Maintenance and Financing of Land Drainage in Lithuania
Zemes nosusināšanas sistēmu apsaimniekošana un finansēšana Lietuvā

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Abstract. The paper analyses the current situation in land reclamation sector in Lithuania and discusses agricultural drainage management under the conditions of market economy. Land reclamation practice plays a significant role in agriculture of Lithuania. Until 2004, about 2.98 million hectares (85.5%) of agricultural land were drained. Though ownership rights to land were restored after regaining independence in 1990, privatization of land reclamation structures was not started along with the land reform. Drainage systems were included into the state property. Their maintenance is government-funded and makes only 4.4 € ha^{-1} per year on average, which is largely insufficient as drainage systems continuously deteriorate. The state bailout measures for maintenance of land drainage should be optimized and geared to the economic expediency. Four scenarios of the reallocation of subsidies for land drainage are submitted for approval. Having applied the methodology suggested, priority should be given to the regions where revenue from agriculture is highest. Therefore in the region of middle Lithuania where water regime control is profitable, current subsidies for land drainage would increase by index 1.24±0.10. Whereas in the territory where land productivity is low and the percentage of abandoned land is more than the mean value of the country, the financing would be reduced by index 0.71±0.17.
Key words: land drainage, maintenance, state subsidies, financing scenarios.

Introduction

The territory of Lithuania is subdivided into 44 districts (municipalities) attributed to ten counties with a total area of 65.3 thousand km^2, about 60.6% of which are used for agriculture purposes. Specific climate conditions, relief and soil properties have resulted in certain hydrological problems (Motuzas et al., 1996). Excess water in the soil is evident in the spring snow-melt period and lack of water regime control extremely aggravates agricultural activity and mechanization. Therefore the bulk (about 3 million ha) of agricultural land has been drained (Maziliauskas et al., 2005). The percentage of drained land varies from 35.4% in hilly areas to 98.8% in plain districts with more fertile soils (Fig. 1).

Until 1990, when Lithuania restored its independence, the land and land drainage structures were exclusively the state property and were used for agricultural development, which was oriented towards the Soviet Union (Russia) market (Šaulys and Lukianas, 2003). The situation changed when the land reform had started and ownership rights to land had been retrieved. As reorganization of land reclamation management was not carried out along the land reform, the agricultural land obtained two owners: (1) the owner of the plot, and (2) the state as the authority for the operation and maintenance of implemented drainage systems. As the landowners are economically weak, they are not interested in taking responsibility for the operation and maintenance of drainage systems in their ownership and the state cannot always carry out the necessary maintenance because of the lack of funds (Offringa et al., 1999). Insufficient maintenance of drainage leads to systems deterioration.

Similar problems emerged not only in Lithuania, but also in neighbor states that have economical straits influenced by the process of transition. Dzalbe and Busmanis (2004) have mentioned that socio-economic transformations and privatization had affected the situation in soil management in Latvia.

The possibilities of reducing governmental bailout for land reclamation have been under consideration for a long time because the merger of private and state capital is complicated and, moreover, there is a lack of such experience in Lithuania. Several authors have analyzed the situation in land reclamation sector and have discussed the advantages and disadvantages of the privatization of land drainage structures, as well as the experience of land reclamation associations in the Netherlands, Norway, and Germany (Kuiper, 1998; Vaikasas et al., 1998; Šaulys and Lukianas, 2003; Maziliauskas, 2004). Monsees (2004) has proposed that the administrative structure model of Water and Soil Associations could be applied to the countries searching for modern institutional organizing forms

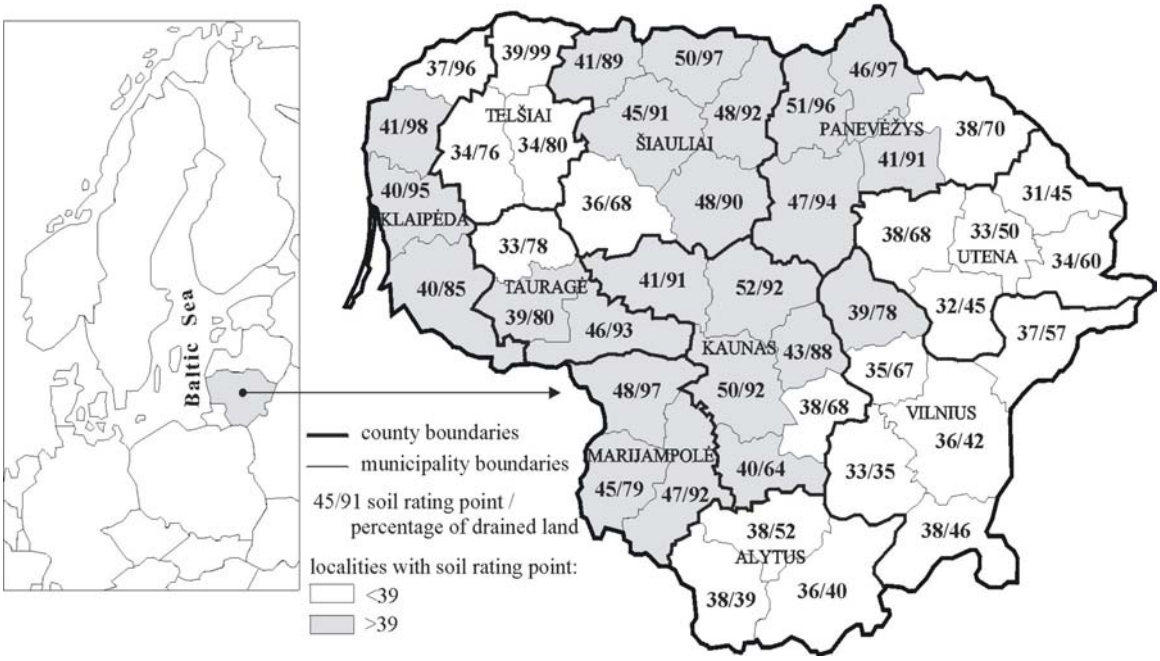

Fig. 1. Administrative subdivision of Lithuania into counties and municipalities.

for a more sustainable water and land management. A very long experience of a successful organization of collective activity and management of land and water resources according to local standards has been gained in Germany. The possible usefulness of implementing this experience in Lithuania is still under consideration.

After a long discussion, only in 2004, a new Land Reclamation Law dealing with the changes in the property rights of land reclamation structures was approved (Lietuvos Respublikos …, 2004). According to this law, the greatest part of subsurface drainage came into possession of the landowner: drainage laterals and collectors with the diameter less than 12.5 cm were transferred to the landowners while the rest of drainage network remained the state property. The following changes were dictated by the structural funds of the EU that can be used only for the renovation of private land reclamation structures (the share of the EU funds amounts to 50%). In the financial support regulations it is stated that the whole financing from the state budget will be provided only for the repair works of drainage collectors with the diameter more than 12.5 cm. In all other cases the share of personal funds should be no less than 15%.

Under the conditions of market economy, the investments in land improvement should be profitable. Therefore, further financing of land reclamation maintenance from the state budget should be optimized and focused on the economic expediency and development of regions most suitable for agriculture. No investments should be allocated where the operation of drainage systems is unprofitable.

The aim of the study was to motivate the necessity to improve the maintenance of land reclamation structures and to prepare new scenarios for the allocation of state subsidies considering the economical efficiency of the financing of land reclamation activities. To achieve this aim, the following tasks were set up:

- to analyze the current situation in the land reclamation sector and the technical state of drainage systems;
- to carry out the analysis of land reclamation financing from the state budget;
- to ascertain the factors having a direct effect on the economic efficiency of the drainage systems exploitation;
- to prepare the redistribution model of the financing of land reclamation activities basing on regional priorities.

Materials and Methods

The study is based on the analysis of the present technical and financial situation in the land reclamation sector in Lithuania. The data from the Statistics Department of Lithuania, State Land Management Institute, Lithuanian Institute of Agrarian Economics as well as from Agricultural Ministry of Lithuania have been used and processed by the method of statistical analysis.

The economical benefit of the reparation of deteriorated drainage has been estimated in line with trade prices of crop production and drainage reparation costs for the period of three years (1999-2001) in order to avoid possible meteorological effects and uneven price fluctuation. The data about

drainage reparation costs were obtained from the Land Reclamation Services in municipalities. The average value of efficiency has been expressed as the ratio of the profit gained from crop cultivation after the reparation of damaged drainage systems to the costs of reparation.

The "MS Excel 2000" program was used to prepare the algorithm for allocation of state subsidies for land reclamation purposes.

Results and Discussion

Analysis of the situation in Lithuanian land reclamation sector

A total of 3.04 million hectares or 88.4% of waterlogged soils have been drained during the forty years of Soviet period (1950-1990). Subsurface tile drainage was carried out in the area of 2.62 million ha (Maziliauskas et al., 2005). Construction of new drainage systems was stopped after 1990. In the period of 1990-2004, only 38.1 thousand hectares of waterlogged soils were drained (Valstybinis …, 2004) (Table 1). The greatest part (63%) of subsurface drainage systems in Lithuania exceed the useful service life of 30 years generally accepted in Western Europe (Rimidis and Dierickx, 2003). Notwithstanding the average lifetime of tile drainage has been forecasted to be 50 years, reliability of drainage systems decreases permanently.

Approximately 20-25 thousand hectares of drained land yearly become unsuitable for agriculture activities due to imperfect drainage (Sivickis, 2002). In the informative publications of the Lithuanian Ministry of Agriculture it has been reported that at the beginning of 2004 about 275.6 thousand hectares of agricultural land (10.7%) had an imperfect drainage status (Valstybinis …, 2004). Investigations carried out during 1996-2001 have shown that subsurface drainage in the region of Middle Lithuania generally is becoming insufficient after 28±1.2 years of operation (Bastienė, 2002). Whereas in the territory with more complicated natural conditions (diverse and contrasting soil surface structure, specific features of the relief and soil hydrology), drainage deteriorations emerged even earlier, i.e., after 23-25 years of operation. However, it should be noted that drainage deteriorations mostly occur due to inadequate maintenance necessitated by economic reasons.

Land drainage can be maintained properly only when the funding is sufficient. Only 60% of drainage deteriorations were repaired for 23.2 million € of the state funds allocated for the maintenance of implemented subsurface drainage systems in 1999. Therefore the financial support for land drainage was reduced to 11.6 million €, and only 42% of drainage failures were eliminated in 2000. During the period of 2000-2001, a total of 3.9 € ha^{-1} were contributed to the needs of land reclamation. So far the limited funds for land reclamation have been allocated regardless of the profitability of agricultural activities in different regions of Lithuania.

Figure 2 gives a comparison between the income from gross agricultural production and the state funding for drainage maintenance in 2004. Significant differences have been observed when comparing

Table 1

Land reclamation activity and financing in Lithuania in the period of 1995-2004

Year	Drained area, ha			Funds allocated	
	total	subsurface drainage	reconstruction	total, million €	€ ha^{-1}
1995	2298	2030	4214	43.8	14.4
1996	1354	1286	4311	39.1	12.8
1997	633	633	4037	37.1	12.2
1998	500	500	3758	37.1	12.3
1999	148	148	2822	23.2	7.7
2000	86	96	839	11.6	3.9
2001	5	5	1320	11.6	3.9
2002	0	0	1830	13.0	4.4
2003	10	10	2312	13.0	4.4
2004	0	0	2200	13.0	4.4

Note: as Lithuania reintroduced its national currency only in 1993, the data of the period 1991-1994 are omitted. The litas (Lt) is the legal tender in Lithuania and is pegged to the euro (€) at 3.4528:1

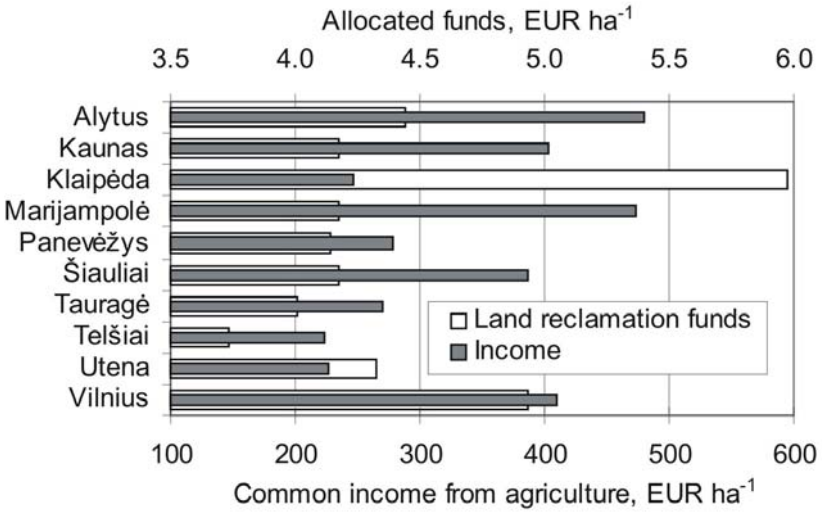

Fig. 2. The income earned from gross agricultural production in the counties of Lithuania and the state allocations for land improvement in 2004 (Data from the Statistics Department of Lithuania and State Land Survey Institute: Lietuvos žemės …, 2005; Valstybinis …, 2004).

the profit gained from agriculture and the funding for land drainage in separate counties. The state subsidies for land drainage make 6.0 € ha^{-1} in Klaipėda county with the least total revenue from agriculture (247 € ha^{-1}), whereas only 4.4 € ha^{-1} are allocated to Alytus county where the income (479 € ha^{-1}) is twice higher than that in Klaipėda county. The same situation is in Marijampolė county (4.2 € ha^{-1} and 473 € ha^{-1} respectively).

The process of transition has influenced the farming in Lithuania. It is obvious that a relatively low income is gained from agriculture: yield of corn was on average only 3.25 t ha^{-1} in 2004. Calculations made by the Lithuanian Institute of Agrarian Economics suggest that corn yield of at least 4 t ha^{-1} is needed to make farming profitable (Lietuvos žemės…, 2005). Such yield has been obtained only in some municipalities located in the region of Middle Lithuania. So, for the present, the efficiency of drainage rehabilitation is very low in Lithuania. For the period of 1999-2001, it varied from 0.23 to 0.37 in the region of Middle Lithuania and from only 0.15 to 0.24 or 36% less in the rest part of the territory (Bastienė, 2002). These rates have been calculated considering the profit gained after the rehabilitation of drainage systems.

Under the guidance of market economy, the efficiency of rehabilitation of deteriorated drainage systems should be determined before allocating the funds (Morkūnas and Šaulys, 2002). In order to obtain maximum profitability, land reclamation activity should be oriented towards regional priorities.

Modeling of the financing of state-owned land reclamation structures

In 1997-1999, a group of advisers from the European Union (the Netherlands and Germany) implemented an EU-PHARE Program and an executive Lithuanian Land Reclamation Project. The optimal costs for operation and maintenance of drainage systems were estimated at 15 € ha^{-1} for ditch maintenance and 13.6 € ha^{-1} for subsurface drainage on average (Offringa et al., 1999). According to these calculations, 85.3 million € are required annually for the maintenance of drainage structures in 2.98 million ha of drained land. However, allocation from the state funds has amounted to 13 million € during the past four years (2002-2005), i.e., 4.4 € ha^{-1} or 15.2% of the sum required according to the EU-PHARE Project.

The EU Directive on the establishment of a framework for Community action in the field of water policy (2000/60/EC) requires that a new model of agricultural drainage management and financing be developed. Statistical estimation shows that until the year 2005, state subsidies for land reclamation mainly have been allocated considering the residual value and depreciation of drainage structures in the territories of municipalities (r = 0.92-0.98) (Lietuvos Respublikos ..., 2003). Taking into consideration the high value of state investments required for ensuring steady operation of land drainage, it is important to reject the funds allocated on equality principles and give preference to the regions where the maintenance, repair and renovation of these structures are more efficient.

Due to the non-homogeneous texture and fertility of topsoil layer, the regional income from agricultural subjects as well as draining efficiency is different (Fig. 3). It is estimated that income from crop production in rich soils exceeds that in poor soils 3.5 times. Gross crop production has reached 510 € ha^{-1} in localities where soil rating exceeds 40 points and has decreased to 283 € ha^{-1} where soil rating is lower than

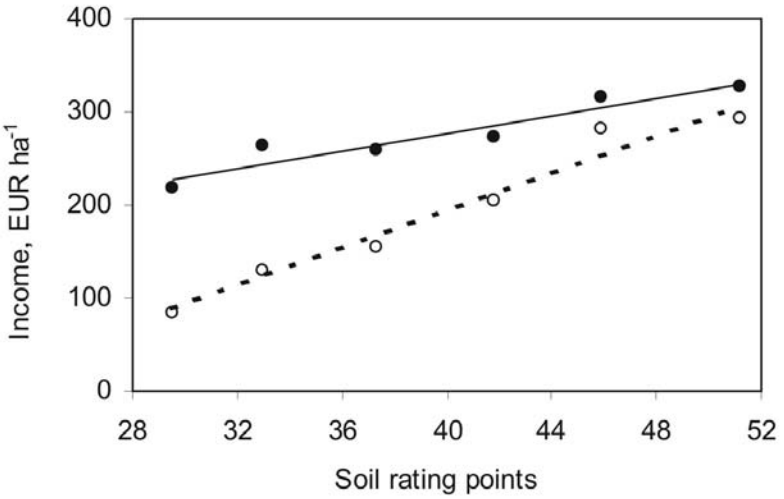

Fig. 3. Dependence of a farmer's income from gross agricultural production (solid line) and crop production (dashed line) on land productivity (Data from the Lithuanian Institute of Agrarian Economics: Lietuvos žemės ..., 2005).

35 points (marketable plant growing is payable only in regions where soil rating exceeds the mean value of 39 points) (Lietuvos žemės …, 2005).

Land reclamation practices aim at increasing the soil productivity, however, drainage does not increase the land quality equally. Drained soils with hypergleyic loamy or clayey texture (*Hyperglei-Calcaric Gleysols*) have got the highest evaluation – 24 points. The *Calcari-Hypogleyic Luvisols* and *Calcari-Gleyic Cambisols* with sandy loam texture have been evaluated at 10-15 points after draining. Sandy soils with gleyzation features after draining have improved only by 3 points (Juodis et al., 2001). The greatest increase in soil productivity has been observed in middle Lithuania, where agricultural development is most intensive. A properly functioning drainage therefore is particularly important for this region. Whereas land productivity in Lithuania much depends on the water regime control (drainage), the financing for land drainage should be adjusted in respect of how much those means have increased the land productivity.

Maintenance of drainage systems becomes problematic and even useless if the land has no owner or lies fallow. Analyzing the rural development tendencies of the last years, it has been observed that the area of abandoned land is constantly increasing (Brusokaitė-Stravinskienė, 2002) and in different municipalities varies from 0.2 to 17.9% (Lietuvos statistikos …, 2003). Considering the fact that it is not economically feasible to allocate funds for land drainage in abandoned land, this parameter should be regarded as one of the evaluation criteria when allocating the budget subsidies.

On the basis of these considerations, four possible scenarios of reallocation of state subsidies for land drainage are distinguished:

scenario I – subsidies allocated considering the residual value and depreciation of state-owned land drainage structures in the territories of municipalities (base subsidies – $F_{(I)_i}$);
scenario II – base subsidies adjusted according to the increased land productivity due to water regime control ($F_{(II)_i}$);
scenario III – base subsidies adjusted according to the area of abandoned land in municipalities ($F_{(III)_i}$);
scenario IV – base subsidies adjusted according to both criteria (increased land productivity and the area of abandoned land in municipalities – $F_{(IV)_i}$).

According to scenario I, base subsidies for different municipalities are calculated and allocated by the following equation:

$$F_{(I)_i} = k_{V_i} \cdot S_{rec}, \quad (1)$$

where $F_{(I)_i}$ – base subsidies for land reclamation for the i^{th} municipality;
S_{rec} – share of special subsidies for the maintenance, repair and reconstruction of land drainage;
k_{V_i} – coefficient assessing the residual value and depreciation of land drainage structures in the i^{th} municipality. This coefficient is calculated by the following equation:

$$k_{V_i} = \frac{V_{r_i} \frac{D_i}{100 - D_i}}{\sum_{i=1}^{n} V_{r_i} \frac{D_i}{100 - D_i}}, \quad (2)$$

where V_{r_i} – residual value of state-owned drainage structures located in the i^{th} municipality;

D_i – depreciation of drainage structures in the i^{th} municipality in percent.

According to scenario II, adjusted subsidies for the municipalities are calculated by the following equation:

$$F_{(II)_i} = \frac{k_{B_i} F_{(I)_i}}{\sum_{i=1}^{n} k_{B_i} F_{(I)_i}} \cdot S_{rec}, \quad (3)$$

where k_{Bi} – coefficient assessing the increased land productivity due to water regime control in the i^{th} municipality. This coefficient is calculated by the following equation:

$$k_{Bi} = \frac{B_{rec_i}}{\sum_{i=1}^{n} B_{rec_i}} \sum_{i=1}^{n} F_{(I)_i}, \quad (4)$$

where B_{rec_i} – increased land productivity (in soil rating points) due to water regime control in the i^{th} municipality.

According to scenario III, adjusted subsidies for the i^{th} municipality are calculated by the following equation:

$$F_{(III)_i} = \frac{k_{A_i} F_{(I)_i}}{\sum_{i=1}^{n} k_{A_i} F_{(I)_i}} \cdot S_{rec}, \quad (5)$$

where k_{A_i} – coefficient assessing abandoned land areas in the i^{th} municipality. This coefficient is calculated by the following equation:

$$k_{A_i} = \left(\overline{A}_{der_i} - \frac{\frac{A_{der_i}}{A_{ag_i}}}{\overline{A}_{der_i}} \right)^{2.5}, \quad (6)$$

where A_{der_i} – area of abandoned land in the i^{th} municipality, ha;

A_{ag_i} – area of agricultural land in the i^{th} municipality, ha;

$\overline{A}_{der_i}$ – mean value of abandoned land in the country in percent (about 5.2% in the year 2003).

When allocating the funds according to scenario IV, a certain part of base subsidies is adjusted considering the increased land productivity due to water regime control. The other part of subsidies is regulated basing on abandoned land areas in municipalities. In that case, adjusted subsidies for the i^{th} municipality will be the sum of the above-mentioned values of the equations (3) and (5):

$$F_{(IV)_i} = F_{(II)_i} + F_{(III)_i}. \quad (7)$$

On the basis of the given algorithm, a special "MS Excel 2000" program was created to calculate all possible variants of the adjustment of state subsidies (calculations can be done in any currency). When calculating according to scenario II, regions where drainage increases land productivity by 12 points, get 15-50% lower state subsidies, whereas regions where land productivity increases

Table 2

Reallocation of state subsidies for maintenance of land drainage considering regional priorities (based on the data of 2003)

Regions[1)]	Scenario II[2)]			Scenario III			Scenario IV		
	Indexes of base subsidies								
	Max	Min	AV±SD[3)]	Max	Min	AV±SD	Max	Min	AV±SD
1	1.49	1.25	1.36±0.08	1.36	1.17	1.25±0.05	1.40	1.08	1.24±0.10
2	1.15	0.87	0.99±0.09	1.16	0.71	1.00±0.13	1.06	0.95	1.00±0.04
3	0.86	0.50	0.76±0.09	0.67	0.12	0.44±0.16	0.93	0.38	0.71±0.17

Notes: [1)] 1 – the region of fertile soils (Middle Lithuania) where efficiency of land drainage exceeds the average value in the country; 2 – the region where land productivity and the area of abandoned land in municipalities corresponds to the average value in the country or slightly differs from it; 3 – the region of poor soils where the area of abandoned land exceeds the average value in the country.

[2)] Financing according to scenario I equals 1.

[3)] AV – average value in the region, SD – standard deviation.

by 18-21 points, get 125-149% higher subsidies (Table 2). When calculating according to scenario III, state subsidies are reduced as the abandoned land area in the municipality exceeds the mean value in the country. When abandoned land area is less than the mean value, the funding is increased. It should be noted that there can be many transitional variants between scenarios II and III.

To achieve more benefits from the drainage systems, maintenance of land drainage must be financed considering both factors without giving priority to any of them (scenario IV). In that case, several financing variants may be applied, depending on the reallocated part of subsidies due to increased land productivity (B_{rec_i}) and abandoned land area (A_{der_i}). Basing on the indexes given in Table 2, subsidies for any selected scenario can be calculated. Applying the suggested methodology, the base subsidies would increase up to 140% in the region of Middle Lithuania where land drainage operation plays a significant role in the development of agriculture and the efficiency of funding is high. In the territory where poor soils are prevailing, land productivity is low and land drainage is less significant, the base subsidies would be reduced by about 29±17%. For municipalities where drainage increases the land productivity approximately by 14.5 points, the adjustment of base subsidies is changing only by ±4% on average.

Conclusions

1. The greatest part (63%) of subsurface drainage in Lithuania exceeds the useful lifetime of 30 years. Approximately 20-25 thousand hectares of drained land yearly become unsuitable for agricultural development due to imperfect drainage.
2. Deteriorations in land drainage quality are mostly due to economic reasons in Lithuania. The amount of 4.4 € ha^{-1} allocated for land reclamation needs in the past four years (2002-2005) is only 15.2% of the sum required according to the EU-PHARE Project.
3. The expedience of investments in land reclamation is determined by climate conditions and soil fertility of the regions. The most productive areas are situated in the region of Middle Lithuania. The efficiency of renovation of the implemented drainage systems is 36% higher in this region than in the rest part of the territory.
4. The methodology for reallocating subsidies for land drainage should be in line with the economic prospects. In conformity with the land productivity and abandoned land areas in the territories of municipalities, the base subsidies would increase to 140% or would be reduced to 38%.

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Anotācija

Rakstā analizēta pašreizējā situācija zemes meliorācijas sektorā Lietuvā, kā arī lauksaimniecības zemju nosusināšanas sistēmu apsaimniekošana tirgus ekonomikas apstākļos. Zemes nosusināšanas praksei Lietuvas lauksaimniecībā ir nozīmīga loma. Līdz 2004. gadam apmēram 2.98 miljoni hektāru (85.5%) lauksaimniecības zemju bija nosusinātas. Lai gan privātīpašuma tiesības uz zemi Lietuvā tika atjaunotas 1990. gadā, zemes nosusināšanas struktūru privatizācija netika uzsākta vienlaicīgi ar zemes reformu. Tā kā nosusināšanas sistēmas ir iekļautas valsts īpašumā, to uzturēšanu finansē valsts. Sakarā ar šo sistēmu pastāvīgo nolietošanos piešķirtais finansējums (vidēji tikai 4.4 € ha^{-1} gadā) nebūt nav pietiekams, tādēļ subsīdiju piešķiršanai izstrādāti četri projekti. Pielietojot ieteikto metodoloģiju, prioritāte tiktu dota rajoniem ar augstāko ienākumu no lauksaimniecības. Tādēļ Lietuvas vidienē, kur ūdens režīma kontrole ir ienesīga, pašreizējās subsīdijas zemes nosusināšanai paaugstinātos par indeksu 1.24±0.10. Savukārt teritorijā, kur zemes produktivitāte ir zema un pamesto zemju procentuāli ir vairāk nekā vidēji valstī, finansējums samazinātos par indeksu 0.71±0.17.