

PN-ACB-469

# **The Lithuanian Karst Zone Management Plan**

## **A Case Study in the Management of Agro-environmental Issues in Lithuania**

Vilija Budvytiene, Walter E. Foster,  
Antanas Sigitas Sileika, and Almonas Gutkauskas

*Baltic Basin Agriculture and Environment Series Report 96-BB 1*  
April 1996

**Center for Agricultural and Rural Development  
Iowa State University  
Ames, IA 50011-1070**

*Vilija Budvytiene is a senior research associate, Lithuanian Rural Sociology Association, Vilnius; Walter E. Foster is a senior scientist, CARD; Antanas Sigitas Sileika is the director of the Lithuanian Water Management Institute, Kedainiai, Lithuania; and Almonas Gutkauskas is the chief environmental protection specialist of the Lithuanian Ministry of Agriculture and Chairman of the Karst Fund Tatula Council, Vilnius.*

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CX822175-01-0 to the Center for Agricultural and Rural Development, Iowa State University. It has been subjected to the Agency's peer and administrative review and has been approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

- 1 -

## **THE LITHUANIAN KARST ZONE MANAGEMENT PLAN**

### **A Case Study in the Management of Agro-environmental Issues in Lithuania**

In 1991, contrary to the concept of a large, all-encompassing program for rural environmental protection that was proposed by several Lithuanian ministries, a proposal that the Ministry of Agriculture concentrate its resources on a small, but environmentally sensitive territory won the favor and approval of the parliament (Appendix A). The karst zone of Northern Lithuania was chosen as the pilot for preparation of a rural environmental protection program.

Once the pilot area was selected, it was necessary to delineate the boundaries within which management restrictions would be introduced and also to decide how to deal with the economic effects of such restrictions. A committee composed of technical staff from various government agencies studied the idea for two years before drafting and presenting a resolution to the parliament for discussion. When the resolution was debated in the Seimas, it was decided that consideration of the economic effects of the program would be delayed until the details of the program's implementation were developed.

After the Karst region boundaries and restrictions to be applied to it had been confirmed by the government, an interdisciplinary work group, comprised of scientists from different institutions, was formed. In 1992, this group designed and presented to the government the document "Targeted Program on Groundwater Protection and Sustainable Agriculture Development in the Intensive Karst Zone" (Appendix B). It described a complex environmental protection program and detailed the implementation of measures for stopping both point and nonpoint source pollution, not only in the intensive Karst zone, but also in a surrounding protection zone. This approach supported the implementation of sustainable and organic agriculture in the region to groundwater reduce contamination.

While these complex environmental protection measures were designed to be initially implemented in a small territory—the karst region—it is anticipated that similar measures will be extended to all of Lithuania as economic recovery and transition progresses.

In 1993, the targeted program was finally confirmed by the Seimas and received financing. One million litas were initially budgeted to implement the program. Start-up activities included issuing interest-free credits of 400,000 litas each to four farmers for the transition to organic farming. In addition, two farmers providing agro-services for organic farming, were each granted a 320,000 litas of interest-free credit. During the first year, these farmers were the only ones ready to develop organic farming and thus be eligible for financial assistance. The design and construction of four waste-water treatment plants also began. Other measures integral to the program were implemented; several reports were published, seminars and workshops were organized, an organic farming control and certification system was started, and an environmental monitoring program was implemented.

In 1994, work on the program was on a larger scale; the amount of money budgeted for implementation of Karst region environmental protection measures was four million litas.

This report describes the context, development, and implementation of the Karst Region Management Program. The first part of the report describes the physical setting of Lithuania, the condition of the agricultural sector, and its impact on the environment. The report then focuses on the special conditions of the karst region, details the evolution and mechanics of the Karst Area Management Program, and describes issues associated with its implementation.

### **Context of the Program in Lithuania**

#### **Geography, Climate, and Soils**

Lithuania is 65,300 square km. Its coordinates are 54°54' of Northern latitude and 26°19' of Eastern longitude. The total border length is 1842 km, including the Baltic coastline at 99 km. The seacoast is low and shallow; the Kursiu Lagoon is at the southern end, separated from the Baltic Sea by a narrow strip of dunes. The River Nemunas flows into the Kursiu Lagoon. The catchment area of the Kursiu Lagoon is 100,458 square km; 98 percent of which is the Nemunas River Basin. The Nemunas River drains 73 percent of Lithuania as well as a portion of Belarus, Poland and the Kaliningrad District of Russia. The maximum east-west length of Lithuania is 373 km, and the north-

south length is 276 km. Lithuania is divided into 44 administrative districts. The population of Lithuania was 37.6 million in 1992; 31 percent lived in rural areas.

Lithuania is divided into three soil regions. The middle lowland in central Lithuania has the most productive soils, followed by the low, deeply washed carbonate soils in western Lithuania. The wooded moraine hills and interspersed sandy plains in eastern Lithuania are of relatively low agricultural productivity. The most characteristic soils are soddy podzolic loams and gleys.

Farmland occupies more than 50 percent of the land area, forests cover 28 percent, urban areas 17 percent, and meadows 5 percent. Forty-one percent of agricultural activities occur on the flat plains, 32 percent on the rolling plains, and 20 percent on hilly relief. Four percent of the total area is under some level of nature protection.

Lithuania's climate is transitional between maritime and continental. The average annual temperature is +6° C (43° F). In the last 50 years, the highest temperature registered was +39° C in 1994, the lowest was -42.9° C in 1956. The average temperature in January is -5° C; in July it is 16.5° C. Plant growth periods range from 169 to 202 days (the shortest period is in eastern Lithuania, the longest along the sea coast). Precipitation amounts vary from 320 to 470 mm during the growing season and evaporation is 390 to 420 mm. The mean precipitation is 630 mm per year. During winter the soil is, on average, frozen to a depth of 40 to 70 cm. The internal climatic differences are influenced by continental factors and proximity to the sea.

### **History of the State and Agriculture**

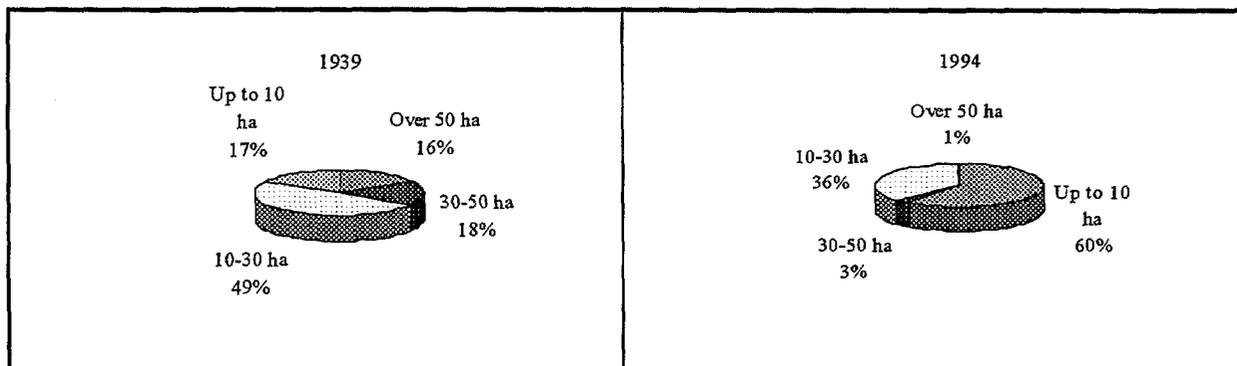
The state of Lithuania was established at the start of the 13th century. From then until the mid-15th century, the Grand Duchy of Lithuania was a powerful state in Eastern Europe, defending the Eastern lands from the Teutonic Order and halting the western advance of the Tatars. In 1569, the Lublin Union Act was signed between the Grand Duchy of Lithuania and Poland, effectively merging the two states into the largest country in Europe at the time. After some time, however, the Lithuanian-Polish state grew weaker as a result of internal discord and was eventually subdued and divided by the agreement of Russia, Prussia and Austria. After the third partition in 1795, the State ceased to exist when the whole area of Lithuania was allotted to Russia. Lithuania regained independence after the First World War in 1918. The United States recognized Lithuania *de jure* in 1922. With the onset of

the Second World War, Lithuania was once again subjugated, first by the Soviets, then by the Germans and, finally, by the Soviets again—a state of affairs that continued until 1991.

Agriculture has been the primary economic activity in Lithuania for most of its history. The agrarian reform that began in 1922 promoted the establishment of individual farmsteads and created favorable conditions for agriculture development. During this time, landless peasants and volunteers were given up to 80 ha of land. This limit was later raised to 150 ha. As a result of this activity, the populations of nearly 7,000 villages were dispersed into almost 160,000 private farms with an average area of 10.4 ha.

By the late 1930s, agriculture was the main branch of the Lithuanian economy, satisfying both domestic needs and contributing up to 80 percent of the state's export income. Almost 26 percent of the meat production, 40 percent of the milk products, and 80 percent of the flax production were exported. Lithuania was the sixth-largest butter exporter in the world.

Lithuanian agriculture was badly damaged during the German and Soviet occupations in the Second World War. After Lithuania was occupied by the Soviet Union in 1940, land ownership was restricted to 30 ha and nationalization of land began. Economic and, later, physical liquidation of land owners was instituted and in June 1941, the mass deportation of private farmers to Siberia began. Only German occupation interfered with these activities, the result of which was the destruction of the core group of individual farmers that had sustained Lithuanian agriculture over the years.



Percent of total farmland

Figure 1. Distribution of farms by size in 1939 and 1994

Source: Sileika 1995

After the Second World War ended, Soviet occupation was restored. In 1948 the pace of the collectivization process increased and all farmland was organized into collective and state farms. The results of such activities are shown in the comparison of livestock numbers in 1939 and 1949; the decrease in horses was 29 percent; pigs, 52 percent; and cows, 45 percent.

In the late 1950s, agriculture began to receive more attention. Farmers' debts were written off, land reclamation work began, more mineral fertilizers were provided, and the energy supply was improved. Even with those measures, agricultural production grew slowly. Pre-war levels were reached only by the mid-1960s. As of 1992, the gross output of collective and state farms was only 67 percent of total production, although these operations held 98 percent of the total agricultural land. Nevertheless, the production on Lithuanian state farms was much higher than that achieved in other Soviet Union republics.

In spite of damage to production by compulsory reforms, the Lithuanian per capita agricultural production was rather high (Figure 2).

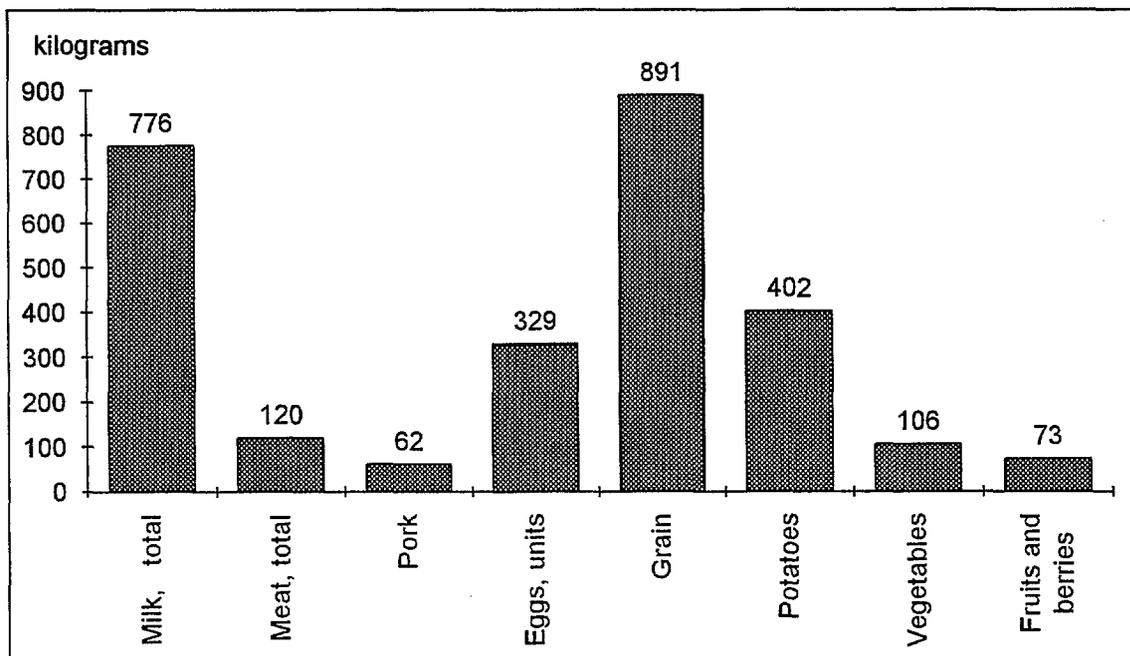


Figure 2. Output of primary agricultural products per capita in 1991

Source: Sileika 1995

The most important agricultural products were meat and milk. The total number of cattle and poultry in 1992 in all farm categories is shown in Table 1.

**Table 1. Number of cattle and poultry in 1992**

<b>Animal</b>	<b>Number (1000s)</b>
Total Cattle	2197
Cows	832
Pigs	2180
Poultry	16994
Horses	83
Sheep and goats	64

Until 1988, farm operations were increased through artificially implemented specialization. For example, large cattle breeding complexes were built during the 1980s without regard for the availability of fodder resources or sufficient area for manure spreading. In 1989, peasant farms began to reappear. But, only after the restitution of property rights that followed independence in 1991 has the number of these farms increased.

The structural development of Lithuanian agriculture from 1988 to 1993 is shown in Table 2.

**Table 2. Lithuanian farm types, 1988–93**

<b>Farm type</b>	<b>1988</b>	<b>1991</b>	<b>1993</b>
<b>Agricultural companies</b>			
Number	1,138	1,219	3,760
Total area, 1,000 ha	3,288	2,487	1,705
Average area, ha	2,890	2,040	453
<b>Family farms</b>			
Number	0	5,904	10,000
Total area, 1,000 ha	0	72	90
Average area, ha	0	12	9
<b>Part-time family farms</b>			
Number	0	0	61,488
Total area, 1,000 ha	0	0	497
Average area, ha	0	0	8
<b>Homeland</b>			
Number	661,000	651,000	413,138
Total area, 1,000 ha	271	863	852
Average area, ha	0.4	1.3	2.1

Source: Carlson 1993.

### **Land Reform Legislation and Land Ownership**

Land reform began in 1989 when the first plots of agricultural land were allotted for peasant farms. Only after independence had been proclaimed on March 11, 1990, was the legal basis provided for a comprehensive system of land reform.

The following five basic laws form the legal framework of the land reform:

- Law on Land Reform, 07.1991
- Law on Privatization of the Assets of Agricultural Enterprises, 07.1991
- Law on Procedure and Conditions of Restitution of Citizens' Ownership Rights on Survived Real Estate, 06.1992

- Law on Agricultural Partnership, 04.1992
- Law on Land, 04.1994

These laws provide conditions for restoring ownership of land for private farming, renting land for agricultural companies, and selling or renting land on which the owner intends to build a home.

Ownership rights may be restored by returning a plot of land to the former owner in the same location, by allotting an equivalent plot of land in another location, or by paying compensation to the former owner in a single payment. The ownership rights of former land owners and their heirs can be restored only by application of a citizen of the Lithuanian Republic. At the owner's request, the completion of ownership restoration can be delayed for up to five years. The workers on collective or state farms who want to leave their enterprises and establish private farms are allotted machinery and animals in proportion to the acreage restored to them. Preference is given to prospective owners who are prepared for farming and have buildings, machinery, and equipment; the family has to have enough farm resources and skill. Much of the land is returned to urban owners because of their knowledge of legislation and ability to lobby government officials responsible for the reprivatization.

The land near rural settlements is not returned to land owners. Land owners can obtain land in another location or accept compensation. Agricultural workers and other people who live and work in the agricultural sector can buy or rent up to two or three hectares of homeland near their settlement without regard to the land owner's wish to restore his ownership.

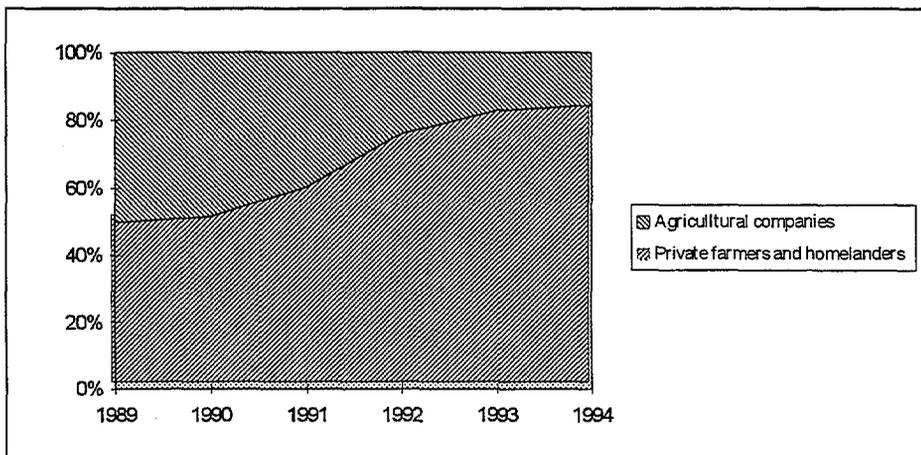
The land near the large complexes and agricultural companies has to be rented to these enterprises for 10 years. The area to be rented depends on number of animals in the enterprise (no less than 0.5 ha per cow).

Implementation of agrarian reform when there are two, or sometimes three, applicants for the same plot of land has caused many problems. Many people are unsatisfied with the current law. To fulfill the requests of all applicants, there is a need for almost twice as much land as there is in Lithuania. The agrarian reform services often cannot find a proper solution; therefore, land reform is slow and the rural people are angry. More than 415,000 people applied for the restitution of land ownership by 1993, but ownership documents were received by only one-third of them. There are 72,700 people who wish to receive compensation and others who want to get their land back later. About 23,200 former owners would like to lease the land.

Another problem is caused by the land reform amendment law that restores land ownership to grandchildren of deceased owners. In accordance with this amendment, small land plots of former owners are divided once more. Therefore, the average area of the private farm now is only nine hectares, which is less than it was before the Second World War.

### **The Agricultural Sector Economy and Market Situation**

After independence was proclaimed and the land reform accompanying the transfer to a market economy had begun, the economy in Lithuania changed drastically. Agricultural production dropped to the 1985 level. The main reasons were the sudden increase in prices for energy, raw materials and machinery, and interruption of market ties with Russia without the possibility of selling agricultural products to western countries. The sudden structural changes in the agricultural sector also contributed to decreased agricultural production (Figure 3).

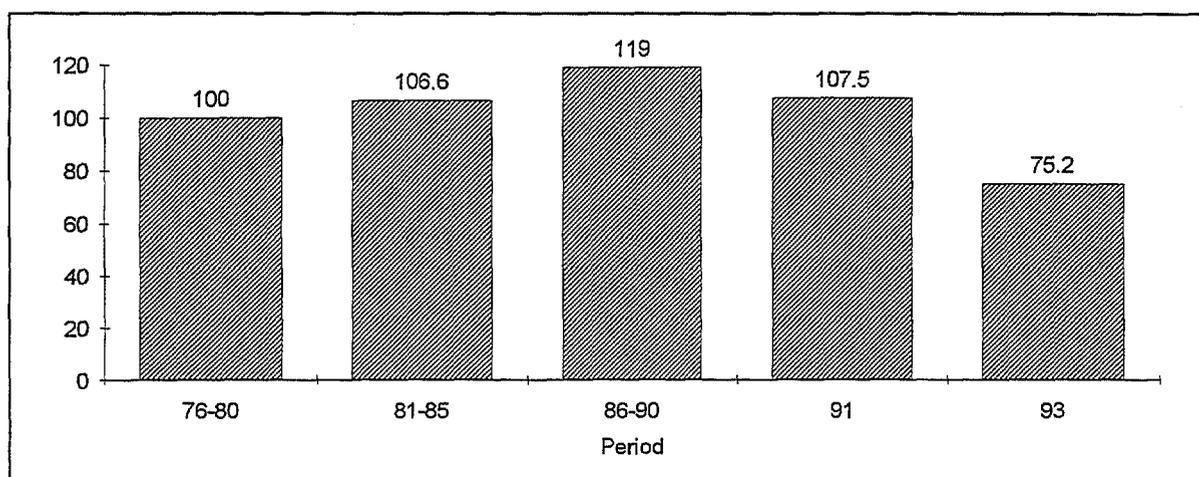


**Figure 3. Percentage change in the proportion of agricultural production**

Source: Sileika 1995.

When large collective and state farms with powerful machines were divided into small farms, problems arose. Existing machinery was meant to be used on large areas and was not suitable for small farms. The farmers could not afford to buy new machines, so they began to work with horses.

The problems were aggravated by fuel prices that have jumped more than 1,000 times since 1988. Food product prices increased only 400 times during the same period. For this reason, about 500,000 hectares of agricultural land was left unplowed or unharvested in 1994. The gross agricultural output of all farm categories is shown (Figure 4).



**Figure 4. Gross agricultural output in percent of base period (1976-80) for all farm categories**

Source: Sileika 1995.

Throughout the Soviet period, Lithuania delivered 40 to 45 percent of its meat and milk products to, and received 1.1 to 1.3 million tons of feed grain and protein additives for animal fodder from, the former Soviet Union. Now Lithuania cannot deliver agricultural products to Russia because Russia introduced double taxes for imports from the Baltic states and, in any case, cannot pay for products supplied; Russia is more than 2 billion rubles in debt to Lithuania.

Because of obsolete food processing and packing technologies, Lithuania cannot sell agricultural products, in spite of their rather good quality, to western countries. The domestic market is over-supplied; food processing plants cannot sell food products, and pay farmers and agricultural companies for products supplied, for more than half a year. Food processing plants are currently more than 100 million litas in debt to suppliers and are almost unable to buy any more agricultural produce.

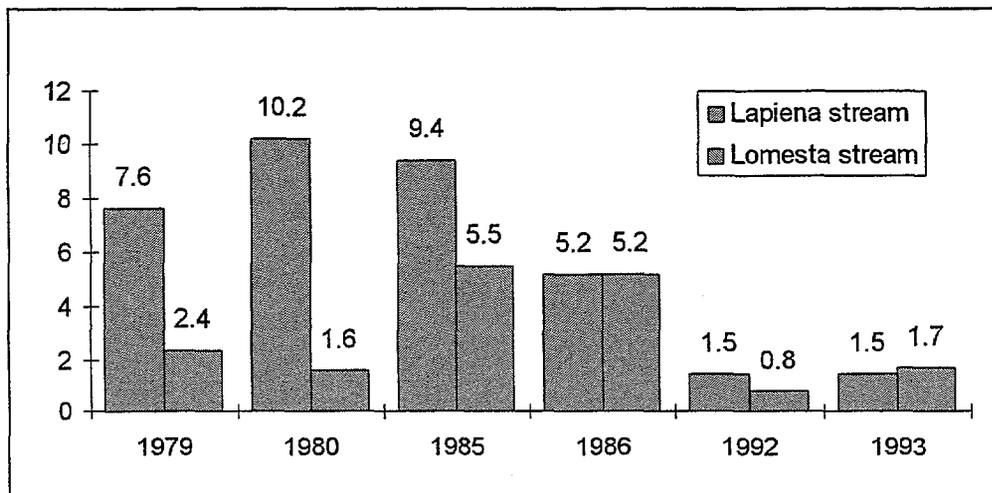
To protect the domestic market, the Lithuanian government introduced customs taxes. According to government regulation, there are no export restrictions for the main agricultural products. Import taxes are now levied for all main agricultural products: sugar, meats, milk, milk products, oil, and eggs.

Much harm resulted from the 1994 summer drought in Lithuania. According to Lithuanian Ministry of Agriculture estimates, the cost of the drought was about 50 million litas.

Due to these problems, it is estimated that agricultural production will further decrease and, without foreign investments, the crisis will last for a long time.

**Environmental Impact of Agriculture in Lithuania**

Extensive animal production, with large concentrations of animals in large barns and complexes, and high rates of mineral fertilization spread by aircraft in winter on frozen, snow-covered ground, had a substantial impact on the environment in the former Soviet time. Leakage and surface runoff of nitrogen and phosphorus, as well as air emissions of nitrogen compounds, contribute to contamination of the Baltic Sea. Water quality in rivers, lakes and drinking water wells has been affected. The concentration of nitrogen in two typical Lithuanian streams is shown in Figure 5 (Carlson 1993).

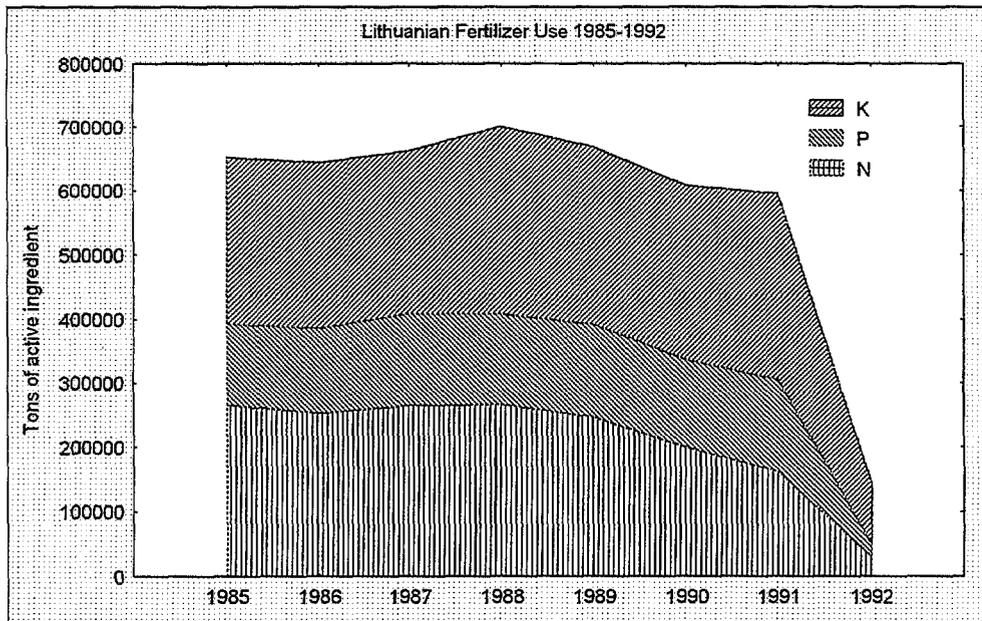


**Figure 5. Concentration of nitrogen in two typical Lithuanian streams**

Source: Sileika 1995.

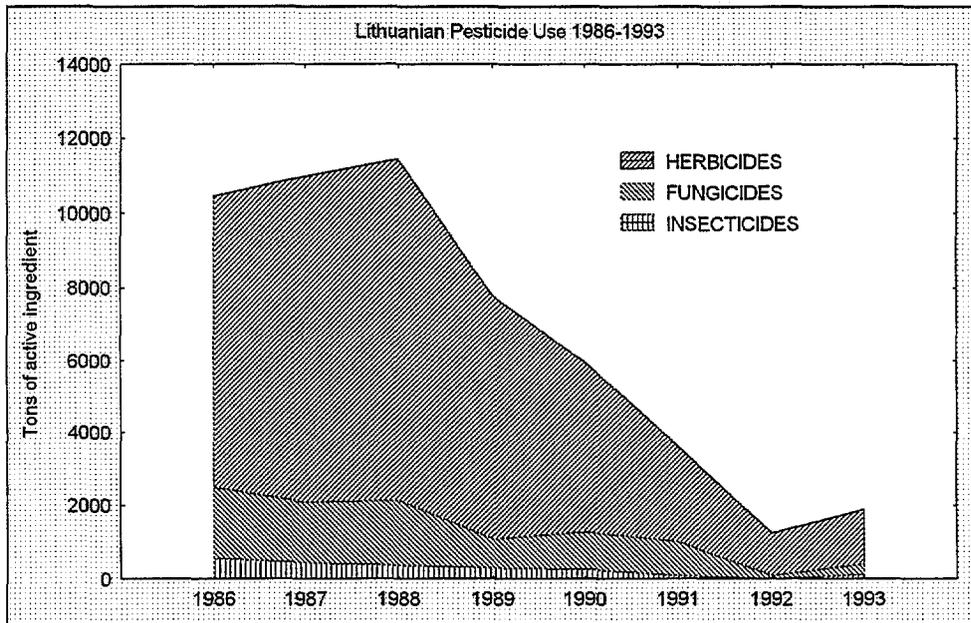
The Lapiena stream watershed is in the intensive agricultural zone in the middle plain of Lithuania, and the Lomesta stream is in the hilly eastern part of the country. The greatest nitrogen concentration occurred between 1980 and 1986 in the Lithuanian middle plain and in 1985 and 1986 in eastern Lithuania. A reduction in nitrogen concentration has been observed since 1992, primarily as a result of decreased mineral fertilizer use since independence (Figure 6).

It should also be noted that pesticide use has decreased concurrently (Figure 7).



**Figure 6. Fertilizer use in Lithuanian agriculture 1985–92**

Source: Adapted from Budvytiene et al. 1995).



**Figure 7. Pesticide use in Lithuanian agriculture, 1986–93**

Source: Adapted from Budvytiene et al. 1995.

Investigation of drinking water quality in dug wells has shown that, during 1988, in many districts of Lithuania, the quality of the water was below health standards. More than 50 percent of the wells sampled had nitrate concentrations above the health limit of 45 mg  $NO_3/l$ . In the districts of Panevesys and Kaunas, nitrate concentrations up to 300 mg  $NO_3/l$  were detected. Mean nutrient concentration is shown in Table 3. As might be expected, the highest concentrations were found in wells dug near barns, gardens, and greenhouses.

**Table 3. Drinking water quality in the watershed of the River Graisupis, 26.08.1994**

Site Number	Water extraction site	<i>N</i> – <i>NO</i> <sub>3</sub> <i>N</i> – <i>NH</i> <sub>4</sub> <i>P</i> – <i>PO</i> <sub>4</sub> <sup>3</sup>		
		mg/l		
1	The River Graisupis at the road Kėdainiai-- Kračkės	0	0.045	0.224
2	The River Graisupis at the weir 1	0	0.08	0.194
3	Deep bored ground water well	1.45	1.025	0.022
4	Dug well at farmer M.Vaitkaitienė	66.85	0.05	0.019
5	Dug well at farmer S.Babenskaskas	13.95	0.05	0.029
6	Dug well at farmer J.Valatka	5.9	0.11	0.021
7	Dug well at farmer V.Liutkevieius (new household)	10.5	0.08	0.32
8	Dug well at farmer P.Sulcas	10.5	0.175	0.024

The health limits for drinking-water wells and open water bodies in Lithuania are:

*N* – *NO*<sub>3</sub> , 10.17 mg/l; *N* – *NH*<sub>4</sub> , 1.55 mg/l; *P* – *PO*<sub>4</sub><sup>3</sup> , 1.14 mg/l.

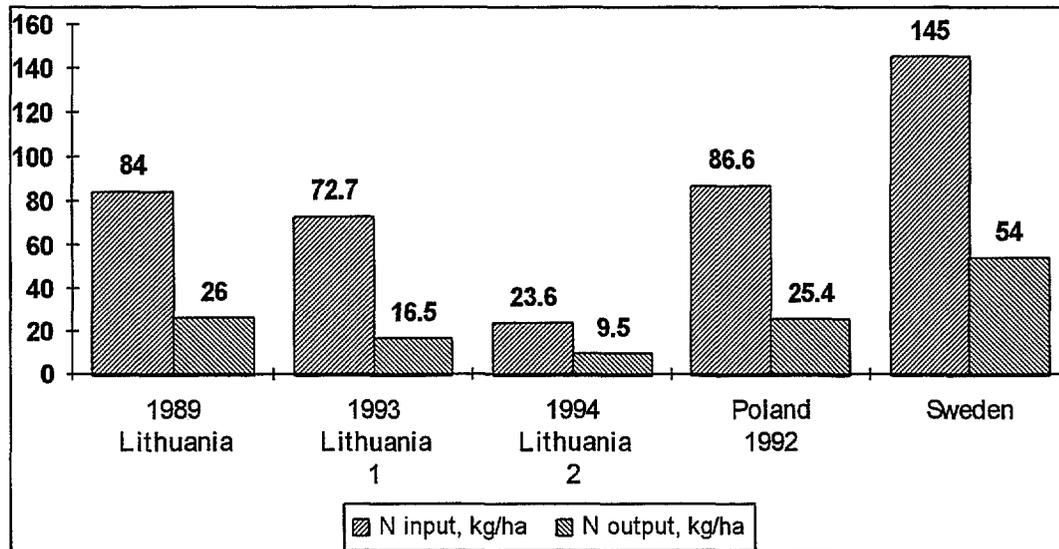
The permissible limit for fish in open water bodies is:

*N* – *NO*<sub>3</sub> , 9 mg/l; *N* – *NH*<sub>4</sub> , 0.39 mg/l; *P* – *PO*<sub>4</sub><sup>3</sup> , 0.2 mg/l; *BOD*<sub>5</sub> , 2-4 mg/l.

The decrease in nutrient losses since 1989 can also be observed in farm nutrient balance calculations. Nutrient balance calculations for typical Lithuanian, Polish, and Swedish farms are shown in Figure 8.

Data for the Lithuanian farm in 1989 were taken in loamy soil in the intensive agriculture zone of middle Lithuania. It was a part of the Lithuanian Institute of Agriculture experimental farm and had 314 cows.

The nutrient balance for Lithuania 1 in 1993 was taken from a private farm in the same district. The farmer had 7 dairy cows, 2 heifers and 4 calves. Farm acreage was 16.8 hectares, including 6 hectares of hay. Data for Lithuanian farm 2 in 1994 were taken from a farm in eastern Lithuania. The farmer had a 64-hectare farm, including 26 hectares of hay, 3.5 hectares of forest and a 2-hectare homeland. Animal production consisted of 4 dairy cows, 2 calves, 2 beef cattle, 2 sows, and 10 hogs.



**Figure 8. Nutrient balance on typical Lithuanian, Polish, and Swedish farms**

Source: Sileika 1995.

The data for the Polish farm in voivodship Ostroleka were taken from Sapek (1994). The farm area was 24 hectares, including 14.5 hectares pasture. The pasture was mostly in peat soil and the arable land was sandy. The nutrient balance in Sweden was calculated using the NPK model (Fagerberg et al. 1993). The farm area was 82 hectares, including 30 hectares of hay with clover. The farmer had 40 dairy cows, 20 heifers, and 20 calves.

The examples of nutrient input and output on Lithuanian, Polish, and Swedish animal farms show that nutrient input in Lithuania is much less than in Sweden. The utilization rate (the ratio between nutrient *out of* and nutrient *into* the farm) in Lithuania is 22.7 percent, in Poland 29.3 percent, and in Sweden 37 percent. Utilization rates on Lithuanian intensive farms are much less than on Swedish farms. This indicates that Lithuanian farms are less productive as well as more poorly balanced. The sample results show that reductions in nutrient use may not alone reduce water contamination. Calculations of nitrogen losses show that the farm balance in Sweden is positive while in Lithuania it is negative (12 kg N/ha per year). The Lithuanian farm has thus suffered a loss of nutrients. This example shows the importance of conducting a nutrient circulation survey and nutrient balance

calculation for farm management, for both economic and environmental considerations. Supply and removal of plant nutrients should be in good balance. Such a sustainable agricultural practice will be possible to implement only when farmers understand its importance to their economy and environment. Such understanding in Lithuania is currently very poor.

### **The Karst Zone, Its Agriculture, and Associated Water Quality**

#### **Geology**

The active Lithuania karst zone extends up to 2,000 square kilometers in the Birzai and Pasvalys Districts. A thick layer of gypsum, together with dolomite, marl and clay layers, amounting to several tens of meters, are characteristic of the surficial strata of the region. Numerous sinkholes were formed by the gypsum dissolution process. The karst phenomenon is progressing. Almost no (or a very thin layer of) quaternary deposits are present in the region. This geology results in contamination of groundwater through the broken karstic terrain.

The area with thin quaternary deposits is almost twice as large as the active karst zone. So, the groundwater is easily polluted in an area up to 4,000 square kilometers. In the remainder of Lithuania, artesian ground water is comparatively well protected by the nature of the geology. The quaternary deposits are rather thick, and reach up to 300 meters.

The obvious feature of the active karst zone is the presence of sinkholes. Density varies widely, depending on the intensity of karstic activity. The range of sinkholes per hectare in three demonstration watersheds is shown in Figure 9.

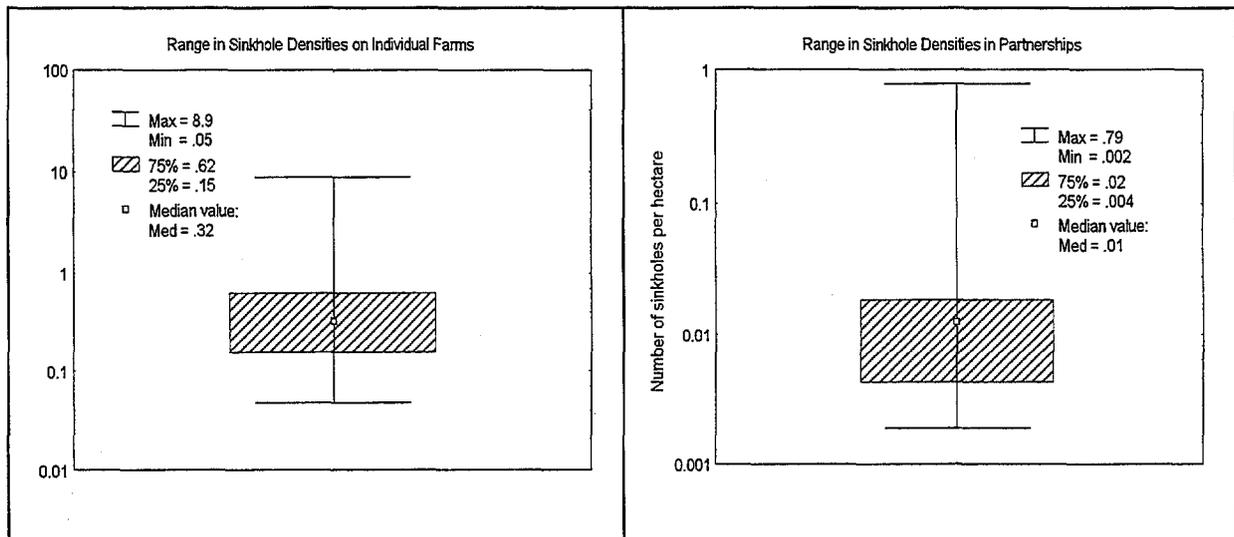
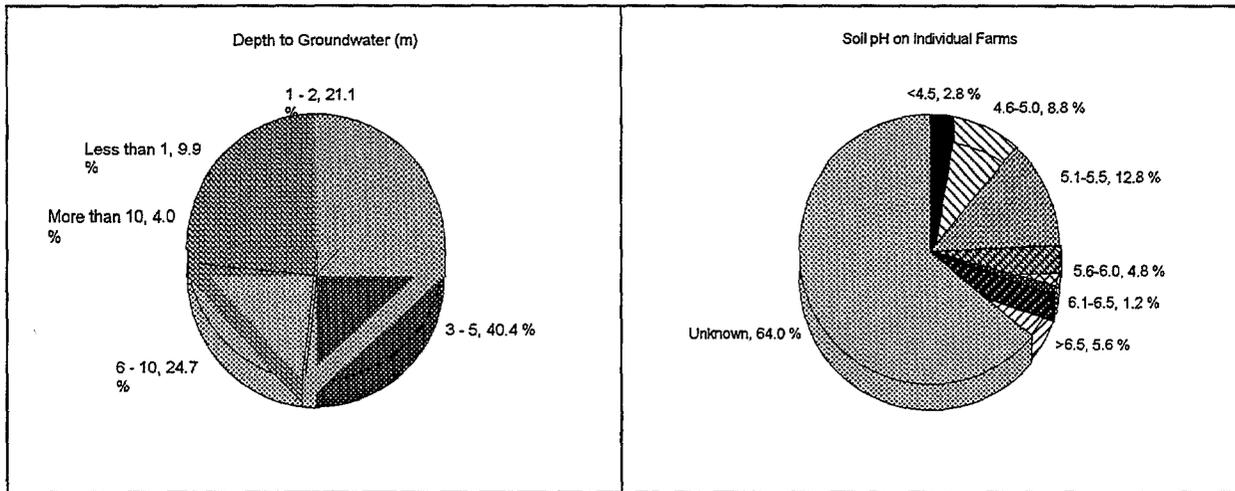


Figure 9. Sinkhole densities in the karst zone

The intensive karst zone is defined as those areas where the density of sinkholes is greater than 80 per square kilometer. This also corresponds to the area of greatest groundwater vulnerability to contamination.

Figure 10 shows that groundwater depths are very shallow, mostly less than 5 meters as measured in wells in use. Coupled with the extremely rapid recharge characteristic of karst activity, this makes drinking water resources in the area extremely vulnerable to contamination. Soils are predominantly acid, contributing to the karst activity.



**Figure 10. Groundwater depth and soil pH in surveyed watersheds**

The karst zone crosses the Lithuanian border and extends into Latvia, making the problem international.

### **Agriculture**

Karst zone agriculture has been analyzed in an Iowa State University and Lithuanian Rural Sociology Association survey. The data will be used in a project sponsored by the U.S. Environmental Protection Agency to assist the Lithuanian government in implementation of the karst area management plan.

Partnerships and individual farms are the two main types of agricultural operations in the karst zone area. As can be seen in Figures 11 and 12, individual farms average about 14 hectares, and partnership farms average over 500 hectares. Size varies widely, however, ranging from 2 to 91 hectares in the individual farms surveyed and from 51 to 1457 hectares in the surveyed partnerships.

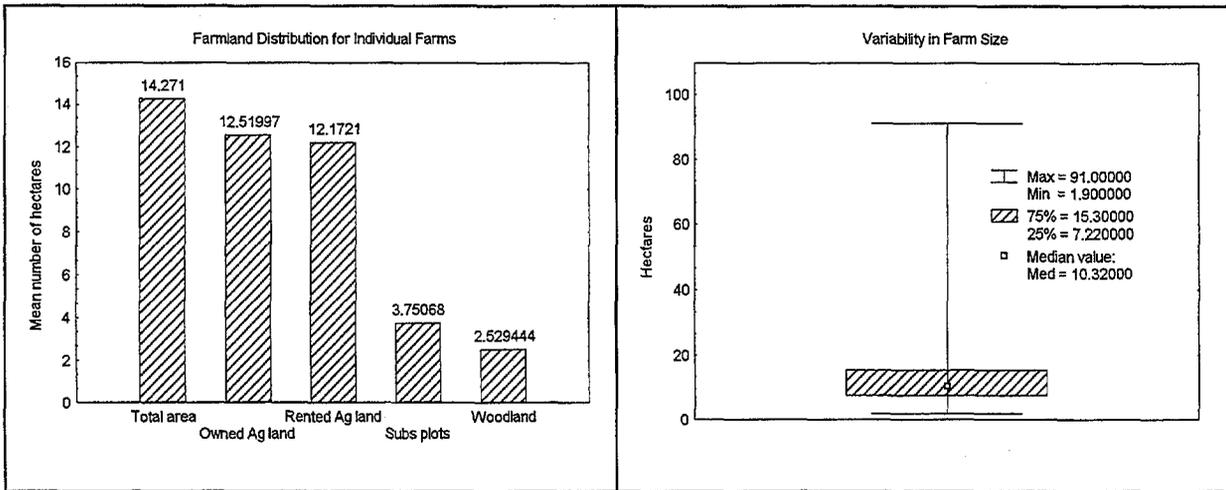


Figure 11. Land use and size variability in surveyed individual farms

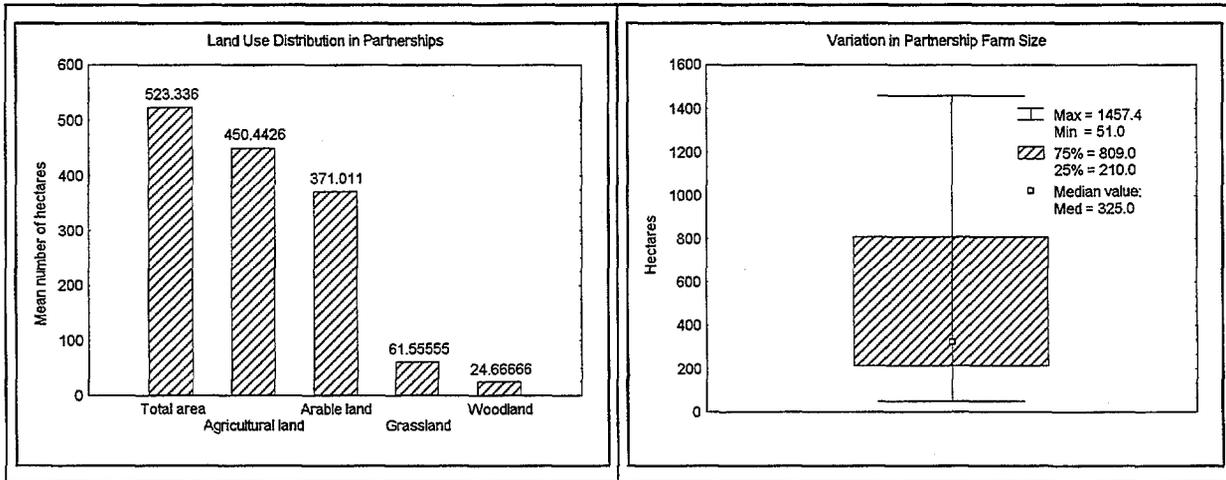
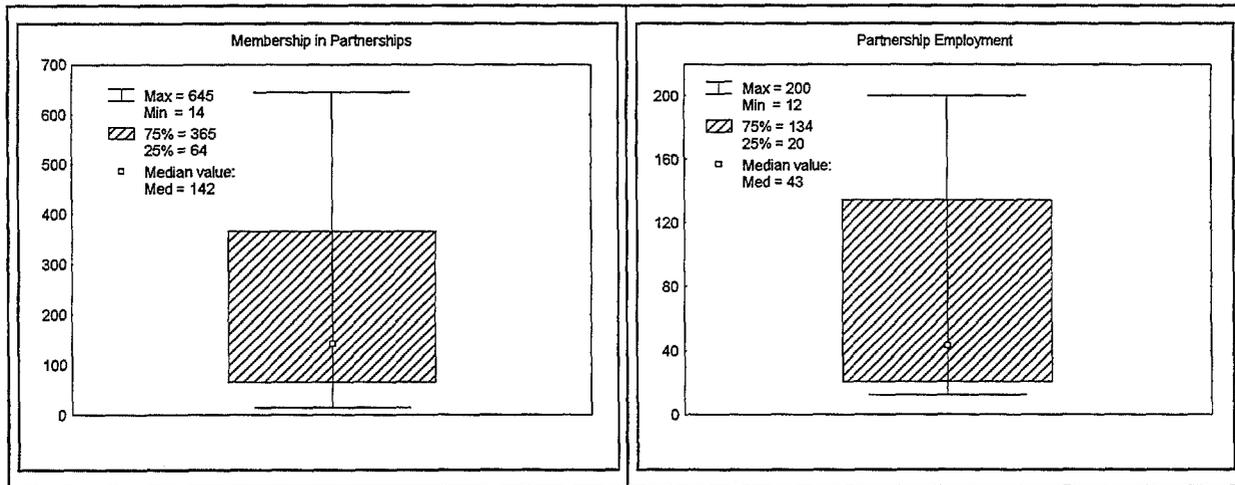


Figure 12. Land use and size variability in surveyed partnerships

The partnerships are composed of members and employees, who may also be members (Figure 13). In the sampled watersheds, memberships vary from 14 to 645 and employees vary from 12 to 200.



**Figure 13. Partnership organization**

Based on the survey, it is evident that crop production in the karst zone is oriented toward cereal grains and feed crops on partnership operations and, on a smaller scale, on individual farms. However, on individual farms, cash crops such as flax and subsistence crops such as vegetables (see Figures 14 and 15) are also grown.

Fertilizer use is indicated by the annual purchases as shown in Figure 16. Viewed together with Figure 6, it is evident that after a period of decline during the conomic transition, the use of mineral fertilizers is once again rising, a situation that has serious implications for groundwater resources in the karst zone.

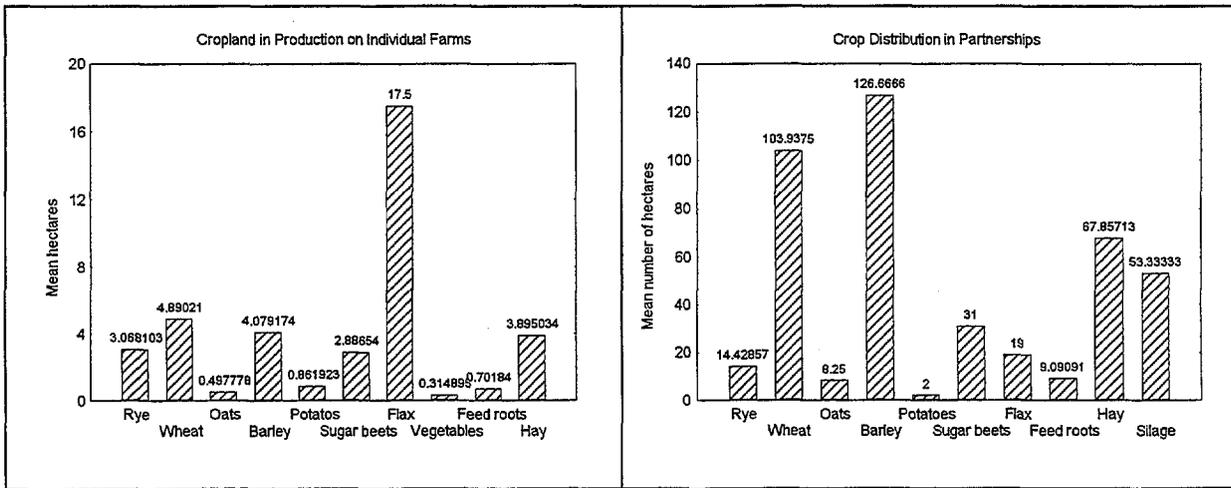


Figure 14. Crop production on individual farms and partnerships

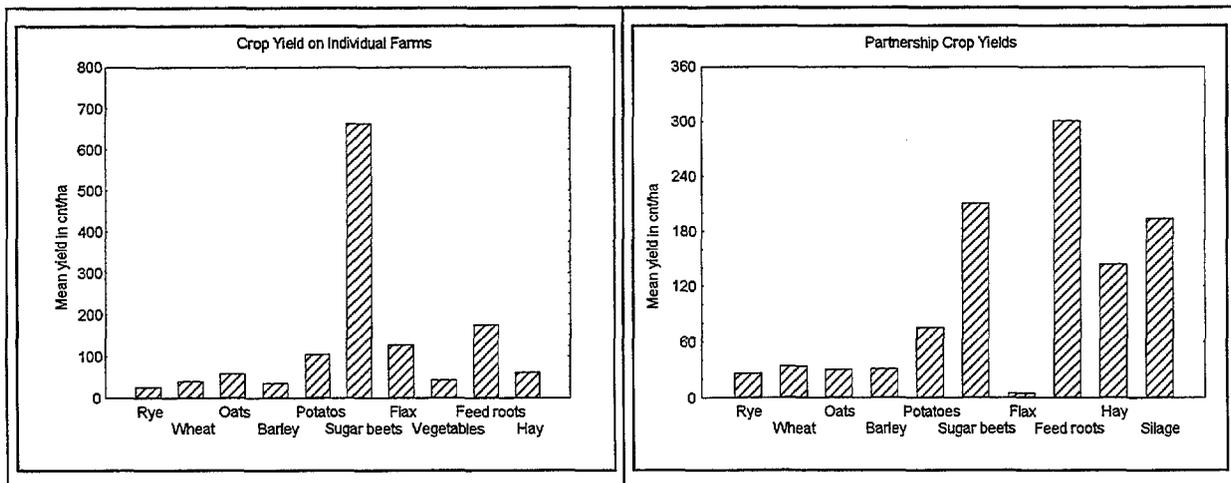


Figure 15. Crop yields on individual farms and partnerships

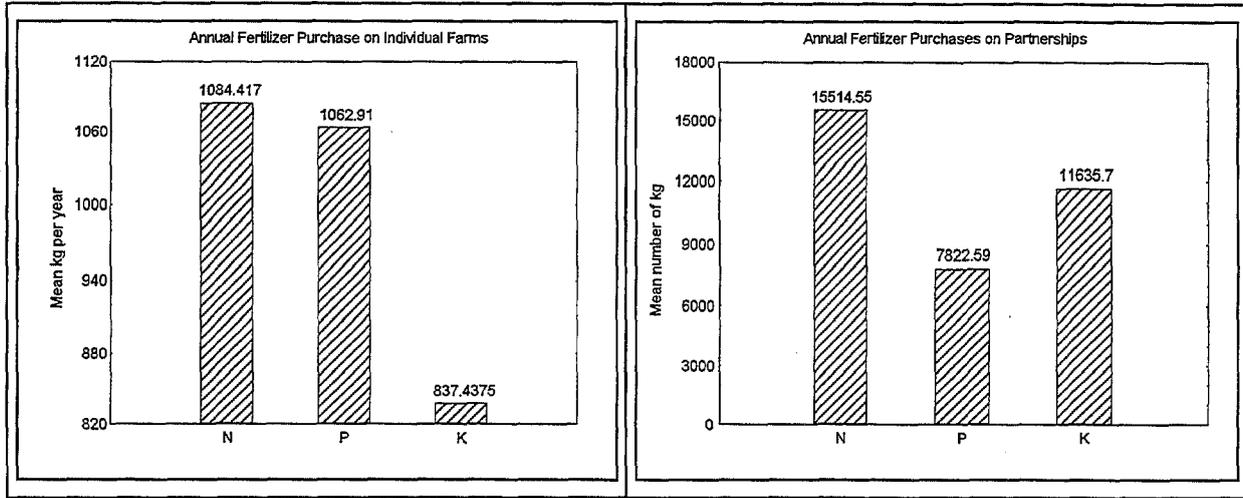


Figure 16. Fertilizer use on individual farms and partnerships

Livestock production is focused on pork and dairy operations in both groups of farmers, albeit at considerably different scales (Figure 17). Milk production is, at best, mediocre by western standards (Figure 18). A few individual farmers have milk production approaching 6,000 l/unit/year, but the norm for both individual farmers and partnerships is around 3,000 l/unit/year.

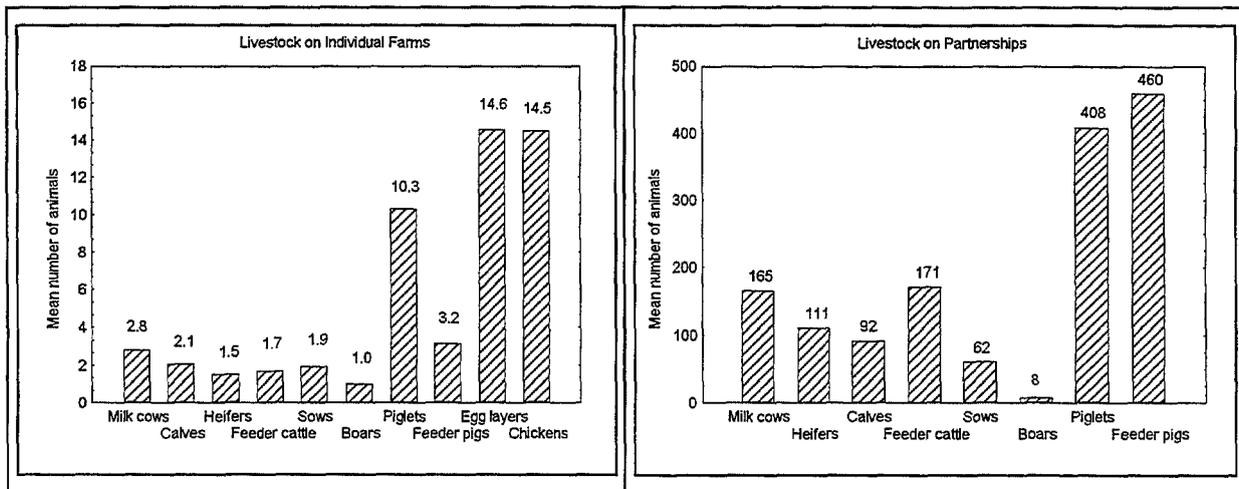


Figure 17. Livestock production on individual farms and partnerships

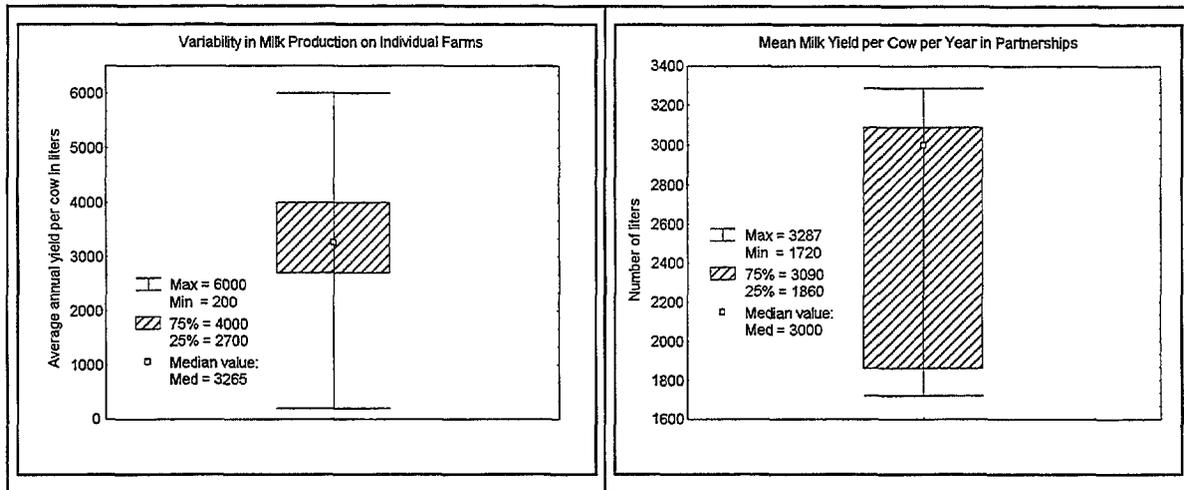
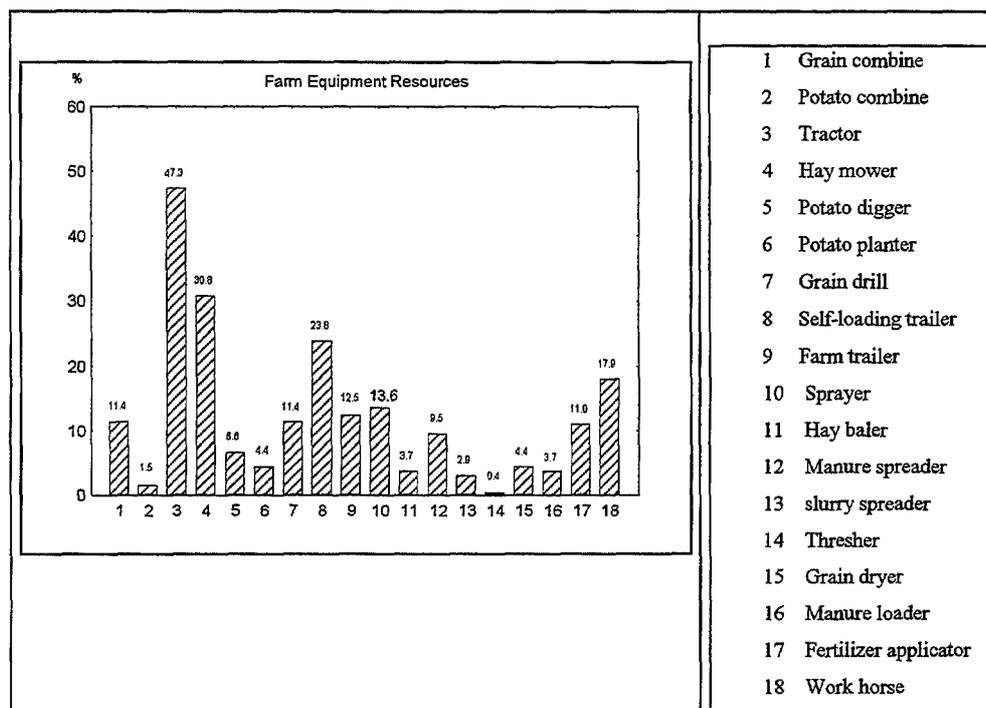


Figure 18. Milk production on individual farms and partnerships

Much of the equipment in the hands of the individual farmers was obtained from state farms that were dissolved. Although many farmers appear to be well equipped (Figure 19), the truth is that most of the equipment is ill-suited to small-farm operations. Results of this situation that directly affect the environment include improper doses of fertilizers and pesticides due to inaccurate mixing and application equipment and soil compaction from oversized and needlessly heavy equipment.

Agriculture in the karst zone generally reflects that in the rest of Lithuania. The difference is in the vulnerability of the setting—the unique geological characteristics make surface and groundwater contamination a serious risk to human and ecological health in the region. Many current practices can be altered under the Karst Zone Management Plan to both increase production and, at the same time, decrease the risk of water contamination. In addition, significant investment in point source control such as wastewater treatment for communities, rural households, and large agricultural operations is a necessity.



**Figure 19. Equipment resources**

### Water Quality

Point source pollution is the major contamination source for the karst zone. Waste treatment plants in the town of Birzai, and in 23 settlements or villages where the total population amounts to 100,000, need to be built or reconstructed. For the rest of the population and production centers there are no waste treatment facilities at all.

Primary point source pollution impacts come from production units. There are 170 cattle farms with a capacity ranging from tens to several thousand animals. There are also 30 fertilizer storage facilities, two dumping sites for home waste, chemical storage facilities, and machinery yards in the intensive karst zone.

Both individual farmers and large scale operators need to pay closer attention to locating potential contamination sources of drinking water supplies (Figure 20). The relative proximity, particularly on

individual farmsteads, of household wells to livestock barns and manure storage invites contaminated drinking water.

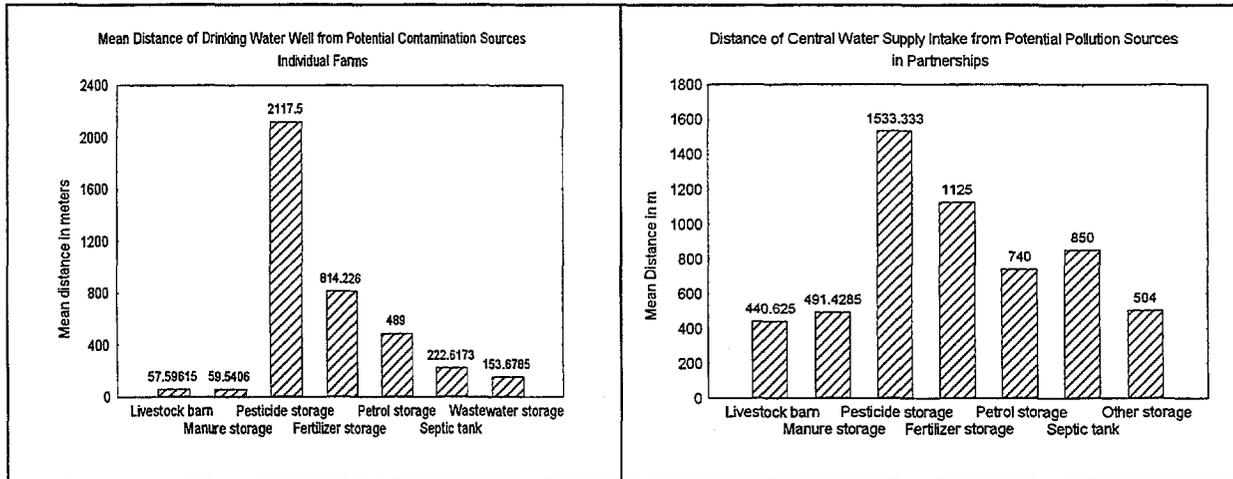


Figure 20. Potential contamination sources for drinking water supplies

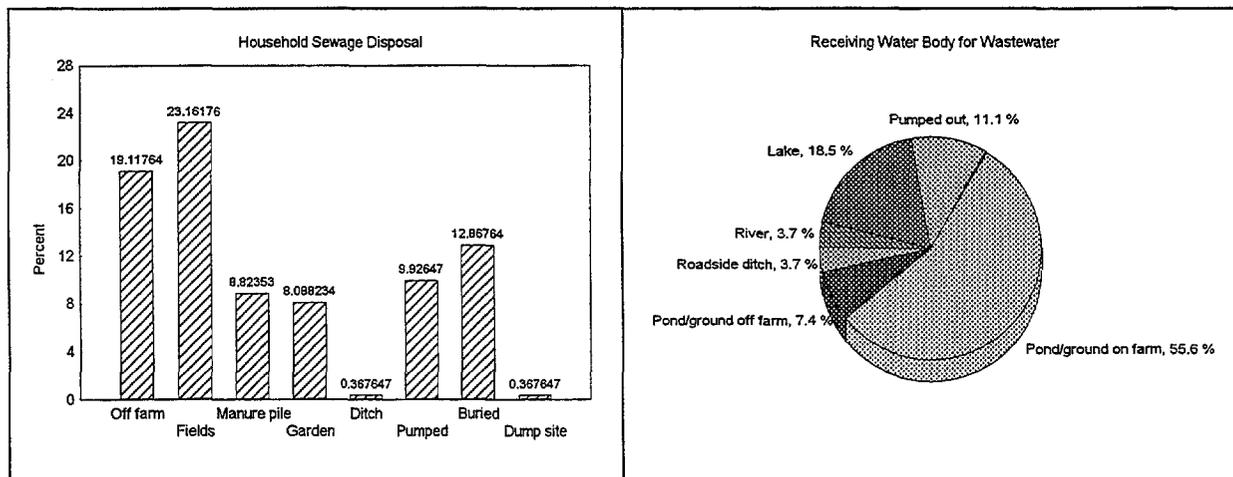
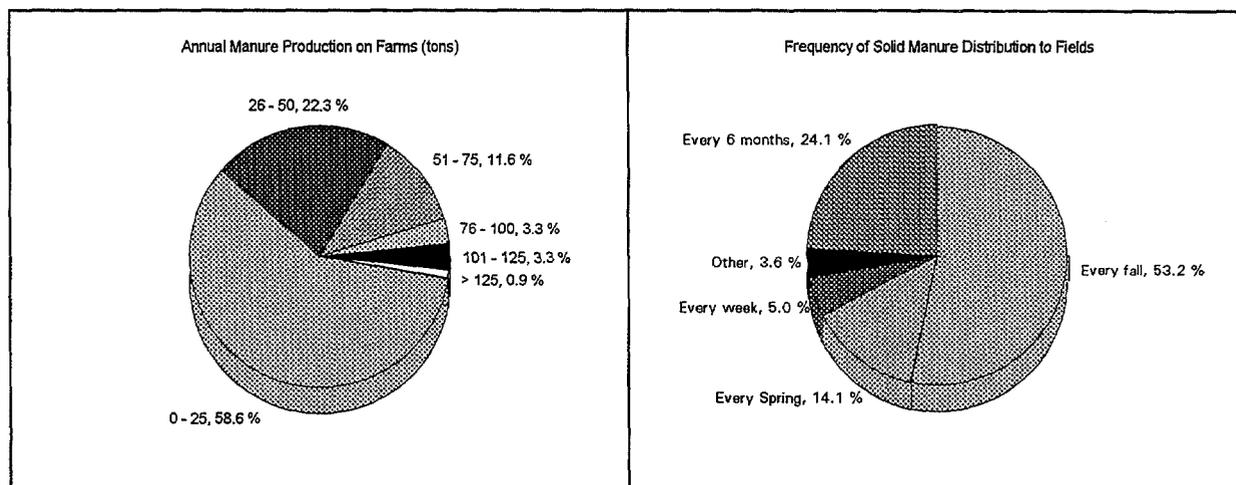


Figure 21. Surface and groundwater vulnerability to contamination

Figure 21 shows that more than 50 percent of farmers dispose of household sewage on the farm and that about 90 percent of all wastewater is transported to surface and/or groundwater.

Waste loading for the region amounts to 1.8 million tons per year. Organic waste makes up 101,000 tons per year. Home wastes comprise 478.7 cubic meters and only 13 percent of that number is treated.



**Figure 22. Manure loading potential from farms**

### The Lithuanian Karst Zone Management Program

Water protection problems in the karst zone have been addressed by various organizations. There are scientific studies by the Institute of Geology, Institute of Agriculture, and Institute of Land Reclamation, among others. Several environmental protection and water quality measures were implemented under government resolutions in 1977 and 1982. It should also be noted that the majority of personal and collective government awards to increase agricultural production have been given to karst zone farmers, especially in the Pasvalys region. It is therefore obvious that local specialists and managers did not consider these governmental resolutions before deciding to intensify agricultural activities in the karst zone.

Water quality problems in the karst zone were addressed seriously in 1987, when the Lithuanian Environmental Protection Agency was created at the Ministry of Agriculture. That agency no longer exists, but solutions to water quality issues in the karst area are being continuously sought.

At present, conditions are favorable for solving the karst zone problems: The Lithuanian government established the program entitled "Protection of Ground Water Against Pollution and Development of Sustainable Agriculture in the Intensive Karst Zone of Lithuania" (Appendixes A and B). To implement that program, a special executive body—the karst zone fund Tatula—was created. Lithuania is prepared (in the moral sense) to start solving the environmental protection issues in the karst zone even though it has few resources with which to solve its rural environmental problems and priority water quality issues. Nevertheless, work is being done to begin sustainable and biological farming in order to improve agricultural water quality in the karst zone. At the same time, internal and export demands and markets for organic production are being explored. The Lithuanian internal policy and foreign attitudes toward Lithuania are favorable for expanding multilateral relationships. At the current rate of implementation, Lithuania will complete the karst zone program in 30 to 40 years. This would be fatal to the program; thus, foreign donations are vital to the program's success.

Since 1987, the government's karst program development and implementation activities have been conducted in three stages.

1. As a first step, it was necessary to define the size of the karst zone territory and to make decisions about appropriate farming activities in it. Although interests and attitudes of geologists, agricultural scientists, and land managers differed, decisions were made through coordination.
2. In December 1991, the government adopted a special resolution on the karst zone and restrictions for agricultural activities within it (Appendix B). According to this resolution, the intensive karst zone in Lithuania was set at 29,000 hectares, and the protective zone at 164,000 hectares.
3. The intensive karst zone is divided into four groups according to the number of sinkholes per square kilometer. Sinkholes were chosen as an indicator because their density provides a measure of karst activity and groundwater vulnerability. In the fourth zone, where the density of sinkholes is more than 80 per square kilometer, farming activities are severely restricted. Fertilizer use, including manure, is prohibited, as are any chemicals.

In the first zone, the sinkhole density is not more than 20 per square kilometer. The restrictions are minimal, because the land owners cannot afford chemicals and their use is minimal. Activities around each sinkhole are severely restricted in all zones.

There are crop specifications for traditional farming set in each zone to control fertilizer and chemical utilization. For example, in the fourth zone natural meadows are allowed and woodland,

various curative herbs, and plants are permitted. In the third zone, in addition to the crops listed here, managed pastures and meadows are allowed. When the plan and control system for certification of ecologically clean agricultural production is introduced, restrictions concerning crops will no longer be needed. If farmers agree to undertake sustainable (in zone 1) or biological farming (in all zones), they will be permitted to grow various plants, and raise many types of animals and birds.

Farmers are informed of the agricultural restrictions in the karst zone when they apply for farmland. They receive the land ownership documentation only if they agree to observe the restrictions. In the protected area, there are also several restrictions set for land use for construction purposes.

In early 1992, by the government's decree, a group of specialists and scientists was established to work out the karst zone program. The goals of that program are:

1. To develop measures to stop point source pollution (from cities, settlements, production units, and farmsteads) and nonpoint source pollution (from agricultural fields), to create a program for sustainable and biological agriculture implementation designed to solve environmental problems, while at the same time producing ecologically clean production to meet market demands.
2. To create economic incentives for the program's implementation during the transition period.
3. To propose ways to establish an infrastructure for ecological farming and to estimate the required investments.
4. To establish an ecological education and training system for specialists.
5. To establish an environmental monitoring program.

The program was presented to the Lithuanian government in December 1992, and in September it was discussed and approved (Government's Resolution No. 719 of September 17, 1993), (Appendix B).

The program was implemented in 1993. A special fund was established by 55 founders. According to the fund's statutes, state organizations cannot be founders or members. The fund elected its functioning administrative bodies, including a Board, Observers Council, and Commission for Competition Organization.

In 1993, there were one million litas available for the fund's operations. Of this, 980,000 litas were transferred to the fund from the Ministry of Agriculture. Because that money was assigned from the national budget, it had to be spent before January 1, 1994.

Construction of four experimental waste water treatment systems in settlements and other areas began in 1993. The fund budget assigned 212,000 litas for that purpose. On September 20, 1993, a competition was held to select the sites. And on October 5 a competition for project and construction work was held among organizations not only from the karst zone, but from all over Lithuania.

The development of sustainable and biological farming also began in 1993. Based on competition, 730,000 litas were assigned for that purpose and for organization of small agro service enterprises. The fund assisted farmers in preparing for the competitions by helping choose a farming model and business plan. The fund renders assistance to all farms willing to start sustainable or biological farming.

A control and certification system for biological production, one of the most complicated problems, was also introduced. Probably the most important problem, however, is convincing individual farmers to follow the example of the experimental biological farms. Typically, the cost of biological production is 30 to 100 percent higher than traditional production. Many farmers question whether biological farming can be profitable.

There are two economic proposals in the program addressing this problem:

1. Create a farm taxation system that favors biological production practices in protected areas.
2. Encourage the state to subsidize biological production during the transition period to support the food processing industry, and wholesale and retail trade.

### **Issues Affecting Implementation of the Karst Zone Management Program**

#### **The Role of Different Organizations in Implementing the Karst Program**

According to the program, the main body implementing the karst program is Tatula, the karst fund. All of the implementation work that is done by Tatula is in competitions; any organization or individual is free to participate in those competitions. During an interview with the head of the

Observers Council, A. Gutkauskas mentioned several organizations that have an impact on the activities of Tatula. The karst fund has very close relationships with the Departments of Agriculture at local municipalities that organize competitions and other work conducted by the fund.

Also active in organizing educational activities is Gaja, which promotes bio-organic farming in Lithuania. In A. Gutkauskas' opinion, Gaja's activities are less supportive than they should be; it used to be involved mostly in educational activities and farmers' training in the karst zone, because it won a competition organized by Tatula. The Farmers' Union had no impact on the program's implementation. This union was very popular after private farms started to spread in Lithuania. At that time, farmers who were members received second-hand equipment that was donated to the union, or they could buy new equipment at a better price than nonmembers. At present, the Farmers' Union cannot provide such support, so it is less popular.

A farmer can be a member of the Farmers' Union and the karst fund at the same time; being a member of the karst fund makes the farmer eligible for many benefits. He can apply for low-interest credits, get a free education on his farming activities in the karst zone, and be guaranteed that his production will be purchased and processed.

The Ministries of Agriculture and Environmental Protection do not play an active role in the karst program. The budget for the karst program is allotted through the National Agriculture Development Program and is transferred to the Ministry of Agriculture. The amount allotted depends on the estimate prepared by the Fund. The draft estimate has to be coordinated with the Boards of Agriculture at the Pasvalys and Birzai regions and approved by the government (usually the Minister of Agriculture is authorized to do that). Then, the money goes to the Ministry of Agriculture, and the ministry transfers the money to the fund's account at the Agricultural Bank. The fund, through competitions, gives credits to the farmers. The karst fund is a type of "crediting cooperative" for farmers.

The Ministry of Environment should participate in the karst program by allotting money for waste water treatment facilities in the region, but at present all its finances are concentrated on construction of waste water treatment plants in the major cities of Lithuania. It should become more visible in the karst zone in the future.

The Ministry of Health should also be involved in hygiene issues in the region as well as in water monitoring, but its participation is hampered by financial shortages.

### **Implementation Activities, 1993 to 1995**

In 1993, one million litas were assigned for karst program implementation. Twenty percent was spent on the reduction of point source pollution, including construction of four wastewater treatment plants. During the first year, two agro-services were started to assist organic and sustainable farming. Four farmers received interest-free credits to begin biological or sustainable farms. A basis for a certification system for biological and sustainable farming and for education and training was developed.

In 1994, four million litas were allocated for karst program implementation. Actually, only 3.5 million were transferred from the state budget; 1.8 million litas were spent for point source pollution, such as for additional construction on the above-mentioned waste treatment systems. One and a half million litas were spent for nonpoint source pollution. Six hundred and fifty thousand litas were spent on credits to bio-organic and sustainable farmers. Twelve additional farmers received 20,000 to 250,000 litas in interest-free credits, by winning a competition based on their submitted business plans. They are obliged to transfer their farms and pay back the credits in three years. At the end of 1995, all farms receiving credits became demonstration farms. In 1993 and 1994, the establishment of three cooperatives for the purchase, processing, and sales of production was supported through additional credits:

1. A grain processing enterprise, Aviza, in Pasvalys.
2. A grain processing enterprise, Gruda, in Birzai.  
For these two enterprises, the karst fund Tatula assigned 560,000 litas in interest-free credits.
3. A vegetable processing line to be launched by the stock company Birzu Pienas received a 350,000-lita credit.

Two hundred thousand litas were spent for education, training, and advertising and for the further establishment of the certification system for biological production.

At present, 30 farmers (16 of whom have received credits from Tatula) are transferring their farms to biological and sustainable farming. Tatula spends 300 litas per year per farmer to finance their participation in the certification program. The number of participating farmers is gradually increasing as farmers begin to understand that they don't have a favorable future with traditional agriculture in the karst zone. They understand that by complying with restrictions and participating in the activities of

the karst fund they will have higher profits because they are guaranteed that their production will be purchased without any middlemen and at a better price.

Most of the educational activities are concentrated in the Joniskelis Agricultural School. A new specialty of organic agriculture is offered to students. Seminars and training courses are being organized for karst zone farmers. Last winter, 20 farmers participated in a special course on organic and sustainable farming. Several publications have also been prepared. The preliminary market research was conducted by the Institute of Agricultural Economics and there are plans to begin specialist training at the Joniskelis school so that assistance can be provided to local farmers who apply.

The Joniskelis Agricultural School receives some foreign assistance in organizing educational activities on organic farming. A Danish company is participating, and in fall 1995, four teachers of the Joniskelis Agricultural School were trained in Denmark. Later, teachers from Denmark will go to Joniskelis so that all local teachers can be trained in one place.

In February 1995 Iowa State University, along with the U.S. Environmental Protection Agency Region VII and the Lithuanian Rural Sociology Association, conducted a survey of farmers and partnerships, providing a database on their farming practices, potential pollution sources, and attitudes towards environmental protection in the region. The surveyed farms and partnerships were mapped by the Lithuanian Institute of Land Reclamation and were digitized by the Institute of Geography. Additional data have been collected by the Institute of Land Reclamation at Kedainiai. The best management models for different karst zone groups were created and presented to Tatula and the Lithuanian government at the end of 1995. These institutions also plan to support educational activities at the Joniskelis Agricultural School.

In 1995, an allocation of 3,630,000 litas was confirmed. The fiscal year started July 1 and 300,000 litas have already been transferred. All of it was assigned as a credit for a partnership that had won a competition to convert its pig farm into a chicken farm so that its pollution was significantly reduced. The rest of the money is to be spent (on a competitive basis) as follows:

1. 1,263 000 litas for nonpoint source pollution: farmers' credits will be 923,000 litas, 300,000 litas will be spent on market establishment for organic production, 220,000 litas will support further construction activities of the Birzu Pienas vegetable processing line, and 80,000 litas are allotted to the Birzai mill and bakery.

2. 2,221 000 litas will be spent for point source pollution—two of the waste water treatment plants have already been constructed; work continues on the remaining two. 300,000 litas will be spent for manure storage facilities construction. 80,000 litas are allocated to machinery yards, 50,000 litas will be spent on water intake reconstruction, and 80,000 litas will be used for surface water intake reconstruction production units.
3. Ecological education, training, and monitoring will receive 146,060 litas.

In October, 1995, organic production fairs were held in Vilnius, Kaunas, and Panevezys. Organic and sustainable farming and production were advertised and prospects prepared, so that more farmers will switch to biological and sustainable farming, not only in the karst zone but all over Lithuania.

#### **Economic Issues in Implementing the Karst Program**

The extension of organic farming today is not only an expression of environmental protection concern, but also an expression of the current economic state. Compared with traditional agricultural production, organic agriculture reduces the use of material and energy resources or it uses organic fertilizers with a biological means of plant protection, field rotation. Bio-production is highly rated in the world; its supply is constantly growing and still is not able to meet the actual demand. In many countries, bio-production prices are 20 to 100 percent higher than for traditional production.

Productivity decreases when fertilizer is reduced. Nevertheless, ecologically pure production has higher market value and compensates losses for those decreases.

Tatula currently has 95 members, about one-half of whom are individual farmers, preparing to produce ecologically pure crops. Together, they control 1,117 hectares of land, distributed as follows: 27.4 percent - 10 hectares; 19.6 percent, 11-20 hectares; 33.3 percent, 30 hectares; 13.7 percent, 31 to 50 hectares, and 6 percent of farmers, more than 50 hectares.

For farmers to transfer to organic or sustainable farming more easily, it is necessary to choose proper farming models and to develop the economic structure so that these farms can compete with other producers.

The majority of those ready for the transformation process have up to 10 hectares or more than 30 hectares of land. Economic index for different productions have been calculated for those farms (Table 4) and for several production branches (Table 5).

Table 4. Forecast economic index for ecologically pure production in the karst region

	Production	Cost per 1 cwt	Price per 1 q	Income	Expenses for 1 ha or 1 animal	Profit per 1 ha or 1 animal
	q/ha or kg			litas	litas	litas
Winter grain	30	29	45	1350	869	481
Summer grain	27	28	38	1026	756	270
Peas	20	43	63	1260	860	400
Potatoes	115 <sup>a</sup>	28	50	6960	5290	1610
Sugar beets	320	8	13	4160	2656	1504
Flax seeds	5 <sup>b</sup>	67	300	1500	438	1062
Vegetables: cabbage	200	38	50	10.000	7.600	2.400
Carrots	130	40	70	9.100	5.200	3.900
Cucumbers	120	50	80	9.600	6.000	3.600
Caraway seeds	7 <sup>c</sup>	131	1000	7000	917	3042
Orchards (apples)	130 <sup>d</sup>	31	65	8450	4030	4420
Annual milk per cow	4000	36	50	2000	1456	544
Weight gained per year per animal	237	295	440	900	699	343
Hogs	110	300	500	550	330	220
Birds (broilers)	1.6	250	420	6.7	4	2.7

<sup>a</sup> sales 58 percent.

<sup>b</sup> flax seeds for diet catering.

<sup>c</sup> caraway production will begin the second year of farming.

<sup>d</sup> orchard production will begin the fifth year of farming.

Table 5. Composition of production branches in the karst zone

Indexes	Farm Type					
	10 ha			50 ha		
	non-specialized	dairy/livestock	horticulture/gardening	dairy/livestock	pigs/ dairy	plant breeding
Grain area	4.7	4.0	2.0	22.4	26.0	30.0
Sugar beets	0.2	1.0	2.0	-	2.9	-
Potatoes	0.2	0.2	0.5	1.4	1.4	4
Feed roots	0.4	0.5	-	3.6	2.0	-
Vegetables	0.2	0.1	1.5	0.4	0.2	2 (beans)
Corn	0.8	0.6	-	-	-	-
Perennial grasses	3.5	3.6	1.0	22.2	17.5	14.0
Orchards	-	-	3.0	0	0	-
Average annual, ha	6	10	-	43	28	-
Cattle						
Cows	2	5	-	23	18	-
Pigs	10	2	-	5	60	-
Horses	1	1	-	2	2	-
Birds, number	20	25	-	20	20	-
Profit, litas	5180	6620	20250	30460	29200	29030

Conditions are favorable for karst zone farms to improve yields without applying mineral fertilizers. According to calculations, the most profitable crops are vegetables and caraway seeds. If apple tree breeds are properly selected, orchards may also be very profitable. But productivity improvements predicted here will be achieved only by the fifth year of farming. Due to high costs and low prices, breeding cattle results in low income (nevertheless, prices for ecologically pure production are 20 percent higher than current producer prices). Therefore, to increase farm profitability, it is necessary to use part of the farm for vegetables, fruit, and berries. A survey conducted by the Institute

of Agrarian Economics indicates that ecologically pure vegetables, fruit, and dairy products have the greatest demand.

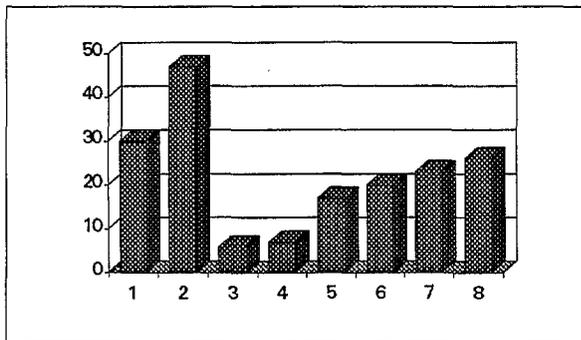
Vegetable production is highly labor intensive; it should be supplemented with bird raising, cattle breeding, or pork production. Such diversified operations have the additional advantage of organic fertilizers for good composts, which are necessary for growing vegetables. Recommended planting practices favorable for growing fodder, In the first karst zone it is possible to raise more animals to expand dairy.

In order to reduce production costs, farmers should specialize and keep animals in one location. Barns, manure storage, and equipment could then be used more intensively, yielding higher profits. In the third karst zone, the possibilities for fodder production are low, so it is recommended that sheep and bird production, fruit orchards, and grain production should occupy no more than 30 percent of the arable land.

Farm profit analyses indicate that there are large variations in profitability. For example, on 10-hectare size gardening farms, growing caraway seeds, cucumbers, cabbages, and early potatoes result in profits three to four times higher than on nonspecialized and dairy cattle breeding farms (Table 6).

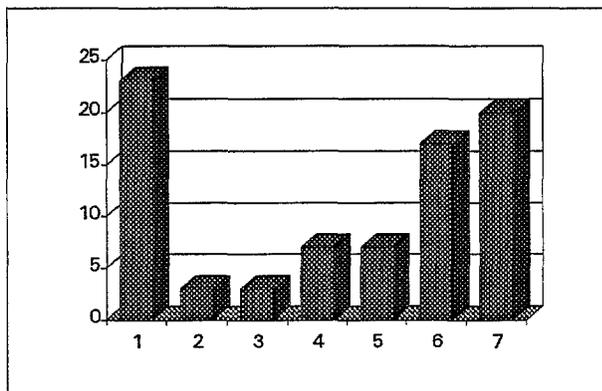
Karst region farmers need to monitor the demand for ecologically pure production and then select profitable agricultural specializations and mixtures that benefit the environment. Tatula guarantees farmers who have signed its agreements that their ecologically pure production will be purchased for the next several years.

According to the Institute of Agrarian Economics research, in the karst region, where the majority of farms are small, agro and cooperative services for production processing and marketing services are very important. The karst zone farmers' survey, conducted by the same institute, indicates that only 13 percent of respondents are satisfied with their equipment. Most farmers would prefer to acquire machinery because it is not profitable to provide services for others. Harvesting services are most in demand; 47 percent of all respondents need such services. Figures 23 and 24 show the services that Tatula members would like and those that they could provide to others.



1. Harvest processing 30%
2. Harvesting 47%
3. Cattle slaughter 6%
4. Agrochemistry 7%
5. Plant protection 17%
6. Machinery repair 20%
7. Soil tillage 23%
8. Transportation 26%

Figure 23. Tatula members' desire for services



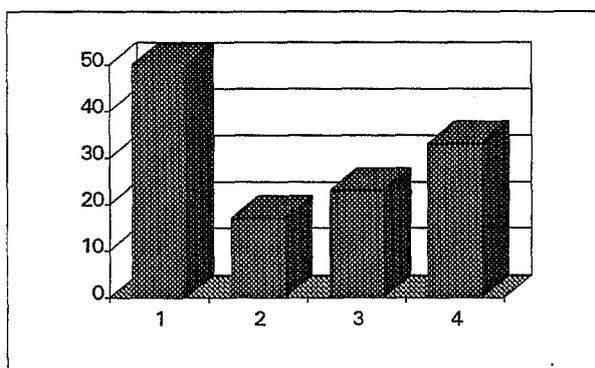
1. Soil tillage 23%
2. Machinery repair 3%
3. Harvest protection 3%
4. Consultations 7%
5. Harvest processing 7%
6. Transportation 17%
7. Harvesting 20%

Figure 24. Services that members of Tatula can provide to others

Some farmers have several tractors and all necessary machinery, while others have almost nothing. Therefore, there is high demand for soil tillage, harvest processing, and other farming services.

Cooperation among farmers would help to solve the problem. The machinery and maintenance could be more effectively maintained at cooperatives. Cooperation would reduce the need for investments, which are hard to obtain. Tatula supports cooperation based on a business plan, and the

money assigned to these enterprises is used more efficiently than it would be if it were assigned to single farmers. Karst region farmers will have to use cooperatives for production processing and marketing. That is confirmed by the survey data that indicates farmers would join cooperatives for production processing and sales. Every karst fund farmer would like to participate in some kind of cooperative; several farmers would like to join to four or five cooperatives. One-third of farmers would join meat and dairy cooperatives; 17 percent would join grain cooperatives, 23 percent are interested in fruit and vegetable processing cooperatives, and 50 percent of the farmers questioned would join production sales cooperatives. Agricultural cooperatives, engaged in production processing, sales, supply, and credit are very popular worldwide. Their expansion is supported by the profit that members of the cooperative are able to generate, especially those having small farms. The members of Tatula would like to participate in the activities of such cooperatives (Figure 25).



1. production sales 50%
2. grain processing 17%
3. vegetable-fruit processing 23%
4. meat and milk processing 33%

**Figure 25. Cooperatives in which fund members would like to participate**

Based on the survey data of the Institute of Agrarian Economics, these cooperatives could be established in the karst region: meat, milk, grain, vegetable and fruit processing and marketing; production supply (with seeds, fodder, fuel, veterinary and technical services); and production cooperatives, joining together several farms but not violating the private ownership rights of cooperative members. In 1994, the Karst Fund assigned a free interest credit for the establishment of the first cooperative "Aviza." Karst region farmers understand the benefits of cooperation and are ready to use services provided by mechanization, marketing and production processing cooperatives.

### Karst Zone Residents' Attitudes and Participation in Associations

Based on a comprehensive socioeconomic survey of karst zone agricultural operations, both individual and partnership, it is now possible to identify areas where attitudes may hinder implementation of the karst zone management program and areas where intervention might prove fruitful.

As was previously mentioned, karst zone farmers must comply with many restrictions. Data showed that about 30 percent of the surveyed farmers were aware of them. They were asked if the restrictions cause problems; 64 percent of surveyed farmers indicated that they did (Figure 26).

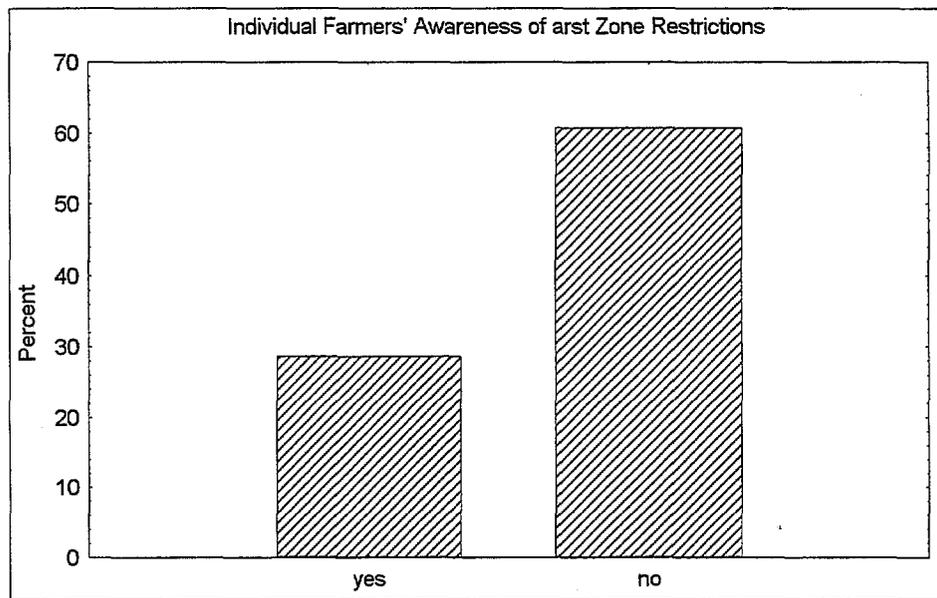
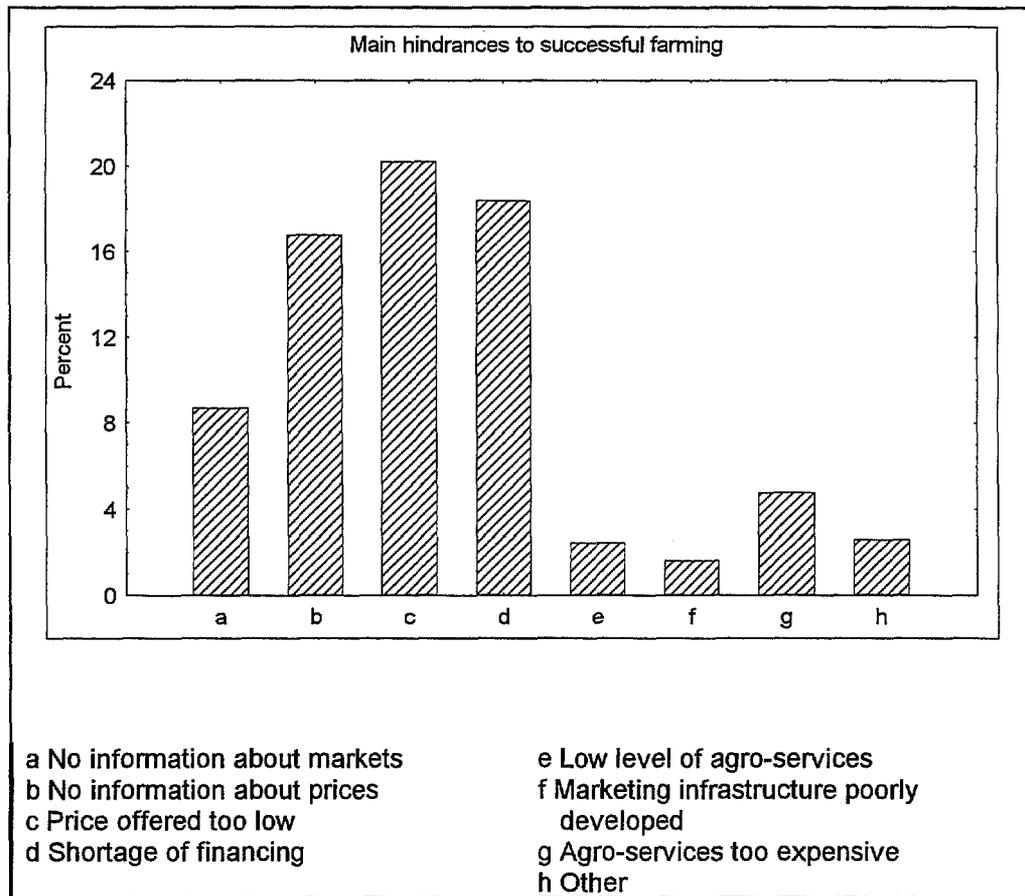


Figure 26. Individual farmers' awareness of karst zone restrictions

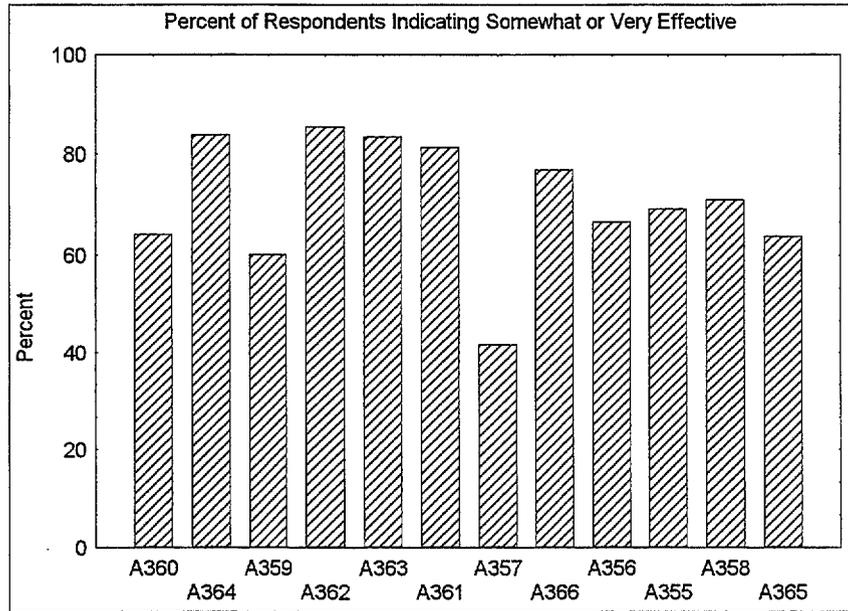
Nevertheless, the main hindrances for successful farming are encountered not only for karst zone farmers, but by all farmers in Lithuania: (1) processing enterprise prices do not cover production expenses (20.2 percent of respondents); (2) there are financial shortages for needed techniques, fertilizers, seeds, etc. (18.3 percent); (3) there is no information about prices (16.8 percent ) (Figure 27).



**Figure 27. Main hindrances to successful farming**

For water quality improvement, respondents believed the following proposals would be the most effective (Figure 28): (1) safe fertilizer/pesticide storage (85 percent of respondents); (2) reduction or elimination of pesticides used (correspondingly 84 percent and 77 percent); (3) reduction or elimination of fertilizers (84 percent and 64 percent).

To reduce farm contamination (Figure 29), the most helpful proposals for farmers would be: (1) financial assistance for sustainable and biological farming development (23 percent); (2) equipment to avoid use of pesticides (11 percent); (3) financial assistance for adequate manure storage facilities (11 percent).

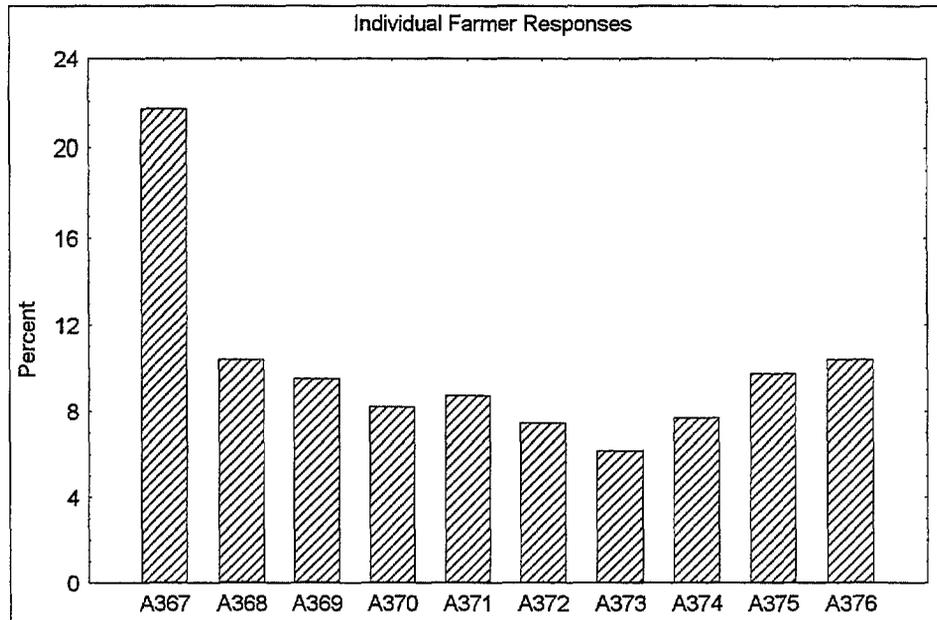


**How effective are the following proposals to improve water quality:**

1) Non effective 2) Rather effective 3) Very effective

- 355. Introduce compact systems to handle household wastes
- 356. Introduce central systems to handle wastes in settlements
- 357. Reconstruct waste systems that are old and function poorly
- 358. Separate food processing factory wastes for separate use and treatment
- 359. Isolate waste stream of some industries from other municipal waste
- 360. Change production and waste handling of large concentrations of livestock
- 361. Improve manure storage and distribution
- 362. Provide safe storage for fertilizers and pesticides
- 363. Reduce the amounts of fertilizers used
- 364. Reduce the amounts of pesticides used
- 365. Eliminate the utilization of fertilizers
- 366. Eliminate the utilization of pesticides

**Figure 28. Farmers' opinions on ways to improve water quality**



**How valuable would the following proposals be in helping you to reduce contamination from your farm?**

(1) Of no value (2) Of some value (3) Very valuable

367. Financial assistance for sustainable and biological farming development

368. Financial assistance to build adequate manure storage facilities

369. Installation of composting facilities

370. A service to apply manure correctly and on time

371. Repair well(s) for drinking water and livestock to reduce contamination from the surface

372. Test soils to help determine the amount of fertilizers to use

373. Provide plants and seeds to protect sinkholes and other karst lands from contaminants

374. Provide a service to determine the need for pesticides before use

375. Provide equipment for accurate pesticide and fertilizer application

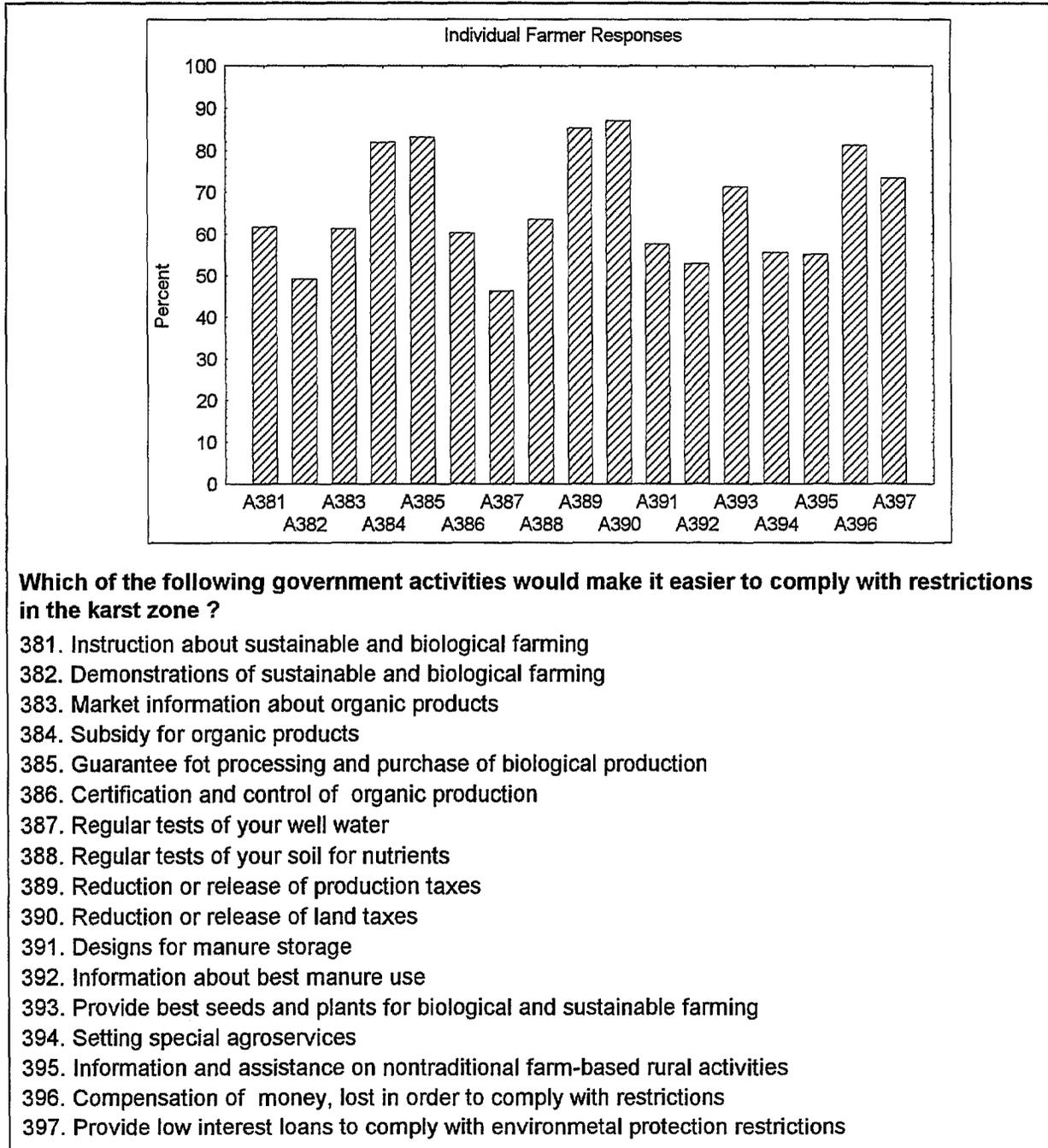
376. Provide equipment and technology to avoid utilization of pesticides

**Figure 29. Farmer opinions on assistance necessary to reduce agricultural contamination**

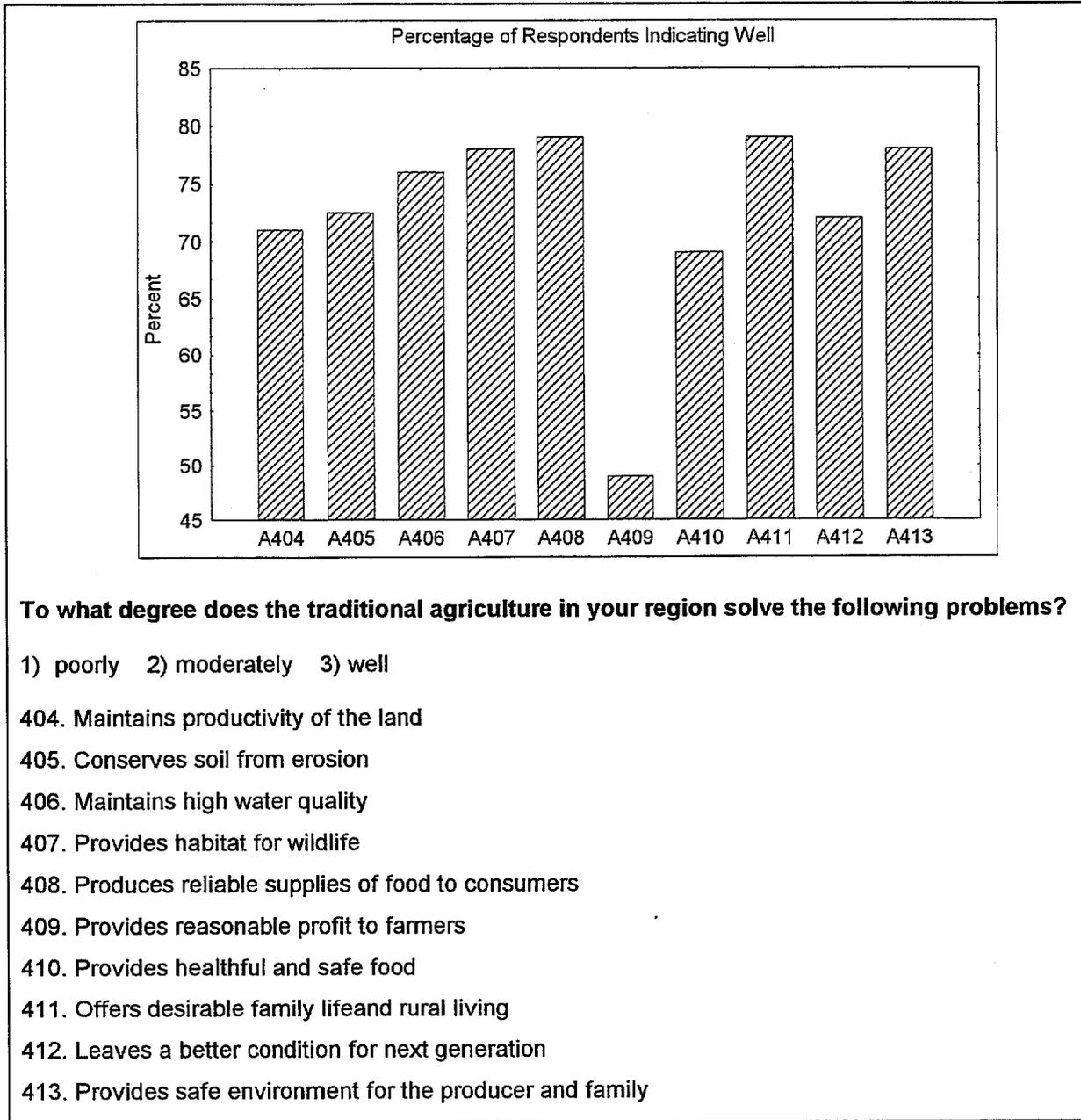
Karst zone farmers were asked what government activities would make complying with restrictions easier (Figure 30). The most valuable, in their opinion, would be: (1) reduction or release of production taxes (87 percent); (2) reduction or release of land taxes (85 percent); (3) guarantee for processing and purchase of biological production (83 percent); (4) subsidy for organic products (82 percent) and (5) compensation for money lost in complying with restrictions (81 percent).

Traditional agriculture in the karst zone offers the following (Figure 31): (1) desirable family life and rural living (79 percent); (2) reliable food supplies (79 percent); (3) habitat for wildlife (78 percent); and (4) a safe environment for the producer and family (78 percent). With the exception of financial returns, karst area farmers have a rather high opinion of traditional agriculture. Nevertheless, as indicated in subsequent questions, they are willing to consider new practices to protect their environment.

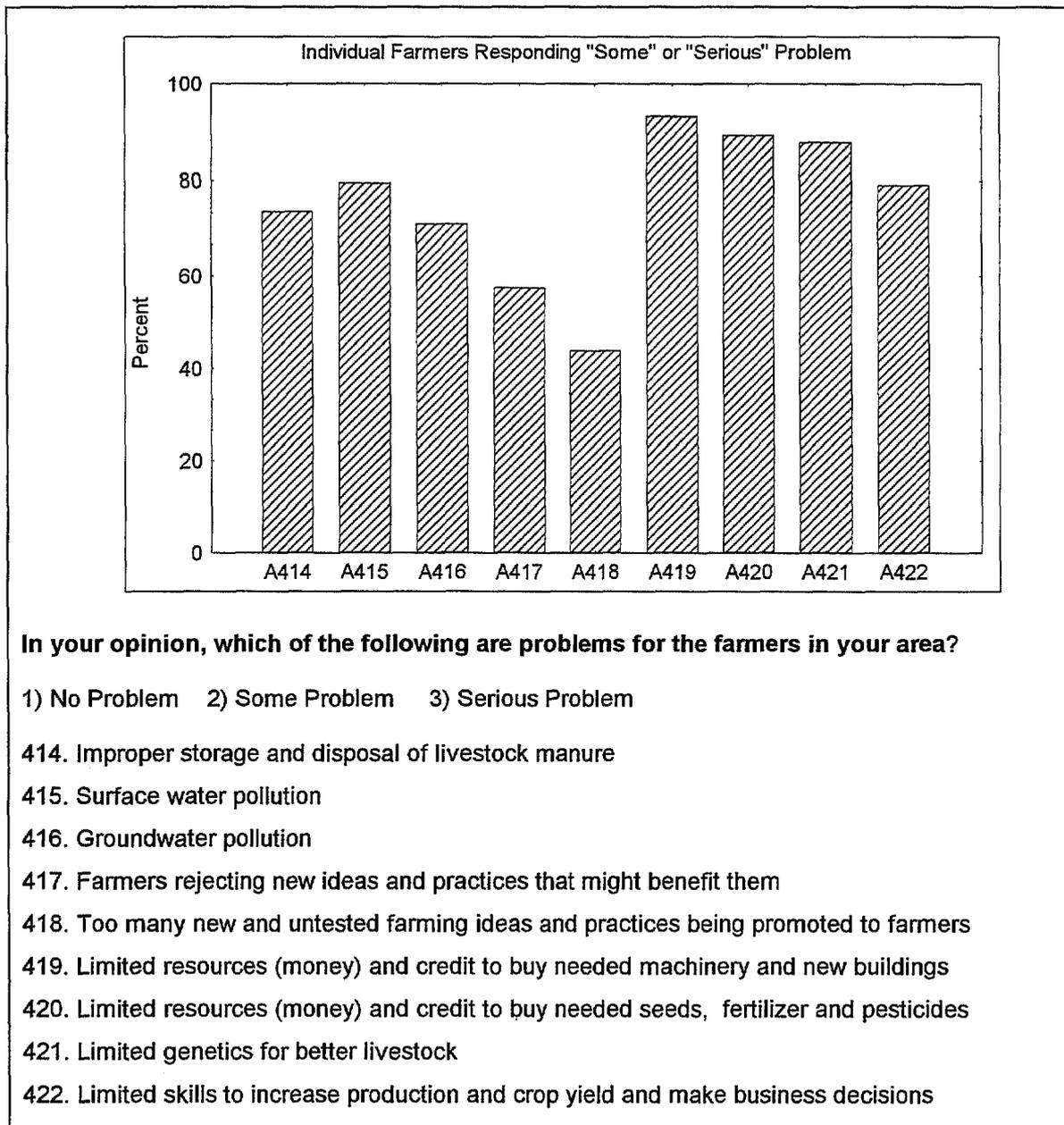
The majority of respondents indicated (Figure 32) that material problems are the most important: (1) limited resources—money and credit to buy needed machinery and buildings (93 percent); (2) limited resources—money and credit to buy needed seeds, fertilizers and pesticides (89 percent); (3) limited livestock genetics (88 percent). Farmers also consider the following rather serious: (1) improper disposal/storage of livestock manure (74 percent); (2) surface water pollution (79 percent); and (3) groundwater pollution (71 percent). Results from this question reflect the prevailing economic conditions, but also indicate an underlying concern for environmental health risks.



**Figure 32. Farmers' ideas on assistance needed for compliance with karst restrictions**



**Figure 33. Farmers' beliefs on the benefits of agriculture**



**Figure 33. Farmers' perceptions of problems in farming successfully**

In making decisions, farmers use these: (1) listen to radio or TV, 57 percent; (2) discuss decision with spouse, 48 percent; (3) talk with or seek advice from a relative or family member, 32 percent.

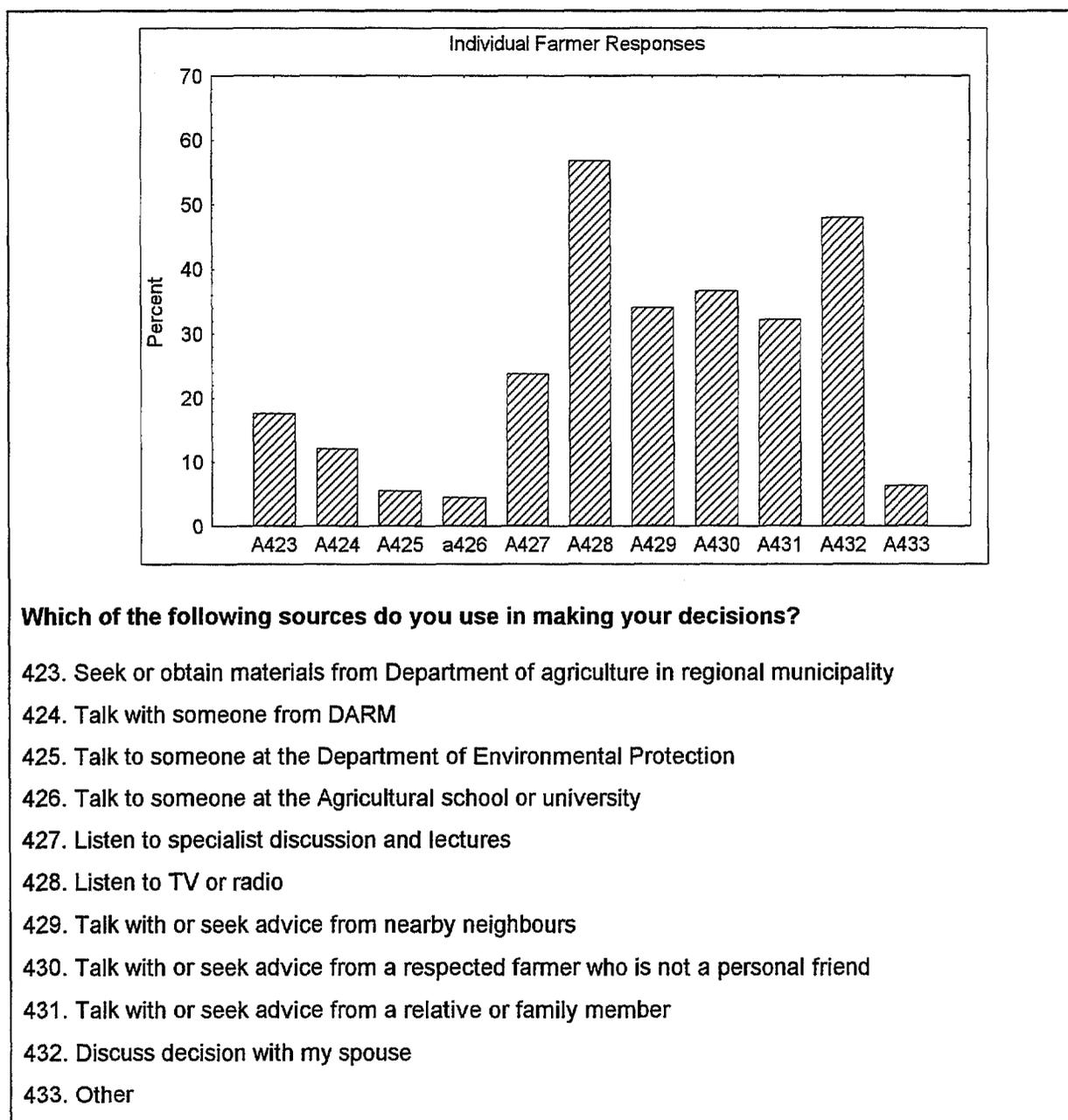
Answers to this question (Figure 33) show how education and information programs can be designed to effectively reach the most residents.

Farmers believe that in the next 20 years new ideas for better farming will mostly arise from (Figure 34): (1) on-farm experimentation by farmers (78 percent); (2) universities or schools of agriculture (66 percent); and (3) the Tatula (63 percent). This indicates where the karst program should focus its education and technology transfer components.

The majority of farmers surveyed (Figure 35) agreed with the following statements: (1) I worry about the purity of my family's drinking water (88 percent); (2) I worry about the purity of drinking water for the regional inhabitants (85 percent); and (3) With proper management of livestock manure there is little need for commercial fertilizer on my farm (75 percent). They clearly indicate concern with water quality and willingness to consider alternatives to traditional high-input practices.

Farmers were asked to indicate their future plans (Figure 36). More than half of the questioned farmers intended to continue farming conventionally (52 percent); 26 percent were willing to implement sustainable farming; and 28 percent were willing to start biological farming in the future. Thus, more than 50 percent of the farmers are willing to attempt to implement agricultural practices in line with karst program requirements.

The most valuable help for farmers would be (Figure 37): (1) agricultural extension advisory services (38 percent); (2) land bank (38 percent); and (3) karst region fund service (37 percent). Farmers are seeking training and services to improve their operations, and are very specific in their perceived needs.



**Figure 34. Sources of information in farmers' decision-making**

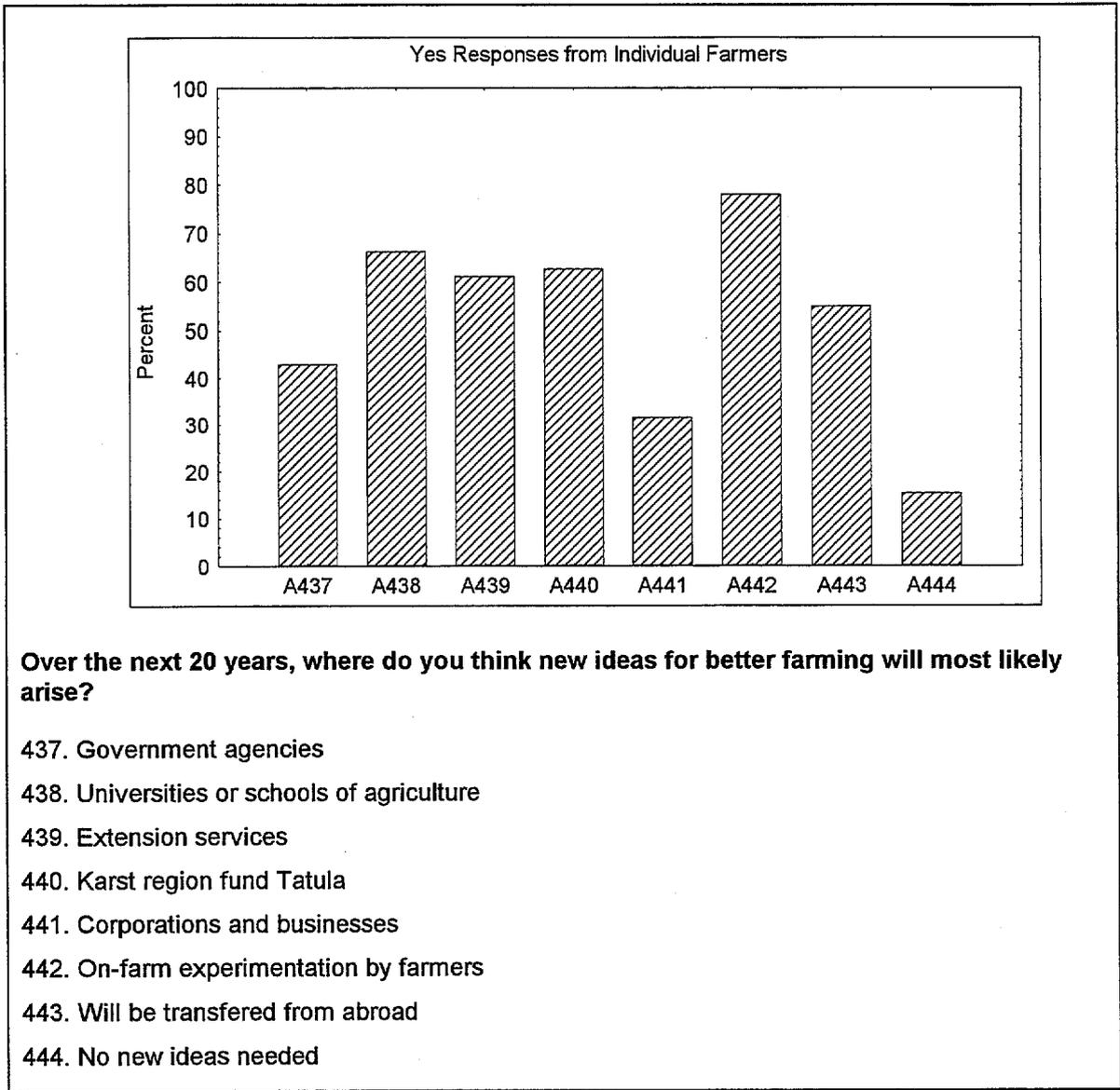


Figure 35. Farmers' attitude on sources of new farming ideas

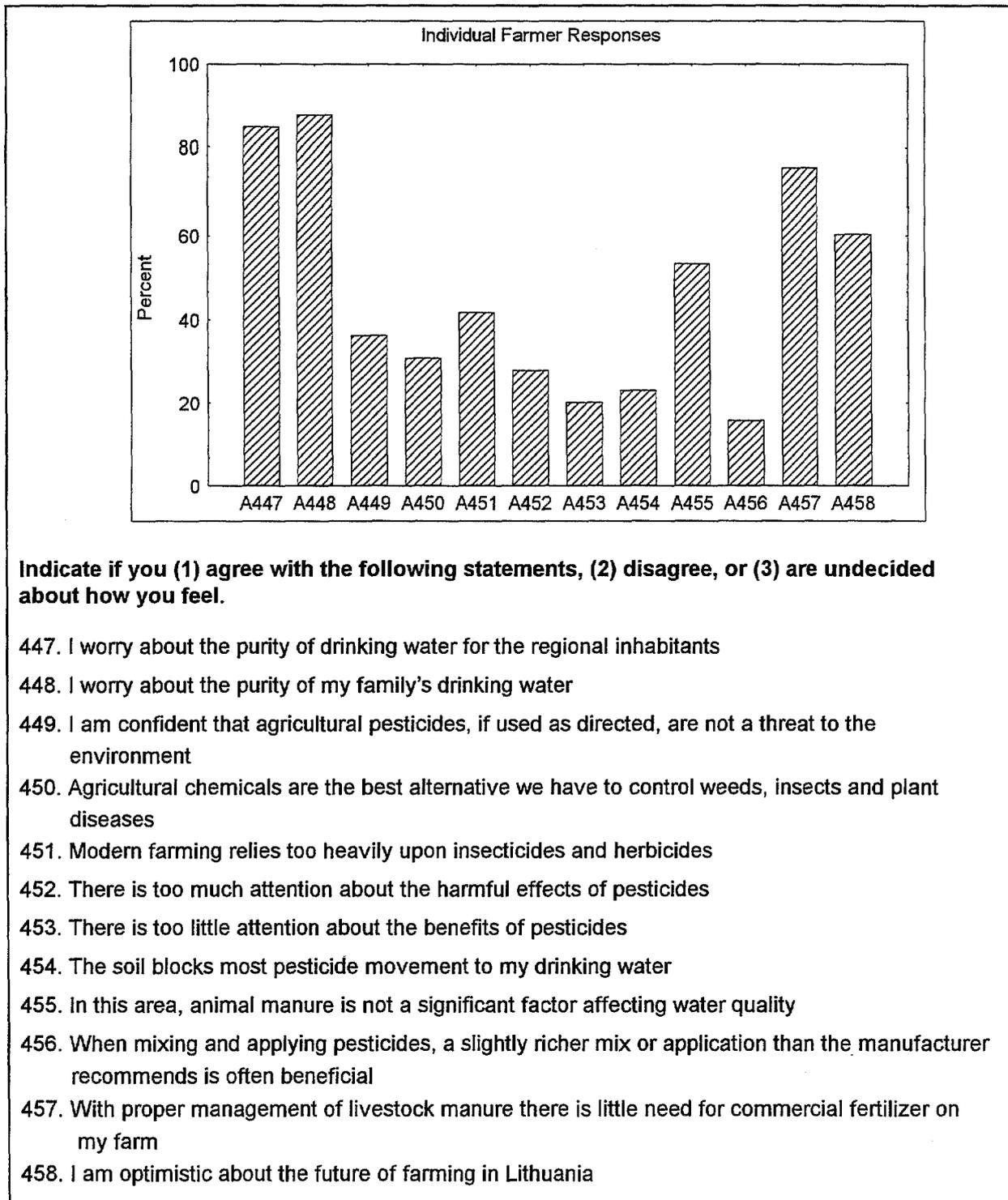


Figure 36. Farmers' attitudes on water and agro-chemicals

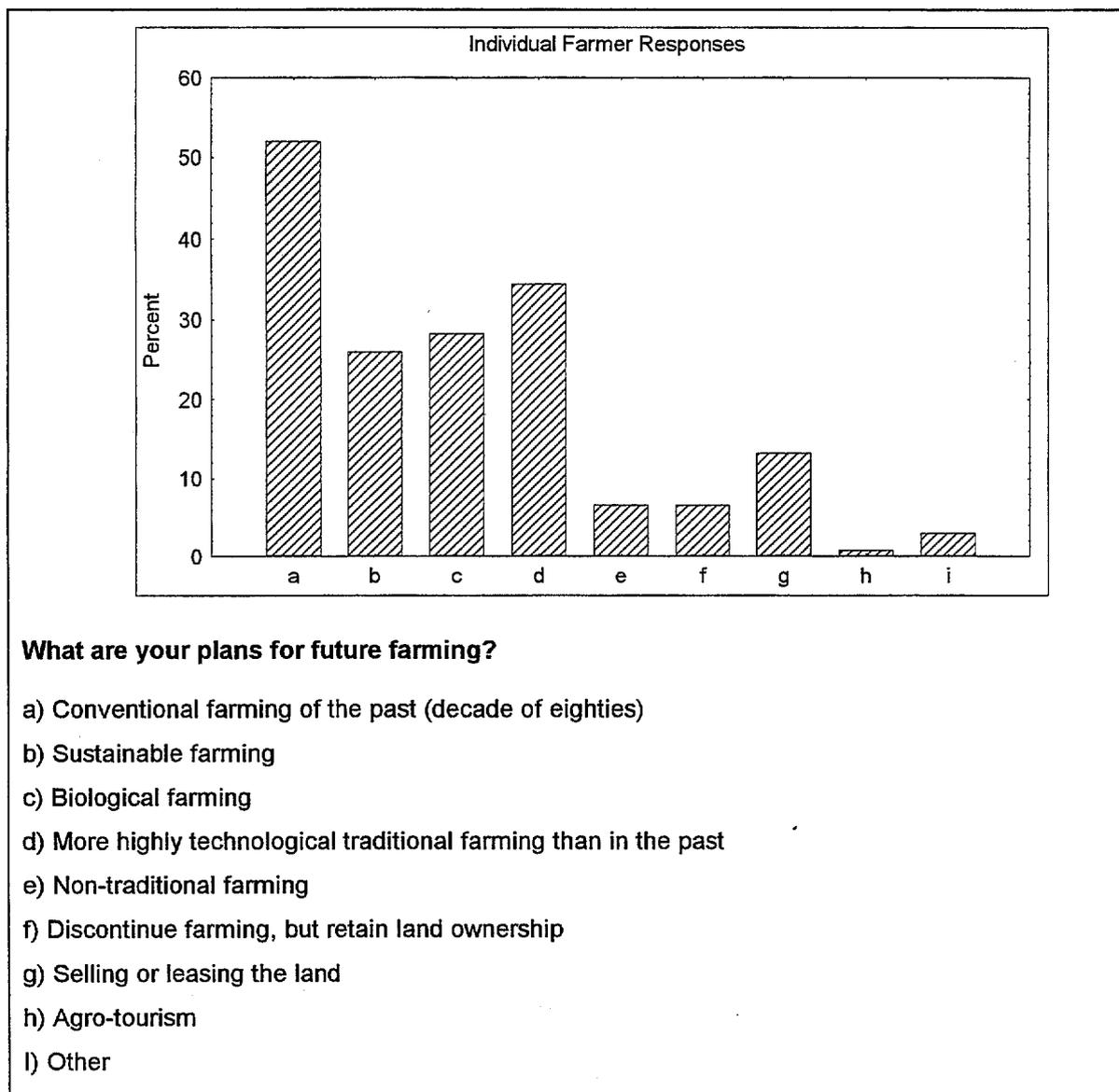
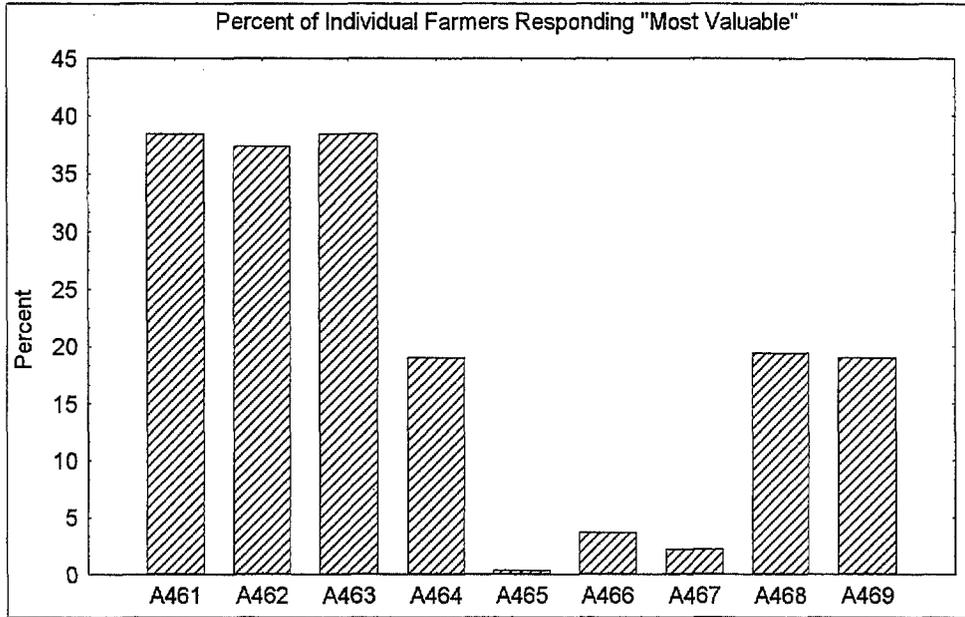


Figure 37. Farmers' future farming plans



**How valuable would the following institutions and activities be in helping you to farm?**

1) Little or no value    2) Of some value    3) Very valuable

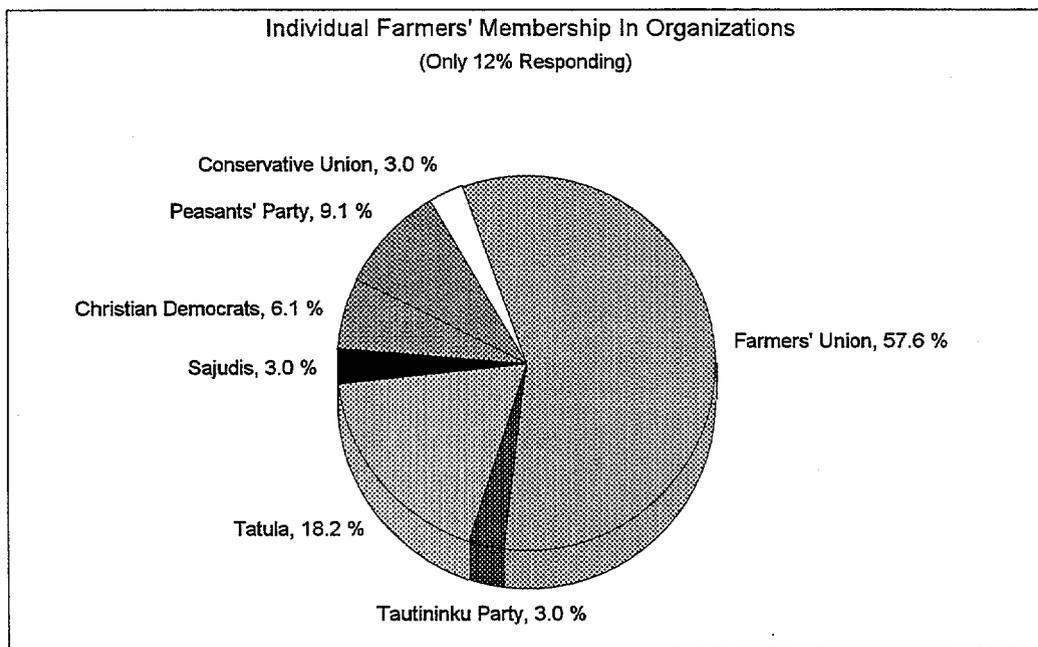
- 461. Land bank
- 462. Karst region fund's service
- 463. Agricultural extension
- 464. Leadership training
- 465. Industrial training
- 466. Night schools for mechanization
- 467. Night schools for management
- 468. Demonstration and experimental farms
- 469. Courses at agricultural school

**Figure 38. Institutional needs for farming assistance**

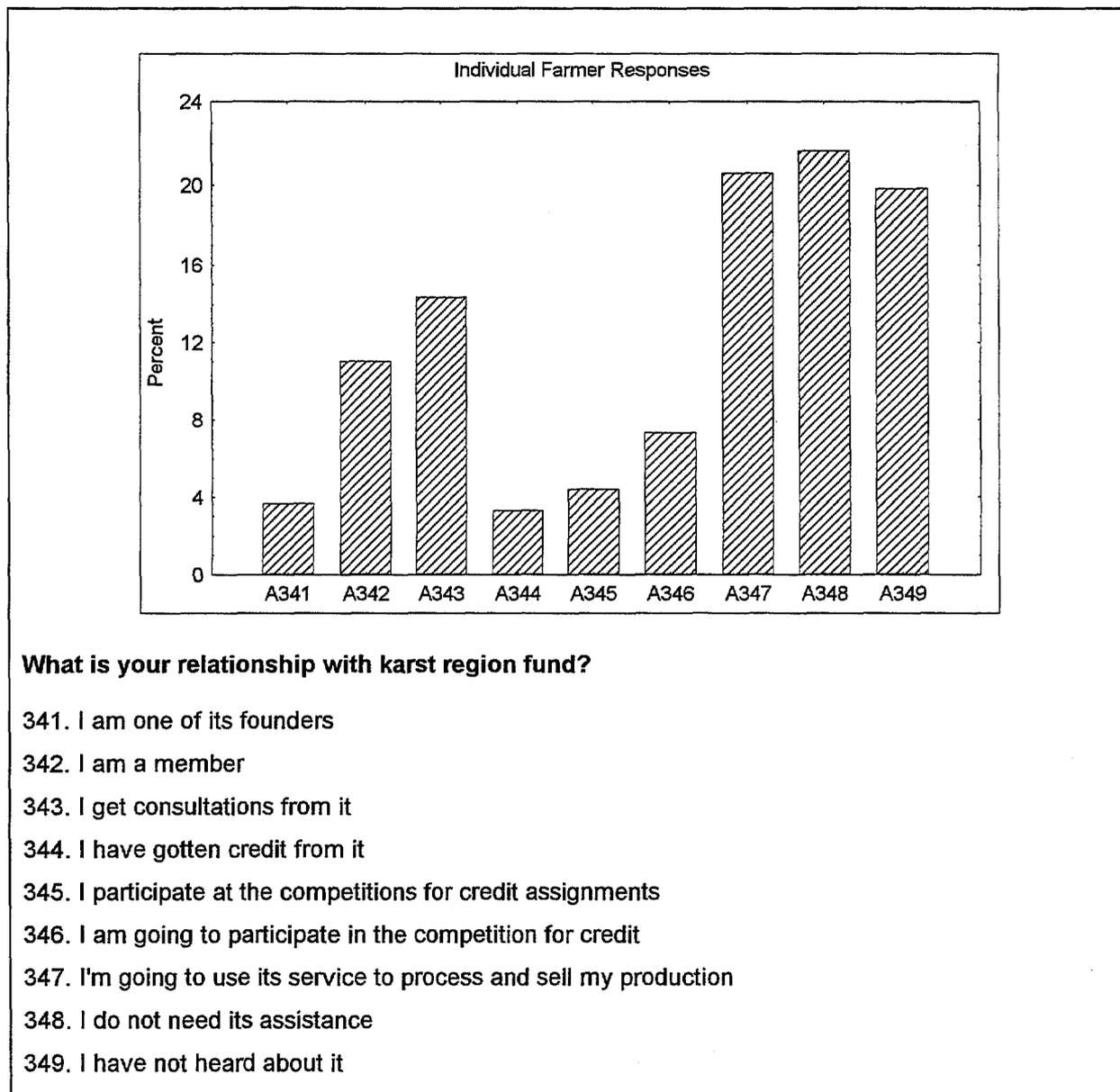
Only 12 percent of questioned farmers answered the question about organizational membership. 57.6 percent of those who answered were members of the Farmer's Union; 18.2 percent were members of

Tatula and 9.1 percent were members of the Peasants' Party. The widespread reluctance to answer this question can probably be attributed to recent history.

Individual farmer involvement with regional organizations is shown in Figure 38 and the relationships with Tatula are shown in Figure 39. Interestingly, more than 40 percent of the respondents have either not heard of the karst fund or state that they need no assistance from it. This indicates that the plan is not being advertised and/or promoted sufficiently, a conclusion that was supported in interviews with program managers (see next section).



**Figure 39. Farmers' membership in various regional organizations**



**Figure 40. Farmers' relationships with Tatula**

### **Management Officials' and Policymakers' Attitudes**

For a complete assessment of the potential for success of the karst zone management plan, it is necessary not only to understand farmer's attitudes and knowledge, as described in the previous section, but also to have some understanding of the knowledge, attitude and commitment of the management officials at the national and local levels who are responsible for the plan's implementation.

A survey of a representative sample of these officials was conducted (Appendix E) to determine the answers to these questions. The following are three representative responses from a scientist, national manager, and local manager.

All respondents agreed that the plan is very useful for addressing the critical situation in the karst zone, but that the implementation process is too slow and, because of that, the plan has so far been unable to slow down the negative impacts of pollution and control the ecological situation in the karst zone.

The respondents believe that, while the general organization of the plan appears to be economically sound given the prevailing conditions in the karst zone, there was not enough attention paid to designing means of implementation for the plan. For example, more funding should be assigned to address the issues of production practices and to the purchase of organic production, and for ecological education and monitoring.

Underfunding is the universally stated problem with plan implementation. The Ministry of Agriculture has allotted enough money, but the Ministries of Environmental Protection and Health should be involved, yet they have not so far committed significant funding. Therefore, there is not enough money to address the critical problems of point source pollution and there is also a lack of implementation of water monitoring and continued scientific research.

One major shortcoming of the program lies in its coordination with the design of land reform legislation. The respondents believe that land in the most intensive karst zone should not have been privatized but should have been placed in a nature protection reserve. The karst program on protection of sinkholes and protection of the most intensive karst zone lands can now be only partially realized. For that reason, these lands should now be purchased from farmers and transferred to the regional park.

The respondents generally believe that plan implementation will be successful if by 2005 a significant portion of the karst zone population (in the intensive karst zone) is involved in the activities. Currently, there are about 20 certified biological farms and more and more people are attracted to the program.

The managers state that the organizational, rather than governmental, nature of the implementing institution is very positive in getting cooperation from area residents. The distribution of funds through competitions is also a positive procedure. To avoid compromise in fund distribution, the fund has set up a procedure of competitions and statutes governing them publicity. The trouble is that the exact procedures cannot be revealed, therefore there will always be some scepticism from outsiders.

The respondents believe that the karst program has already had some positive environmental effects, though not nearly enough. After production went down, pollution decreased and water quality improved in many places. Nitrogen amounts are reduced in separate testing places, but the total average in shaft wells is still rather high (N-60mg in Pasvalys and 80mg in Birzai water wells).

For a long time to come, overall production in the karst zone will be the same as the production all over Lithuania (for economic reasons). Biological farming and bio-production will be practised on separate "islands" and will, hopefully, act as sources of information and as demonstration farms to spread the ideas throughout the region.

Some recommendations provided by the respondents:

- Integrate the Land Use Service into the program and amend land reform laws to reflect the karst program's goals.
- Allocate funding for wastewater treatment facilities
- Implement an intensive monitoring program in the karst zone
- Provide funding for continued research on the geophysical mechanisms operating in the karst  
Local people are well aware of the general character of the karst zone plan, but local Land Use Services should issue a special publication and attach it to the land documents given to the farmers, so that zone
- They know about the restrictions applied to their specific plots of land.
- Economic incentives should be introduced for farmers to compensate for loss of income due to compliance with restrictions.
- Farmers should receive assistance in developing business plans.

### Summary

It is evident that nonpoint source pollution from agricultural practices and point source pollution from rural households and villages present a serious threat to surface and groundwater resources in the karst zone. It is equally evident that the karst zone management plan represents a comprehensive attempt to address these problems in a regional, holistic manner.

Karst zone agriculture is reflective of Lithuanian agriculture as a whole with large state-run enterprises broken up into small individual operations. As a result, waste management has become a dispersed problem, much more difficult to address than in former, centralized times. Agricultural input and management practices are also more difficult to address; large numbers of individual operators are more difficult to reach than smaller numbers of state farm management teams. Nevertheless, individual farmers appear to be much more concerned with environmental issues than the former enterprises were. The karst area management plan reflects a similar concern at the national level.

The plan appears to be well-designed and takes into account both the prevailing economic conditions and the geophysical characteristics of the karst zone. Difficulties in plan implementation derive from those same economic conditions; there is a chronic lack of funding for critical major projects such as wastewater treatment plants for towns and cities in the area. Other needs, such as a widespread, ongoing monitoring program, are also expensive and have yet to be implemented.

Farmers in the zone, while generally aware of the plan and the unique conditions in the area that require special practices, appear to have an unfulfilled need for education and advisory services that will enable them to implement the required practices. The farmers appear to be concerned with their environment and willing to implement practices to protect it. But, the agricultural economy of the area, as in the rest of Lithuania, creates a need for government incentive and/or indemnity programs to induce farmers to comply with restrictions that may affect their fragile economic security.

The authors believe that the karst zone plan can succeed if the government will provide resources for infrastructure construction and will support the economic integrity of area residents upon whom, ultimately, the success of the plan depends. If successful, the plan can serve as a model for regional approaches to agro-environmental problems throughout the Baltic region.

## APPENDIX A

### On Improvement Measures of Ecological Situation in the Karst Region of Lithuania

#### RESOLUTION OF GOVERNMENT OF THE REPUBLIC OF LITHUANIA

Vilnius

December 24, 1991 No 589

#### On Improvement Measures of Ecological Situation in the Karst Region of Lithuania

Seeking to reduce the negative impact of karst processes in Northern Lithuania, to protect ground waters of that region from pollution and to improve the sanitary protection of the Likėnai health resort,

Government of the Republic of Lithuania decides:

1. To confirm:
  - 1.1 Procedure of economic activities in protection zone of the intensive karst zone and in the intensive karst zone (is enclosed).
  - 1.2 Procedure of agricultural activities in intensive karst zone (is enclosed).
2. To define 29,416 ha of land as intensive karst zone with 1-st - 4-th land categories, according to the annex 1.
3. To define 165,9 thousand of land as protection region of the intensive karst zone, according to the annex 2.
4. To define protection 1-st - 3-rd categories zone of the Likėnai health resort, according to the annex 3.
5. To authorize the Ministry of Agriculture by December 30, 1991 to present Government of the Republic of Lithuania proposals on work groups to conduct the following work:
  - 5.1 To design a Targeted Program of Government of the Republic of Lithuania on reduction of negative karst processes and ground water protection in intensive karst zone;
  - 5.2 To design a program for sustainable agriculture development in Karst region.
6. To grant (starting with the year 1992) financial resources from the Lithuanian state budget to the budgets of the Biržai and Pasvalys regional municipalities, according to the targeted program's financing, confirmed by Government of the Republic of Lithuania (5.1 article of this resolution).

**Previous Page Blank**

7. To authorize the Ministry of Agriculture, the Ministry of Forestry and the Board of the Birzai region by 1993 to present proposals on the 4-th category land areas transfer to the state forestry fund.
8. The Department of Environmental Protection of the Republic of Lithuania has to organize and to coordinate the further observations of ecological situation in Karst region of Northern Lithuania, to control how this resolution is observed, and if there is a need, to present corresponding proposals to Government of the Republic of Lithuania.
9. To entrust the State Geology Service to conduct the regime observations of underground hydrosphere, to define directions to scientific investigations of the Karst region in Northern Lithuania, in order to forecast the development of karst phenomena.
10. To entrust the Ministry of Forestry, after coordination with Environmental Protection Department of the Republic of Lithuania and the Council of Birzai region, by December 31, 1992 to present Government of the Republic of Lithuania proposals on establishment of national park in Karst region of Northern Lithuania.
11. To admit as non-valid:

Resolution of the Lituanian Council of Ministers No 232 of June 30, 1972 "On Measures to Ensure the Sanitary Protection of the Likenai Health Resort."

Resolution of the Lithuanian Council of Ministers No 11 of January 18, 1982 "On Measures for Ground Water Protection and Reduction of Karst Processes in the Karst Region of Northern Lithuania."

**G.VAGNORIUS**

**Prime Minister of the Republic of Lithuania**

**CONFIRMED**

By Resolution No 589 of December 24, 1991 of Government of the Republic of Lithuania

**Procedure of Economic Activities in Protection Zone  
of Intensive Karst Zone and in Intensive Karst Zone**

1. In protection region of the intensive karst zone:
  - 1.1 It is prohibited to fill up karst sinkholes with soil, to use these sinkholes for the discharge of rain and drainage waters, to berry garbage, household and industrial wastes in them, to use these sinkholes as peat mines, as well as in construction works, to leave open layers of rocks under influence of karst processes;
  - 1.2 It is permitted to construct settlements, production complexes, dumping sites, hydrotechnical and land reclamation installations and other units, changing environment and increasing its technological load, only after careful research of geological and hydro-geological conditions (including layers, influenced by karst processes) and karst sinkholes and after it is coordinated in a defined procedure with the Environmental Protection Department of the Republic of Lithuania,

State Geological Service, and in the zone of the Likenai health resort - with the Ministry of Health either.

Issues on functioning perspectives of ecologically hazardous units, located in that region, should be solved by means of the same procedure.

2. In intensive karst in addition to restrictions, mentioned in the 1st article:
- 2.1 It is prohibited to install underground oil reservoirs, filtration areas, pools for fecal matters, to construct enterprises and other constructions, discharging hazardous materials, as their exploitation can negatively impact the quality of ground water;
- 2.2 For the protection of natural medical resources of the Likenai resort:
  - it is prohibited to construct new ones and to exploit the current storages of mineral fertilizers and chemicals in the 2nd category protection zone of the Likenai health resort;
  - forests, located in protection zone of the Likenai health resort, should be managed according to requirements, applied for the category of resort forests.

#### CONFIRMED

By the Resolution No 589 of December 24, 1991 by Government of the Republic of Lithuania

#### **Procedure of Agricultural Activities in Intensive Karst Zone**

Regarding to criteria of ecological vulnerability - to activity of karst processes in rocks of geological substrate, density, depth of karst sinkholes, type of hydrographic network, pollution indexes of ground water, the intensive karst zone was divided into 4 land groups (categories). The crop structure and fertilization and plant protection rates are proposed according to these land groups:

1. In the first land group the density of sinkholes is below 20 sinkholes for the square kilometre or to 100 ha. In this land group grain should make up 50%, perennial grasses - around 40%, root cultures - no more than 10%; fertilization rates should make no more than 90 kg/ha for nitrogen, phosphorus and potassium (in active ingredient) and 80 t/ha of spread manure. In this land category it is prohibited to use treason herbicides and chlor-organic insecticides.
2. In the soil of second land category (up to 20-50 sinkholes to 100 ha) it is prohibited to grow root cultures and to start new industrial orchards and gardens; seven-field rotation system is applied in this land group, grain makes up 43% of area and perennial grasses make up 57%; fertilization rates depend on soil data, but not exceeding 60 kg/ha for nitrogen, phosphorus, potassium fertilizers (in active ingredient) and 60 t/ha for spread manure.  
It is prohibited to use herbicides, retardands and insecticides in this land category.
3. In the third land group (50-80 sinkholes to 100 ha) meadows of perennial grasses and pastures should prevail, grain should be sown only as a presowing of perennial grasses. Annual fertilization rates make below 60 kg/ha for mineral phosphorus and potassium fertilizers, it is prohibited to use pesticides, except mordant.
4. In the fourth land category (above 80 sinkholes per 100 ha) it is permitted to grow only meadows and forests; it is permitted to grow plants for honey and medical purposes; no fertilizers are allowed to be applied to fields, it is prohibited to use chemical measures for plant protection.

5. In each land category a special zone no less than 25 meters wide has to be left around open sinkhole. Fertilization, chemical plant control, animal pasture is prohibited; only hay-mowing is permitted.  
These areas should not be included into agricultural land.
6. Ammonium water and liquid ammonium should not be applied to all soils of all four land categories. It is prohibited to use planes for spraying chemicals and mineral fertilizers.
7. In homestead land plots of all land categories, in private farms as well as in other land plots, located in 1st, 2nd and 3rd land categories, when users have concluded agreements on ecologically sound agricultural production, crop structure is not regulated, but it is necessary to observe fertilization and chemicals' utilization restrictions, set for corresponding land groups.

## Annex No 1 to

Resolution No 589 of December 24, 1991 of Government of the Republic of Lithuania

**Land Groups in the Intensive Karst Zone (in ha)**

Region	Apylinke (city, settlement)	Total Land groups				
		1-st	2-nd	3-rd	4-th	
<b>Birzai</b>	Birzai settlement	6829	1896	3514	-	1419
	Nemunelis Radvi-liskis settlement	1243	301	845	-	97
	Pabirze settlement	6609	1482	2271	1458	1453
	Paceriaukste settlement	1871	-	1550	321	-
	Paroveja settlement	1632	175	605	-	852
	Birzai city	1779	-	1779	-	-
	Likenai city type settlement	117	-	-	24	93
<b>Pasvalys</b>	Krincino settlement	2072	1682	178	-	212
	Pasvalys settlement	4567	4177	390	-	-
	Smilgiu settlement	1921	1856	65	-	-
	Pasvalys city	716	716	-	-	-
	Total:	29,416	12,285	11,197	1,863	4,131

S.CILINSKAS

Secretary of Government of the Republic of Lithuania

**Annex No 2 to****Resolution No 589 of December 24, 1991 of Government of the Republic of Lithuania****Protective Region of the Intensive Karst Zone**

<b>Region</b>	<b>Settlement</b>	<b>Area (in ha)</b>
<b>Birzai</b>	Birzai settlement	16,018
	Nemunelio Radviliskio settl.	9,507
	Pabirzes settl.	634
	Paceriaukstes settlement	9,715
	Parovejios settlement	11,812
	Total	47,686
<b>Pasvalys</b>	Daujenu settlement	8,529
	Joniskelio settlement	3,320
	Krincino settlement	10,163
	Pasvalio settlement	5,813
	Pumpenu settlement	11,783
	Pusaloto settlement	11,637
	Salociu settlement	13,233
	Vasku settlement	4,907
Total:	69,392	
<b>Panevezys</b>	Krekenava settlement	7,207
	Naujamiestis settlement	3,348
	Panevezys settlement	17,925
	Smilgiu settlement	8,582
	Total:	37,062
<b>Radviliskis</b>	Sidabravo settlement	9,970
	Total:	9,970
	Total in all these regions:	164,110

**K.CILINSKAS****Secretary of Government of the Republic of Lithuania**

**Annex 3 to****Resolution No 589 of December 24, 1991 of Government of the Republic of Lithuania****1st - 3rd Category Protection Zone of the Likenai Health Resort**

<b>Region</b>	<b>Apylinke (settlement)</b>	<b>Zone</b>	<b>Area (in ha)</b>
Birzai	Birzai settlement	2	537
		3	3,462
	Pabirze settlement	2	2,675
		3	1,168
	Paceriaukste settl.	2	367
		3	1,462
	Likenai city type settlement	1	12
		2	105
	Total according to groups	1	12
		2	3684
		3	6092

**REMARK.** The area of the 1st - 3rd land category protection zone of the Likenai resort is included into corresponding land groups of intensive karst zone, according to annex No 1.

**K.CILINSKAS****Secretary of Government of the Republic of Lithuania**

**RESOLUTION OF GOVERNMENT OF THE REPUBLIC OF LITHUANIA**

**Vilnius**

**No 719, September 17, 1993**

**On Targeted Program for Ground Water Protection and Sustainable Agriculture Development in the Intensive Karst Zone**

Government of the Republic of Lithuania decides:

1. To approve with the "Targeted Program for Ground Water Protection and Sustainable Agriculture Development in Intensive Karst Zone", presented by the Ministry of Agriculture.
2. To entrust the Ministry of Agriculture to organize implementation of the above mentioned program in article 1.

**Prime Minister**

**Adolfas SLEZEVICIUS**

**Minister of Agriculture**

**Rimantas KARAZIJA**

Annex No11.1

**NEED FOR INVESTMENTS TO REDUCE POINT SOURCE POLLUTION  
IN INTENSIVE KARST ZONE**

(IN THOUSAND LITAS) (In prices of December, 1992)

<b>Measures</b>	<b>Need for investments in intensive karst zone, total</b>	<b>Birzai region</b>	<b>Pasvalys region</b>	<b>Responsible for implementation</b>
1	2	3	4	5
I. BIRZAI CITY	1,948.8	1,948.8	-	Birzai re-gional municipality
1.1 Waste water treatment system				
1.2 Pumping stations:	45.5	45.5	-	Birzai regional municipality
1.2.1 PS - IA				
1.2.2 PS - 4 <sup>o</sup>	45.5	45.5	-	Birzai regional municipality
1.3 Sewage system in Pasvalys, Kestutis and Vabalninkai streets	330.6	330.6	-	Birzai regional municipality

1.4 Sewage system in Skratiskiu, Maluno and Kiluciu street	83.8	83.8	-	Birzai regional municipality
1.5 High pressure line up to pumping station	39.0	39.0	-	Birzai regional municipality
1.6 High pressure line up to third pumping station to projected waste treatment system	259.8	259.8	-	Birzai regional municipality
1.7 General program for Birzai city water system. Water pipeline network for residents in Pasvalys, Vabalninko, Kestucio streets region	850.1	850.1	-	Birzai regional municipality
1.8 Sewage system of Rinkuskiu settlement (to be reorganized together with Birzai city sewage system)	1,611.0	1,611.0	-	Birzai municipality
1	2	3	4	5
1.9 Extension of rain water collecton system and construction of treatment system	119.3	119.3	-	Birzai municipality
2. PABIRZE TOWN waste water treatment systems reconstruction and design and installation of drainage system, leading to pool of park of resort.	80.0	80.0	-	Birzai municipality
3. NACIUNAI SETTLEMENT sewage system's network (to be reconstructed together with Pabirze sewage system)	185.6	185.6	-	Birzai municipality
4. PASVALYS CITY	104.4	-	104.4	Pasvalys regional municipality
4.1 Design and construction of 6 rain water collection systems				

4.2 Water and sewage systems reorganization in Birzai and Palevene streets' reg.	88.6	-	88.6	Pasvalys regional municipality
4.3 Installation of water and sewage systems in between Svalia and Levuo rivers, Joniskelis street region	181.0	-	181.0	Pasvalys regional municipality
<b>TOTAL:</b>	<b>5973.0</b>	<b>5,599.0</b>	<b>374.0</b>	

**NEED FOR INVESTMENTS TO REDUCE POINT SOURCE POLLUTION  
COMING FROM RURAL SETTLEMENTS IN INTENSIVE KARST ZONE**

(IN THOUSAND LITAS) (In prices of December, 1992)

<b>Measures</b>	<b>Need for investments in intensive karst zone, total</b>	<b>Birzai region</b>	<b>Pasvalys region</b>	<b>Responsible for imp-ementation</b>
1	2	3	4	5
1. To organize competitions on designs for reduction of negative Pozemio river's impact and reconstruction of Varniunai river basin.	0.5	-	-	Karst region Fund
2. Construction of new biological waste treatment systems	1,651.0	1,023.8	627.2	Karst region Fund
3. Reconstruction and extension of current waste water treatment systems in settlements, installation of sewage network	256.7	175.4	81.3	Karst region Fund
<b>TOTAL:</b>	<b>1,908.2</b>	<b>1,199.2</b>	<b>708.5</b>	

## **APPENDIX B**

### **Targeted Program on Groundwater Protection Against Pollution and Sustainable Agriculture Development In the Intensive Karst Zone in Lithuania**

#### **MINISTRY OF AGRICULTURE OF THE REPUBLIC OF LITHUANIA**

#### **KARST REGION FUND "TATULA"**

Compiled by: A.GUTKAUSKAS (work group leader, Ministry of Agriculture); A.SVIRSKIS (work group leader, Institute of Agriculture); D.BRAZAUSKIENE (deputy work group leader, Agricultural Academy); J.ADOMAITIS (Institute of Agrarian Economics); B.DAGYS (inspector of Environmental Protection in Birzai region); I.EITMANAVICIUTE (Institute of Ecology); V.KUTKA, (Department of Environmental Protection); P.LAZAUSKAS (Agricultural Academy); A.LINCIUS (Institute of Geology); A.MAGYLA (Institute of Agriculture); V.MASAUSKAS (Institute of Agriculture); J.MAZVILA (Institute of Agriculture); V.NARBUTAS (Institute of Geology); Z.STRUSEVICIUS (Institute of Land Reclamation); A.TAMOSAITIENE (Institute of Agrarian Economics).

Birzai, 1993

#### **General Part**

The zone itself and surrounding protection areas were determined based on the Decree of the Lithuanian Government No 589, of December 24, 1991. It regulates economic activities in this zone. The program itself has been adopted by Government on September 17, 1993, by the Resolution No 719.

**Previous Page Blank**

**Goals of this targeted program are:**

1. To stop intensive water pollution in Birzai, Pasvalys towns, in a small town Pabirze, as well as in settlements, located in the intensive karst zone, in production units, homesteads. To determine and abolish intensive point source pollution, located outside of the Karst zone, negatively impacting this zone.
2. To stop non-point pollution, to ease the impact of karst processes in the zone. Based on this targeted program for sustainable agriculture development in karst zone to work out a system of measures encouraging the development of biological agriculture (to start biological farms, agroservices, processing industry, to promote the market for biological production). To formulate economic incentives of "ecological farming" based on subsidies and other support of agricultural producers.
3. To estimate the volume of work and necessary investments to cut pollution and to start biological agriculture in the intensive Karst zone and in its protection zone, to look for the investment sources.
4. To establish environmental monitoring system and ecological education system for population. For the achievement of the above mentioned goals there is a proposal to establish a special foundation by residents of karst and other surrounding zones (e.g. those, who consume drinking water from that area, etc.) as well as businessmen and entities from Lithuania and foreign countries. The largest part of funding, especially at the beginning, has to be contributed by the Government.  
During the period of program's for the Karst zone design it became clear that it is necessary to redefine the areas of intensive Karst zone groups and types of agricultural activities, to be practiced in the zone.

**Measures to be taken to protect ground water from city settlement and other rural point source pollution****Proposals:**

1. Make changes in sequence of measures in settlement development plans and to implement them.
2. During the first year of program's implementation to install 20-30 waste water treatment systems in the intensive karst zone, later on - 40 waste water treatment facilities for rural settlements, production units and homesteads.
3. To establish joint-stock companies in Birzai and Pasvalys regions (one in each) to process waste food. Regional municipalities have to be founders of these enterprises.
4. In 1993-1994 to hold a competition on draft projects of environmental protection measures for reorganization of livestock farms, fertilizer storages, mechanization yards. In the period 1994-2000 to conduct the project works and install environmental protection facilities for 14 units annually.
5. To reprofile into ecologically sound the following production units: in Birzai region - Rimgailiai, Kirkilai, Ripeikiai, Naradava, Klausuciai, Jokubiskiai, Ceniskiai, Kirdoneliai, Balandiskiai, Karajimiskis; in Pasvalys region - Juodzioniai, Daniunai, Uzusienis, Barklainiai, Sindriunai.
6. During the period of 1993-1994 to prepare proposals concerning hazardous chemicals' storage in present storages of partnerships and farms.
7. To modify the drainage system, to introduce ecologically sound horticulture farming into industrial orchards, located in between the rivers Levuo and Musa.

**Measures to be taken to reduce the impact of karst processes and to protect ground water from non- point source pollution**

**Proposals:**

1. To introduce sustainable or biological farming to the first land category of the intensive karst zone. In the second land category of the intensive karst zone either to practice only biological farming, or plant it with forest and leave as non-fertilized meadows.
2. By 1994 to prepare draft projects for the decrease of negative impact of Pozemis river to the karst processes, for recultivating pools of fecal matters and hazardous Varniunai river runoff.
3. To close motorcycle racing facilities in karst zone, close to the Karajimiskiai national park.

**Land use and crop rotation improvement**

**Proposals:**

In the 1st category of soils it is possible to practice conventional agriculture with limited application of fertilizers (maximal dozes of fertilizer used per 1 ha of land have not to exceed 60 kg of N, 60kg of P and 30 kg of K in active ingredient). Manure application has to be limited to 60 t / ha. Triasin, herbicides, chlor-organic insecticides have to be taken out of application practices. Fertilizer norms have to be differentiated by different types of soils and plants grown.

**In the 2nd category of soils only organic agricultural activities are permitted.**

Karst zone farms, practising organic agriculture, can be of crop, livestock or mixed production lines. Crop rotation will depend on farm specialization, machinery available, livestock facilities and labor, as well as on the distance between the farm and potential consumers.

Soil has to be periodically tested in the course of land reform. Soils of the 2nd category, where the pH is lower than 6.0 (33. 6% of the area) have to get additional lime. Monitoring and land improvement have to be funded from Government resources.

To establish agro-service entity in Birzai and Pasvalys, specializing in agricultural production services for karst zone (with specific machinery and implements).

To set up seed production system for Karst zone, growing recommended plants' seeds for all types of agricultural producers.

To apply to international and foreign organizations for methodological and financial assistance in introduction and development of sustainable and biological agriculture in the intensive karst zone.

In the process of land privatization it is necessary to legalize the rights and responsibilities of new owners.

**Selection of plant and animal species**

All plants and animals are allowed to be grown in karst zone. Priority has to be given to pedigree livestock (pure-stock breeding). Restriction - not to graze livestock in sinkholes and their protection zones, to install appropriate manure accumulation and storage facilities to prevent leaching.

Non-traditional agricultural industries are strongly recommended: bee-keeping, production of quail, warms, snails, etc.

For the success of biological farming it is necessary to:

1. Select hybrids of crops suitable for cultivation in extensive karst farming zone.
2. Establish model organic farming entities, to carry out scientific researches there, to formulate recommendations based on research results (Crop Production Institute in Kedainiai).
3. Organize special seed processing, drying and storage facilities in Birzai and Pasvalys region for seeds, used in the karst zone.
4. Expand production of seeds, seedlings and planting material for agricultural and non-agricultural plants.
5. In Birzai and Pasvalys nursery gardens to expand the assortment of plants so that farmers could purchase special plants to plant round their homesteads and sinkholes.

**Agro-technical conditions for organic farming.**

In the framework of organic farming the following nutrition sources for plants should be considered: soil nutrients, organic fertilizers, chemicals-free minerals, production of livestock origin, different algae. Important sources for plants' nutrition are nitrogen, accumulated by leguminous plants. It is permitted to apply bacteriological fertilizers. If there is a need it is allowed to use microelements.

In biological farming it is not allowed to apply synthetic fertilizers.

Microbiological preparations are recommended for pest control.

Sulphur and copper group preparations should be used for plants protection against diseases.

Vegetable and flower seeds in small quantities could be treated thermally against diseases.

In the system of biological farming, free of fertilizers and pesticides, all land cultivation and other agro-technic measures should control weeds.

**State of the art equipment are needed to improve agriculture.**

As in the system of biological farming it is necessary to ensure the rapid mineralization of organic materials, plant waste, siderites and organic fertilizers should be ploughed in less deeply - in 15-17cm depth.

For the soil to be less compressed the field works should be carried out when the soil is humid enough, using double-wheel tractors.

While recultivating protective zones of sink holes the tillage or sowing should be conducted in a combined way of driving around in a spiral Circle. To reduce erosion the rough relief soils should be tilled across slope.

Plant breeders together with breeding centers should select breeds of plants, suitable for biological farming system, i.e. with high resistance to diseases and pests and able to compete with weeds. Scientific research institutions should present agro-technic, suitable for the system of biological farming.

In the system of biological farming sludge should be processed, and only combined with straws it can be utilized.

While growing ecologically sound production, straws should not be sprayed with pesticides and retardants. It is not allowed to plough on straws in the field, because the balance of nitrogen will be disturbed.

The usage of peat mines, located in the karst zone, is undesirable from the standpoint of ecology, as their water filtration functions would deteriorate, and the pollution of ground water will be increased.

For water protection from sludge pollution and for air protection from ammonia it is necessary to install manure tanks or concrete grounds.

For the maintenance of nutrients balance in the soil it is necessary to compost different wastes, bearing organic materials.

Special worms are to be used to improve the composting process.

In the accumulation places of different materials, bearing organic materials, such as: peat, sawdust, waste water silt etc., industrial compost preparation shops should be installed, as well as mobile compost mixer, serving farms.

Composts should be used only after they are tested for the amounts of nutrients.

**Biological farms' control, certification of ecologically sound agricultural production**

It is recommended that the Birzai and Pasvalys region Boards should establish the following services for the Karst region: 1) consultants for biological farming (two employees) and 2) 2 persons for the control and inspection of biological farmers.

Staff of Biological Farmers Control and Inspection Service must assist farmers in making biological farming plans and must consult them.

Biological Farming Control and Inspection Service officers on the basis of tests and control must submit recommendations to the State Committee on biological farms certification to certify biological farmers and award them with corresponding certificates.

It is necessary to conduct the testing of biological farming and bioproducts at the Birzai agrochemistry laboratory. To extend and strengthen the material basis of the laboratory.

With the mediation of Consult and Inspection Service, the Certification Committee must issue a certificate on quality of production. Bearing certificate, it will be possible to sell out production, as it will be more valuable as bio-production.

The State Biological Farms' Certification Committee terminates certificates for those farmers, who do not observe regulations on biological farming. In that case the Committee recommends to cut subsidies and privileges for those farmers.

**Formulation of economic pre-conditions for organic farming**

In 1991, before the land reform, there were 14 agricultural enterprises farming on 48,217 ha of land (26804 ha of agricultural land) in intensive karst zone. For one hectare of agricultural land they sold 331 kg of grain, 4 kg of potatoes, 430 kg of sugar beets, 18 kg of flax, 2 kg of flax seed, 105 kg of fruit, 18 kg of vegetables, 543 kg of milk, 107 kg of cattle meat and 73 kg of pork. For the sold production to one hectare they got 2,509 roubles income and the profit was 1,048. The profit margin made up 71.7%.

In the process of agrarian reform private farms and partnerships make their way. Government has to create incentives to practice organic farming by providing guaranteed income from agricultural

activities in the zone, which has to be not lower than the average for the country, and production profit margin must be not lower than in the enterprises outside of Karst region.

During transitional period Government will seek to increase the profit margin of biologically pure production up to at least a minimal level.

### **Establishment of market for ecologically sound production**

#### **Proposals:**

1. Government will encourage establishment of ecologically sound agricultural production processing enterprises in Karst zone.
2. Government will support the establishment of retail and wholesale trade network, selling ecologically pure products in Karst zone and other regions.
3. It will invest state capital into commercial stock companies, being established for the purpose of purchasing, processing, storing and selling biological production, by economic entities in the karst land of the Birzai and Pasvalys regions. Regional budgets will be the share holders of the capital invested by state.
4. Government will grant the ecologically sound producers the priority right to purchase or rent state land or capital in state's disposition, as well as to participate in conduction of state programs.  
After all of above measures are implemented, the republican market for agricultural production will be created, capable to compete with producers of ordinary agricultural production.

### **Monitoring of environment in intensive Karst zone**

To establish monitoring system in the Lithuanian Karst region, reflecting the situation of all ecosystems in that territory, the quality of water and production from that agro-eco-system. The results of constant investigations will be used to improve the state of environment and to protect human health.

**ATMOSPHERE.** To assess the air pollution of the Karst region and to define which part of pollutants is contributed by the Birzai and Pasvalys cities and transportation, and which part is being accumulated in soil and water.

To recommend the Environmental protection Department in Birzai to set up the air pollution observation station.

**LITHOSPHERE.** To implement litho-monitoring in Karst zone, because regarding to constantly changing ecologic situation of that region it is necessary to watch the variety of landscape, relief, its gypsum layer changes, connection between sinkholes and surface water runoffs.

To observe the soil pollution level, to evaluate the state of its physical-chemical and biological characteristics, the accumulation of nitrates, nitrites, pesticides and heavy metals in soil, plants and livestock products.

To select and set up standard yards for soil testing.

**HYDROSPHERE.** To watch the contamination level, quality and dynamics of ground water, to extend current hydro-geological observations. To extend the network of surface water observation points, to test water in rivers, lakes from the standpoint of their quality and accumulation of pollutants in silt.

**BIOTIC.** To assess the ecological situation of soil regarding to the structural indexes of pedobiontes complexes, to the intensiveness of mineralization-humification processes of organic materials, quantities of pollutants, accumulated in plants and animals.

In water ecosystems to use hydro-biocenoses (phyto and zoo-plancton, benthos) and ichtiocenoses (fish) as bio-indicators.

**HEALTH OF POPULATION.** To include the following data into monitoring program: demographic indexes of the Birzai and Pasvalys regions: birth rate, death rate, professional diseases (in different age groups) related to low water quality.

**DATA BANK.** All accumulated information should be registered into standard protocol tables, corresponding standards of personal computers. To link the information from this monitoring system to the general monitoring data bank of the republic (Data system FOXPRO).

**EXECUTORS AND FINANCIAL RESOURCES OF MONITORING.** In 1993 to prepare detailed program and methodology for monitoring.

To authorize the Karst region Fund to coordinate the monitoring work in the Karst region.

Monitoring should be conducted from financial resources of Karst fund and of other interested institutions.

### **Ecological education**

It is necessary to promote the implementation and expansion of biological agriculture by means of ecological education of society. This work should be organized in several directions: for current and future specialists of agriculture, farmers, consumers of bio-production.

To carry out the following ecological education measures in the intensive Karst region:

1. To use TV, Radio and Press.
2. To educate farmers and specialists on biological farming at the Joniskelis agricultural school.
3. To supply the regional libraries with special literature, related to biological farming.
4. To authorize the Karst region Fund to issue posters, drawing population's attention to karst problems.
5. To send the Lithuanian specialists on biological farming and farmers to study in biological farms abroad.

In the Lithuanian Agricultural Academy to establish education center for biological farmers' training, to organize 10-15 days short training course for specialists.

The Karst region Fund must render methodological support for biological farms.

Based on financial resources of the Ministry of Agriculture and Karst region Fund to issue a series of publication on biological farming: on composting, crop rotation, biological plant protection , measures of agro-technic, etc.

To publish the Targeted Program on Ground Water protection and Sustainable Agriculture Development in Karst zone as a separate issue.

#### **Estimate of needed investment to reduce pollution from cities and settlements**

Waste waters of the Birzai and Pasvalys cities and of settlements are the main ground water polluters in the intensive karst zone. As ground water is the property of state, it is going to support the implementation of waste water treatment systems, that is projected in the program. General need for investments for ground water pollution reduction from cities and settlements in karst zone and protection region around it is given in Annexes 11.1 - 11.3 (estimate is given in prices of the year 1992).

#### **Estimate of investment needed to restrict rural point-source pollution**

Production activities of Karst region economic entities is related to utilization of hazardous chemicals, oil products, mineral and organic fertilizers. After they get into surface waters, they strengthen karst processes and pollute ground waters.

The general need of investments for restricting rural point-source pollution, coming from agricultural production, and for sustainable agriculture development implementation in Karst region and its protection zone is given in Annexes 12.1 - 12.4 (estimate is given in prices of the year 1992).

**Investment sources and mechanisms of ground water protection measure from pollution in the intensive Karst zone in conditions of market economy.**

In conditions of market economy state should not be the only supporter of ecological reform. But the amount of financial resources for implementing measures for ground water protection and sustainable agriculture development in karst zone is too high for the regional economic entities themselves, because even maintaining profit margin of 1991, they would have to give away their 10 year profit. Therefore government will seek that these measures should be financed by all users of resources and consumers of ecologically sound production of Karst region. A special institution is needed to organize accumulation of financial resources and their targeted utilization. Government will create all necessary legal and economic preconditions for the establishment of Karst Fund.

The main function of the Karst region Fund will be to finance the implementation of measures, projected in this program. Fund will conclude agreements with economic entities on project works preparation, construction and reconstruction of equipment for ground water protection, on implementation of ecologically sound production.

Fund will be able to support enterprises on the border of bankrupt, that would accept to start ecologically sound production, they will support export of that production. Fund will be a guarantee for the economic entities of Karst region and its protection zone, in applying for bank credits on environmental measures' implementation and reorganization into biological farming. Fund will invest its capital as a share-holder, based on contracts. Its investments will come back as dividends. These subsidies for economic entities will be free of interest. If economic entities use Fund's subsidy uneffectively, they will have to give it back without arguments. Therefore Fund will have a right to control economic-commercial activities of its members. Fund will assist its members in preparing business plans, will provide consultations. Fund can expand its activities outside of Karst region, if economic entities, located over there, will be affiliated to its members (share-holders).

**The financial resources of Karst region Fund:**

1. the affiliation fee of Fund's members and annual payments;
2. subsidies from state and local municipality budgets;
3. a part of subsidy, granted by foreign countries, different companies and persons for the improvement of Lithuanian ecological situation, as well as direct subsidies for that Fund;
4. Lithuanian residents' donations for implementation of biological farming;
5. other (after Government adopts the necessary regulative documents - taxes for pollution licences in Karst region and its protection zone; deductions from taxes for water, utilized in Karst region and its protection zone; deductions from profit, made by entities, using tourism and other

recreation resources; deductions from profit making enterprises, processing and selling ecologically sound production).

Fund's financial resources will be used strictly according regulations, defined by its statutes. Fund will be granted the status of legal person. Karst region economic entities, enterprises, processing and selling ecologically sound agricultural production, water supply, recreation and other organizations could be affiliated to members and founders of the Karst zone Fund. Participation in Fund's activities will have to be voluntary, based on mutual benefit. Its initial capital will be based on stocks. Fund will register its local headquarters. Fund's expenses will be covered exceptionally only from membership fees.

According to program the environmental protection measures and transition to biological farming system will be carried out in three stages (up to the year 2000). If there is a shortage of financial resources due to economic crisis in Lithuania, the time period will be extended over the year 2000.

### **Summary**

Program covers measures to protect ground water from point-source pollution and non-point pollution in intensive karst zone. It analyses land use changes and its development preconditions and possibilities in transition to private farming. In the 1-st land category it is advised to practice sustainable plant protection and ecologically pure agricultural production. In the 2-nd land category it is advised to practice biological farming or to transfer agricultural land into meadows, fertilized by compost, or planting them with forest. It gives models for biological farming, indicates possible crop rotations, development of crop structure, selection of plant and animal breeds.

Measures of agro-technic, fertilization, biological pest control development in biological agriculture are addressed.

Program discusses fertilization problems in biological farming and raw materials for composting.

Control system of biological farming and ecologically sound production is projected in program.

A scheme of monitoring and ecological education system in intensive karst zone is given by program.

Program offers a market model for ecologically pure production, it gives economic preconditions for the development of ecologically sound agriculture, the need of investments for the implementation

of environmental protection measures and biological farming, it foresees the financing sources and mechanisms, corresponding to market requirements.

### The need for investments to restrict point source pollution from production activities in intensive karst zone

In thousand Litass (Prices for the year 1992)

Measures	Need of investments	Birzai region	Pasvalys region	Responsible for implementation
1	2	3	4	5
1. Competition held for different environmental protection projects design for production units	1.5	-	-	Karst region fund
2. Design of project documentation for environmental protection measures	7052.5	4095.0	2957.5	Karst region fund
3. To terminate ecologically hazardous production in 17 production units to transfer production to non-hazardous.	207.0	159.0	48.0	Birzai and Pasvalys regional municipalities
4. Scientific research work on Birzai treated waste waters complete cleaning and on combined waste processing	15.0	-	-	Karst region fund
<b>TOTAL</b>	<b>7276.0</b>	<b>4254.0</b>	<b>3005.5</b>	

**The need for investments to restriction source pollution from production activities in intensive karst zone**

In thousand Litas (Prices for the year 1992)

<b>Measures</b>	<b>Need of investments</b>	<b>Birzai region</b>	<b>Pasvalys region</b>	<b>Responsible for implementation</b>
1	2	3	4	5
<b>I. Land use development</b>				
1. Design of experimental projects for karst lands and economic landuse (2-4 units)	3.0	-	-	Karst region fund
2. Investigations on plants' selection for biological farming	10.0	-	-	Karst region fund
3. Crop rotation selection and their productivity research for biological farming	20.0	-	-	Karst region fund
4. Establishment of non-chemical weed control for biological farming	2.5	-	-	Karst region fund
5. Specification of karst zone land categories	10.0	7.0	3.0	Karst region fund
<b>II. Development of agro-technic</b>				
6. To conduct soil agro-chemical research of karst region farmers and partnerships	3.0	-	-	Karst region fund
7. Compensation for economic entities for transition to biological farming	4850.0	3200.0	1650.0	Karst region fund
8. To test the soil and water, coming out of former Naradava orchard, for pesticides and heavy metals	1.5	-	-	Karst region fund
9. Design of methodology for biocompost production	0.5	-	-	Karst region fund

## Monitoring of environment and ecological education

10. Cartography program for  
Birzai and Pasvalys cities and  
their influence zones:to test Birzai city soil and  
water for pollution with  
pesticides, heavy metals and  
other elements

40.0

-

Birzai and

the same for Pasvalys

20.0

-

-

Pasvalys regional  
municipali-ties

-

Geology  
institute ARTVA11. Establishment of operative  
control system for testing the  
situation in watershed

20.0

-

-

Karst region  
fund12. Design of local monitoring  
program methodology for  
ecologic region of the  
Lithuanian karst territory,  
installation of stationary  
observation yards

50.0

-

-

Karst region  
fund13. Establishment of control  
system for biological farming

10.0

-

-

Karst region  
fund14. Ecological education and  
training

80.0

-

-

Karst region  
fund

TOTAL

5120.5

3207.0

1653.0

## REFERENCES

- Budvytiene, V., S. Budvytis and N. Kazlauskienė. 1995. Environmental Policy: Institutional and Legal Framework of Environmental Protection in Agriculture—The Lithuanian Case. In K.H. Pederson, ed. *The Institutional and Legal Framework for Environmental Policy in the Agricultural Sector*. Report No. 1: *Incentives and Obstacles to the Implementation of More Sustainable Methods in Agriculture in Estonia, Latvia and Lithuania*. EU Socio-Economic Environmental Research No. CIPDCT930030.
- Carlson, G. 1993. *Agricultural Runoff Management Study in Lithuania*. Final Report.
- Foster, W., V. Budvytiene, A.S. Sileika and A. Gutkauskas. 1995. *The Karst Zone, Agriculture and the Karst Area Management Plan*. Center for Agricultural and Rural Development, Iowa State University, Ames, IA.
- Gutkauskas, A. 1992. *Targeted Program on Ground Water Protection against Pollution and Sustainable Agriculture Development in Intensive Karst Zone in Lithuania*. Ministry of Agriculture. Vilnius.
- Johnson, S R., A. Bouzaher, W.E. Foster, and S.C. Gordon, 1993. Joint United States Agricultural Run-Off Program: Poland Agriculture and Water Quality Protection Project. Project Report, USEPA.
- Sapek, A. 1994. Oddziaływanie na środowisko gospodarstw specjalizujących się w produkcji mleka.
- Sileika, A.S. 1995. Agricultural and Environmental Issues in Lithuania. Unpublished manuscript.
- A.Tamosaitiene, A., S. Seselgiene and A.Gutkauskas. 1995. On Ecologically Pure Production Market Research. "Zemes Ukis." June 1995.
- Vaikutis, V., 1993. Lithuanian Agriculture. Lithuanian Ministry of Agriculture. Vilnius.
- Vytautas, S. and A. Ladyga. 1995. *Agriculture in Lithuania*. Valstybinis Leidybos Centras. Vilnius.

BALTIC BASIN Research Paper Series

No. of  
copies

- \_\_\_\_\_ 96-BB 1 The Lithuanian Karst Zone Management Plan: A Case Study in the Management of Agro-environmental Issues in Lithuania. April 1996.
- \_\_\_\_\_ 96-BB 2 An Adaptation of the Agricultural Nonpoint Source Pollution Model to Lithuania. April 1996.
- \_\_\_\_\_ 96-BB 3 Land Management Alternatives for the Nemunas River Polder Region. April 1996.
- \_\_\_\_\_ 96-BB 4 The Effect of Agriculture Nitrogen on Water Quality in Lithuanian Rivers. April 1996.
- \_\_\_\_\_ 96-BB 5 Water Quality Protection in Polish Agriculture. April 1996.

**Pricing Policy for Baltic Basin Publications.** The charge for the BALTIC BASIN PAPER SERIES is \$5.00 per paper. Exempted parties include U.S. university researchers, U.S. university libraries, Iowa and U.S. legislators, members of CARD funding agencies, and members of CARD affiliate organizations.

**Prepayment is required for all orders** where exemptions do not apply. Foreign orders must be accompanied by a check in American dollars or an International Money Order. Make check payable to **Iowa State University**. Reports are shipped book rate/surface mail. If air mail is required, please add an additional \$5.00 for each three reports ordered. Discounts of 25 percent are given on orders for 30 or more of a single title.

**Publications may be ordered from:** Betty Hempe, Office Coordinator, Center for Agricultural and Rural Development, Iowa State University, 578 Heady Hall, Ames, Iowa 50011-1070. Phone: 515/294-7519, fax: 515/294-6336, card@card.iastate.edu. World Wide Web Site: <http://www.ag.iastat.edu/card>.

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

COMPANY/ORGANIZATION \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

COUNTRY \_\_\_\_\_

\_\_\_\_\_ No. of pubs X \$5.00 = \$ \_\_\_\_\_

-84-