losses for the Facilities of Rural Tourism and Medical Services in the Countryside

Rural tourism as a new alternative branch has come into the countryside of Latvia in line with its successful developing. The rural entrepreneurs are gradually acquiring the aspect of the countryside, the aspect of the people's desire to relax in simple farmsteads, closer to the untouched natural environment. As it is seen by the foreign experience, the fans of rural tourism find GM cultivated plants in the rural environment to be unacceptable and interfering factors. Therewith, they refuse from such type of recreation. Particularly, foreign tourists find the comparatively untouched nature and the expressive non-industrial rural landscape with country estates as a positive and favouring factor for rural tourism. The potential losses as a result of an uncontrolled dissemination of GMO set by specialists are presented in Table 5.

In the estimations, according to the evaluation done by the specialists, a comparatively small part of the losses is presented – 10% of the present level which is evaluated as comparatively low but with a pronounced increase in the recent years. The total potential losses nearly reach LVL 520 thousand. The facilities operating in the branch of the rural tourism calculate that in the future the real potential losses might be higher as the number of the objects of rural tourism is increasing with every year and the public requirements for the quality and security set to the environment are increasing as well, particularly in the places of recreation and health rehabilitation.

Table 4

Potential losses for apiculture farms

Region	Calculation of losses, year 2007		
	number of beehives of bees	average income, LVL per swarm of bees	potential losses =50%, thousand LVL
Vidzeme	14 600	80	583.3
Kurzeme	14 500	100	725.6
Latgale	12 300	60	370.0
Zemgale	10 600	70	372.8
Pierīga	10 200	80	404.9
Total/the country	62 200	–	2456.6

Table 5

Potential losses for rural tourism and health rehabilitation enterprises

Region	Calculation of losses, year 2007		
	number of endangered enterprises	average income, thousand LVL year^{-1}	potential losses =10%, thousand LVL
Vidzeme	63	20	126.0
Kurzeme	44	25	110.0
Latgale	29	15	43.5
Zemgale	28	20	56.0
Pierīga	73	25	182.5
Total/the country	237	–	518.0

Table 6

Calculation of potential losses for seed farming

Region	Calculation of losses, year 2007		
	number of farms	average income, thousand LVL year^{-1}	potential losses =10%, thousand LVL
Vidzeme	35	50.0	175.0
Kurzeme	45	100.0	450.0
Latgale	12	40.0	48.0
Zemgale	28	100.0	280.0
Pierīga	52	100.0	520.0
Total/the country	172	–	1473.0

Moreover, it is to be considered that the rural tourism is rapidly developing, increasing and stabilising incomes, and diversifying the assortment of the offered services. An absolute leader in the development of rural tourism is Riga region. Therefore, in this region, the highest potential losses are found as well – LVL 182.5 thousand or 35% of the total forecasted losses for the threatened facilities in the countryside. Riga, Vidzeme and Kurzeme regions comprise 80% of the potential losses in the event of uncontrolled dissemination of GMO.

Potential Losses for the Seed Farming Agricultural Farms

The potential losses for the seed farming agricultural farms as a result of an uncontrolled dissemination of GM organisms can be considered from several aspects:

– the farm grows seeds from biologically endangered cultivated plants. Then the amount of losses might amount up to 100%;
– the farm grows seeds from biologically secure cultivated plants. Then the losses might be at minimum – up to 10% which are attributed to the behaviour of the consumer in the market.

It is to be noted that in the recent years, the branch of seed farming is on the decline due to the wide offer of seeds from other countries. However, it is argued and also topical if the seeds of the offered cultivated plants are suitable to the agro-climatic conditions of Latvia. By the gain of efficiency in growing cultivated plants, higher requirements will be set to the seed material which will enhance the demand for the seeds of the most suitable varieties of cultivated plants for the local conditions. It will favour the increase of competitiveness of the farms not only at the local but also at the cross-country scale.

At the same time it is to be noted that part of the farmers use self-grown rape seeds. The seed growing for the biological farms is developed. In small amounts, vegetable seeds are grown in "Kurzemes sēklas" (Seeds of Kurzeme) Ltd and other farms.

The approximate losses which might arise for the seed farming agricultural farms as a result of an uncontrolled dissemination of GMO are shown in Table 6.

It is to be noted that in the estimation, seed farming agricultural farms of different sizes and different specialisation and other seed farming centres are presented as, for instance, Stende GSI, Priekuļi LSI, Pūre DIS, Latgale LZC, training and research farms and agencies of Latvia University of Agriculture, etc.. The total estimated potential losses nearly reach LVL 1.5 million, of which the majority – LVL 520 thousand or 35% – are attributed to Riga region. The comparatively high potential losses are forecasted for Kurzeme region – LVL 450 thousand or 30.5% of the total losses for the seed farming agricultural farms in the country. Comparatively low potential losses are forecasted for Latgale region – only LVL 48 thousand or 3.25%.

The greatest part of the seed farming is located in all the regions of Latvia to a greater of smaller extent, and the farms are trying to reduce the operating costs. Although, the lowest possible losses are estimated in Latgale region, this is exactly the region which is evaluated as the region with higher natural priorities used for widening the cultivated crops within the system of the biological agriculture as well as widening of rural tourism and health services.

Summary of the Potential Losses

The estimated potential losses for various subjects of economic activities in the countryside are summarised in Table 7.

As it is evident from figures shown in Table 7, the total potential losses in the event of an uncontrolled dissemination of GM cultivated plants slightly exceed LVL 12 million. The highest potential losses are attributed to the rape growers, the apiculture branch and biological agriculture – LVL 9.6 million, LVL 2.5 million and LVL 1.5 million respectively.

According to the breakdown of regions, more than one third of the potential losses are attributed to Vidzeme and Kurzeme regions each. For both the regions, the total potential losses exceed 51% of the total potential losses in the country in the event of an uncontrolled dissemination of GM cultivated plants. It can be explained by the fact that these regions concentrate the highest peculiar weight of all the endangered subjects of the economic activities in the countryside.

A relatively small part – LVL 2.3 million for losses are attributed to Latgale region. Although, one of the most favourable conditions to develop growing of cultivated plants in the system of the biological agriculture exactly exists in this region. In this evaluation it is to be considered that in Latgale region, a considerably lower economic activity is observed. Therefore, in this region the potential losses make a considerably higher peculiar weight in the balance of the subjects of the respective economic activities than in other regions of Latvia.

The estimated structure figures of the potential losses in the event of an uncontrolled dissemination of GM cultivated plants are depicted in Table 8.

The figures presented in the table give evidence that the potential losses for the farms growing the rape make 72.4% of the total forecasted sum of losses.

Comparing the specific weight of the forecasted losses presented in Table 8, it can be concluded that the estimated losses for the biological agriculture are divided considerably evenly in the regional section, and are fluctuating within the limits of 6%, the highest specific weight in Vidzeme region is 27.5%, but the lowest specific weight in Riga region is 13.4%, and in Latgale region – 14.5%.

Evaluating the potential losses in the biological farms, it is found that the highest specific weight of the potential losses is attributed to Vidzeme and Kurzeme regions – 23.9% and 22.3%, respectively. It is connected with the intensive development of biological agriculture in these regions. Evaluating the potential losses for the farms growing the rape,

Table 7

Summarization of potential losses in regions

Regions	Distribution of potential losses, thousand LVL					
	organic farms	rapeseed growers	seed growers	apiculture	rural tourism	total in regions
Vidzeme	486.9	3066	175.0	583.3	126.0	4437.2
Kurzeme	454.3	2484	450.0	725.6	110.0	4223.9
Latgale	401.4	1470	48.0	370.0	43.5	2332.9
Zemgale	336.9	1967	280.0	372.8	56.0	3012.7
Pierīga	360.9	651	520.0	404.9	182.5	2119.3
Total/the country	2040.4	9638	1473.0	2456.6	518.0	12 196.4

Table 8

Regional structure of potential losses

Regions	Structural division of potential losses, %					total in regions
	organic farms	rapeseed growers	seed growers	apiculture	rural tourism	
Vidzeme	23.86	31.81	11.88	23.74	24.32	27.52
Kurzeme	22.27	25.77	30.55	29.54	21.24	26.19
Latgale	19.67	15.25	3.26	15.06	8.40	14.47
Zemgale	16.51	20.41	19.01	15.18	10.81	18.68
Pierīga	17.69	6.75	35.30	16.48	35.23	13.14
Total/the country	100.00	100.00	100.00	100.00	100.00	100.00

it is found that the dominant position in this index belongs to Vidzeme region with 31.8%, while the lowest specific weight in Riga region is 6.8%, and in Latgale region – 15.3%.

The estimated potential losses for the seed growers in the event of an uncontrolled dissemination of GMO in the regions fluctuate from 3 to 35%. The highest relative amount of the potential losses is attributed to Riga and Kurzeme regions – 30.6%. To a lesser extent, in the event of threatening seed growing, Latgale region can suffer – only 3.3% of the total losses for the seed farming agricultural farms.

Comparing the potential losses for the apiculture branch, it is found that to a great extent, its relative distribution correlates with the potential losses for the biological farms. The highest comparative amount – 29.5% is attributed to Kurzeme region where in recent years, a particularly rapid tendency of increasing bee families can be observed. In Vidzeme region, the potential losses inflicted upon the bee growers equal to 23.7%, and this region is located comparatively near Kurzeme region.

The agricultural enterprises which deal with rural tourism and provide health rehabilitation services, to a greater extent, can be endangered in Riga and Vidzeme regions. Thirty-five per cent of all the potential losses inflicted upon the rural tourism are attributed to the enterprises of rural tourism located in Riga region. The lowest losses are attributed to Zemgale and Latgale regions – 10.8% and 8.4% respectively of the total potential losses in this sphere of activities.

Conclusions

The results of estimating the potential losses give opportunity to make the following most important decisions:

– the potential losses for various subjects of the economic activities in the countryside are estimated using the available information sources and involving specialists. Having considered the uncertainty of the situation on the further development of GM cultivated plants and their impact on the environment, the actual amount of losses for agricultural farms and the environment may be considerably higher;
– the highest relative losses are attributed to Vidzeme region – 27.6% and Kurzeme region – 26.2%. For these regions the forecasted losses exceed 50% of all the potential losses for the biological farms in the country which might arise as a result of an uncontrolled dissemination of GM products;
– comparatively high potential losses are possible for the apiculturists. In Vidzeme and Kurzeme regions – from LVL 0.6 to LVL 0.73 million. It is to be noted that in these regions, the specific weight of the indirect costs is comparatively high in the event of the threat which cannot be unequivocally transformed in the terms of money in relation to the development of tourism and health services in the countryside environment;
– specialists are forecasting increase of the potential losses for different growers of cultivated plants in all the regions as in Latvia a tendency is observed that the number of manufacturers of the biological produce is rapidly increasing as well as the market prices for the biological products are increasing every year with the annual rate of the increase exceeding 7-10%. It increases the competitiveness in growing the biological produce and increases the potential losses as a result of dissemination of GM cultivated plants;
– in eliminating the potential losses as a result of an uncontrolled dissemination of GM cultivated plants, potential losses related to the impact of GMO on the environment, animal and human health are not included. For estimating these losses, the needed information and certainty

of the GMO impact on the environment are missing;
– the applied method for estimating the potential losses can be used in evaluating the necessity of establishing free zones in a larger or smaller territory of the country.

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Anotācija

ĢM kultūraugu audzēšana Latvijas apstākļos no vienas puses saistīta ar iespējamo ražošanas pašizmaksas samazināšanos uz tiešo izmaksu rēķina, bet no otras puses, lauku saimniecībai, pirms lēmuma pieņemšanas par ĢM kultūraugu audzēšanu, jānoskaidro normatīvajos aktos noteiktās prasības par veicamajiem pasākumiem, lai samazinātu ĢM kultūraugu patvaļīgas izplatīšanās iespējas. Šo normatīvajos aktos noteikto prasību izpilde būs saistīta ar zināmām izmaksām pirmssējas periodā, kultūraugu audzēšanas stadijā, kā arī izaudzētās produkcijas novākšanā, pirmapstrādē un realizācijas laikā. Gēnu inženierijas ceļā iegūtie kultūraugi, kuru galvenā iezīme ir tikai tolerance pret vispārējas iedarbības herbicīdiem, ir ne tikai ieguvums lauksaimniecībā, bet tie var radīt arī zināmas pārvaldes, kontroles un ekoloģiskas problēmas. ĢM ziemas un vasaras rapša audzēšana Latvijā iespējams radīs kaimiņos esošām saimniecībām ekonomiskus zaudējumus. Iegūt detalizētāku informāciju par ĢM rapša audzēšanas izdevīgumu vai zaudējumiem Latvijas reģionos, veicot ekonomisko apstākļu analīzi un izvērtēšanu mikrolīmenī. Pētījumu gaitā tiek aprēķinātas konvencionālā un ĢM rapša audzēšanas izmaksas. Lai precizētu ĢM kultūraugu audzēšanas izdevīgumu, jeb neizdevīgumu Latvijas apstākļos, pētījumā atklāti nozīmīgākie ekonomiskie aspekti, ar kuriem jārēķinās potenciālajiem ĢM kultūraugu audzētājiem.