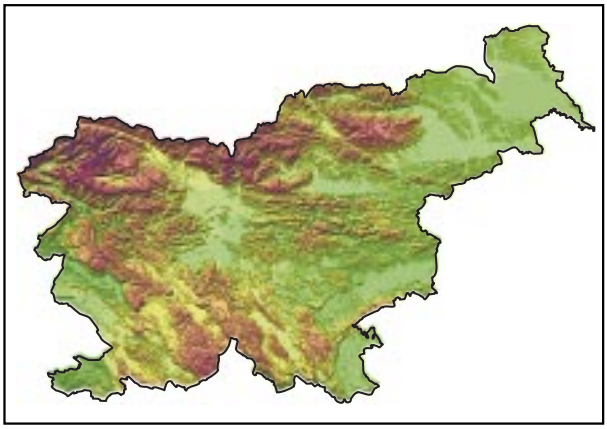
ENVIRONMENTAL PROTECTION ASPECTS OF AGRICULTURE IN LANDSCAPE REGIONS OF SLOVENIA

OKOLJEVARSTVENI VIDIKI KMETIJSTVA SLOVENSKIH POKRAJIN

Irena Rejec Brancelj

Main business of Slovene stockbreeding is cattle breeding and mountain pasturing is still present in Alpine areas (photography Anton Brecelj).
Glavna veja slovenske živinoreje je govedoreja in planinska paša je še vedno prisotna v alpskem svetu (fotografija Anton Brancelj).



Abstract

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Environmental Protection Aspects of Agriculture in Landscape Regions of Slovenia

KEY WORDS: landscape environment, agricultural pollution, use of fertilizers, nitrates inputs, use of plant protection agents, Slovenia

In the paper, several environmental influences of agriculture in 19 selected Slovene landscape regions are described. The investigation focuses primarily on dispersed sources of agricultural pollution, i. e., farms. Based on results of field polls made at over 1000 farms, data was collected and examined on the characteristics of fertilizing agricultural land, the use of plant protection agents, and inputs of nitrogen, one of the most important pollutants of soil and especially of water in agricultural regions. In the central part of the paper, the basic characteristics of these influences, the extent and level of pollution, and the regional differences within Slovenia are described.

Izvleček

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Okoljevarstveni vidiki kmetijstva slovenskih pokrajin

KLJUČNE BESEDE: pokrajinsko okolje, kmetijsko onesnaževanje, poraba gnojil, dušični vnosi, poraba sredstev za varstvo rastlin

V prispevku so prikazani nekateri okoljevarstveni vplivi kmetijstva v 19-tih izbranih slovenskih pokrajinah. V ospredju preučevanja so razpršeni viri kmetijskega obremenjevanja – kmetije. Na osnovi terenskega anketiranja preko 1000 kmetij so zbrani in obdelani podatki o značilnostih gnojenja kmetijskih zemljišč, uporabi sredstev za varstvo rastlin in o vnosih dušika, kot enega od najpomembnejših onesnaževalcev prsti in zlasti voda na kmetijskih območjih. V osrednjem delu prispevka so prikazane osnovne značilnosti teh vplivov, obseg in stopnja obremenjevanja in regionalne razlike znotraj Slovenije.

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Address – Naslov:
Irena Rejec Brancelj, M. sc.
Inštitut za geografijo
Trg francoske revolucije 7
1000 Ljubljana
Slovenia
Phone – telefon: +386 (0)61 200 27 11
Fax – faks: +386 (0)61 200 27 34
E-mail – el. pošta: Irena.Rejec.Brancelj@Uni-Lj.si

Contents – Vsebina

1. Introduction

Previous research shows that the influence of agriculture on landscape pollution can no longer be ignored in Slovenia. In addition to pollution from single-point sources, where until now livestock farms and fish farms in particular have been in the forefront, more attention has recently been devoted to pollution originating from dispersed sources. This is all the more important since one of the basic characteristics of Slovene agriculture is an above-average fragmentation of property and farmland. Modern agriculture, which in regard to cultivation has assumed the characteristics of industrial production, has spread its technology and philosophy onto farms. By using agrochemical agents, today's farms can heavily influence the landscape structure and cause effects beyond their borders; and the effects of such production manifest themselves in the pollution of soil and waters.

A consequence of Slovenia's landscape diversity is its diversity of agricultural activity. In the past, this activity has had a primarily self-supplying character and was adapted in great measure to local circumstances (fruit growing in the hilly regions and livestock breeding in the mountainous regions). On farms, processes ensuring the renewal of provisions were in balance with the use of energy and material. Because of modern needs, however, agriculture has been redeployed, e. g., in some places livestock breeding has moved onto flatlands. This caused changes in the structure of farms (in the seeding structure of land, the flow and balance of substances, energy characteristics, etc.). In the past, the amount of manure available on a farm was an important limiting factor on the farm's production. If it was not possible to secure a larger amount of nutrients, production could not be intensified. However, with the advent of mineral fertilizers, the balance of these relationships collapsed. Due to the overburdening of cultivated areas with livestock (excessive livestock density), the manure balance on farms is upset and there is too much manure, which can become an environmental problem.

The fundamental landscape diversity in Slovenia is the result of its varied rock structure and relief. By considering pedological features and human influences in the landscape, we have included the factors that are most important in evaluating the influences of agriculture. The landscape diversity of agricultural regions requires research by individual types. The main landscape types are karst, flatland, hilly regions, mountainous regions, and high mountains. Each has certain common traits that are significant from the point of view of their environmental sensitivity. In this study, we will present the agricultural activity typical of each individual type and its environmental characteristics. Since from the environmental standpoint the fertilizing of cultivated areas and the use of plant protection agents are the most polluting processes, we will devote most attention to these factors.

2. Methods of work

For studying agricultural pollution in Slovene landscapes, the sampling regions were chosen according to the following criteria:

a) every type of landscape unit in Slovenia should be represented,
b) their economic characteristics should be considered,
c) various agricultural systems should be represented,
d) various settlement types should be represented, and
e) the settlements chosen in each region should vary from the socioeconomic standpoint.

In the process of choosing the sampling areas according to the criteria above, typologies created by Slovene geographers and already established in the literature were used (Gams, Orožen, Kladnik 1995; Vrišer 1994; Drozg 1995; and Ravbar 1995). On this basis, 19 regions were chosen for study (see Figure 1).

The settlements polled were chosen from every socioeconomic settlement type, and their numbers reflect the occurrence of individual settlement types in the studied region. We chose settlements with 100 to

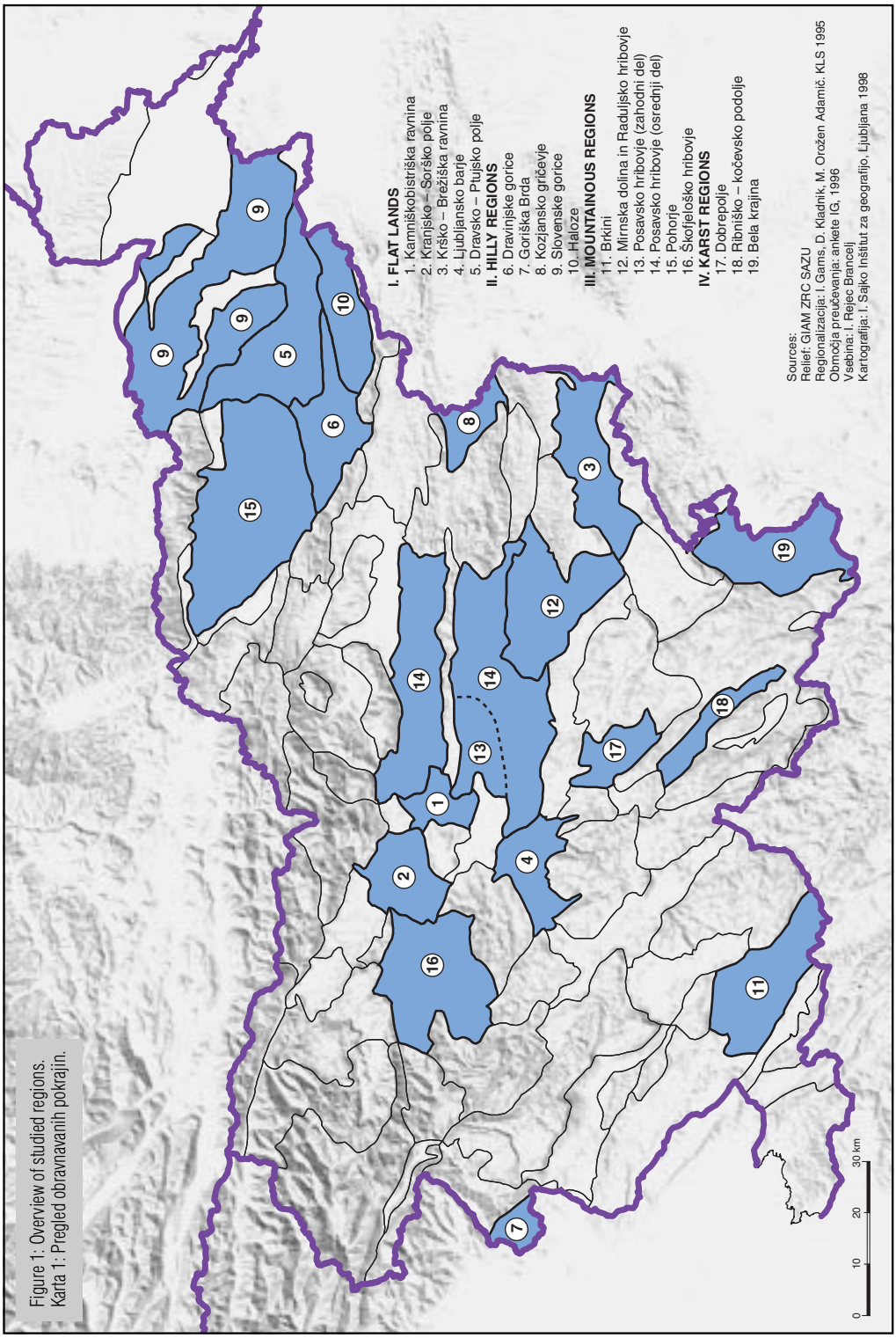


Figure 1: Overview of studied regions.
Karta 1: Pregled obravnavanih pokrajin.

200 inhabitants, as they are predominant in the Slovene structure (Perko 1991). In each region, ten socioeconomically different settlements were chosen where the fieldwork was carried out, and in each settlement, five polls were taken at random. Because additional control polls were done in four regions (Dravsko-Ptujsko polje, Slovenske Gorice, Kranjsko-Sorško polje, and Škofjeloško hribovje), the number of settlements analyzed and polls in these regions is greater. Altogether, 210 settlements were polled and 1006 polls carried out.

Through direct polling of farmers, we tried to establish regional characteristics pertaining to the socioeconomic structure of farms, the land structure, the orientation of individual farms, the marketing of production, the use of farm machinery, the methods of cultivating agricultural land, the quantities and types of mineral fertilizers and plant protection agents employed and their spread of use, the fertilizing routines of farmers, the methods of measuring out the agrochemical agents used, personal protective clothing for using them, observations of the influence these agents have on the environment, the number of livestock, the existence of stables and sewage systems, energy characteristics of farms (use of mineral fertilizers, plant protection agents, rich fodders, fuels, electric energy), and crops.

3. Basic characteristics of regions studied

From flatland agricultural landscapes, the following were included in the study: three regions in central Slovenia (Kamniškobistriška ravnina, Kranjsko-Sorško polje, and Ljubljansko barje), one in southeastern Slovenia (Krško-Brežiška ravnina), and one in northeastern Slovenia (Dravsko-Ptujsko polje). Their rock structure is composed primarily of gravel deposits (Kamniškobistriška ravnina and Kranjsko-Sorško polje contain as much as 78% carbonate gravel, Krško-Brežiška ravnina 36%, and Dravsko-Ptujsko polje 76% silicate gravel) and clay and silt (Krško-Brežiška ravnina 47%, Dravsko-Ptujsko polje 24%, Kamniškobistriška ravnina and Kranjsko-Sorško polje each 3% clay and silt) (Preglednice … 1995). The Ljubljansko barje moor is an exception with 69% clay and silt, 16% carbonate gravel, and 10% siliceous sandstone and conglomerate. Gravel areas are drier and there are more fields on them, while clayey areas are wetter and extensive drainage projects have been carried out on many. Certain other hydrographic characteristics are also common to them, including a location beside a larger river and irrigation possibilities, as well as areas with groundwater. There are also similarities in land use, types of settlements, etc.

Five agricultural landscapes in hilly regions were included in the study: one in western Slovenia (Goriška Brda), one in eastern Slovenia (Kozjansko gričevje), and three in the northeastern part of Slovenia (Dravinjske gorice, Slovenske Gorice, and Haloze). In the studied regions, the surface lies for the most part below 400 m above sea level, and the altitude belt of 200–299 m encompasses their greater part (Dravinjske gorice 51%, Slovenske Gorice 74%, Haloze 47%, and Kozjansko gričevje 38%); the exception is Goriška Brda with 40% of its surface at altitudes of 100–199 m above sea level. The bedrock is mainly tertiary sediments (in Goriška Brda there is 66% flysch, and elsewhere the most widespread stone is marl: 70% in Haloze, 43% in Slovenske Gorice, 37% in Kozjansko gričevje, and 17% in Dravinjske gorice) along with clay and silt (64% in Dravinjske gorice, 33% in Slovenske Gorice, 21% in Kozjansko gričevje, 18% in Haloze, and 12% in Goriška Brda). Kozjansko gričevje differs from others in that it is more karstified: limestone comprises 20% of it, and dolomite 15%. Surface waters dominate and there are numerous small springs, but there are no larger consolidated areas with groundwaters. Due to their location and openness, the studied regions are reached by the influences of the warmer neighbouring submediterranean and Pannonian climates. They have much in common relative to land use, since vineyards and orchards cover a significant proportion of these regions.

We included five mountainous regions in our study: Brkini, Mirnska dolina–Raduljsko hribovje, Posavsko hribovje, the Pohorje mountain range, and Škofjeloško hribovje. They exhibit great diversity relative to rock structure and climate. In the Brkini region (including the Reka River valley), flysch rock comprises three quarters of the surface. The proportion of flysch is also significant in the Mirnska dolina–Raduljsko hribovje region (30%), while limestone accounts for more than 15% of the surface in both regions. Dolomite accounts for more than a half (55%) of the bedrock in the Mirnska dolina–Raduljsko hribovje region.

Figure 2. Vineyards are most intensively spread in hilly areas and there it is typical big use of mineral fertilizers and other chemical plant protection substances. Picture is from Tomaj – Karst area (photography Anton Brancelj).
Slika 2: Vinogradi so najbolj razširjeni v gričevnatih pokrajinah in zanje je značilna velika poraba mineralnih gnojil in sredstev za varstvo rastlin, primer je iz Tomaja (fotografija Anton Brancelj).

Figure 3. Poppy on a wheat field is because of widely spread use of herbicides rare (photography Anton Brancelj).
Slika 3: Mak na pšeničnem polju je zaradi razširjene uporabe herbicidov redek gost (fotografija Anton Brancelj).

The Pohorje range is comprised of 61% metamorphic rock, 12% plutonic rock, and 11% carbonate gravel, rubble, till, conglomerate, breccia, and tillite. The structure of the Posavsko hribovje and Škofjeloško hribovje regions is more diverse. In the Posavsko hribovje region, there is 35% dolomite, 22% siliceous sandstone and conglomerate, 10% claystone, 10% siltstone and 10% limestone. In the Škofjeloško hribovje region the proportions are 28% claystone and siltstone, 26% dolomite, 16% siliceous sandstone and conglomerate, and 15% limestone.

The study also focused on three karst regions in southeastern Slovenia: Bela krajina, Dobrepolje, and Ribniško-Kočevsko podolje (the Ribnica–Kočevje valley system). The rock structure of all three is similar: the prevailing rock is limestone (Bela krajina 66.6%, Dobrepolje 70.9%, and Ribniško-Kočevsko podolje 48%), almost one fifth of the surface is composed of dolomite (Bela krajina 9.6%, Dobrepolje 20.4%, and Ribniško-Kočevsko podolje 16.4%), and the third greatest surface proportion is composed of clay and silt (Bela krajina 19.9%, Dobrepolje 8.3%, and Ribniško-Kočevsko podolje 32.4%). They also have the dominant Dinaric orientation running northwest-southeast and certain hydrographic characteristics in common. Vertical bifurcation is characteristic of the Ribniško-Kočevsko podolje region, which lies between the other two regions. Part of its waters flow underground to neighbouring Dobrepolje and the springs of the Krka River, while the other part flows to Bela krajina and the springs of the Kolpa River. Because of the permeability of the karst world and the water-supply importance of some springs, it is particularly important to know what is happening in their hinterland.

4. Characteristics of agricultural land use

The basic characteristic of agricultural pollution is its broad impact and as a consequence of the land fragmentation typical of Slovenia also its dispersion. Radinja (1997) established that the extent of agricultural pollution can be equated with the surface area of agricultural land, and particularly of cultivated land. Slovenia ranks among the European countries with the smallest proportions of agricultural (43%) and cultivated land (32%). From the environmental protection perspective, this can be seen as an advantage, since more than half of Slovenia's surface (54%) is covered by forest. In recent decades, the forest areas have been increasing in size, which in the European context is a rather exceptional process. This is a consequence of the typical dispersion of settlement in Slovenia and the method of exploiting the land – stripping the forest cover. (Slovensko kmetijstvo ... 1997). From the environmental protection point of view, the overgrowing of former agricultural areas can be considered a positive process since the direct runoff of precipitation water decreases, flood danger decreases, and influences originating from neighbouring cultivated land are relieved (the forest gives shelter to animals), etc. In the last ten years, the surface area of agricultural land in Slovenia has decreased by almost 10%, primarily due to forest overgrowth and urbanization, while in European Union countries it has decreased by 4% (ibid.).

The most intensive agricultural production occurs in fields, vineyards, and orchards, so these areas are most subject to agricultural pollution. In European Union countries, cultivated fields account for almost 55% of all agricultural land but for less than one third – 30% – in Slovenia (ibid.). The fields are therefore limited to small areas, and their proportion is smaller in Slovenia than in any country of the European Union except Ireland. There are 0.12 hectares of field per inhabitant in Slovenia, the critical limit for ensuring food self-sufficiency (Gabrovec, Kladnik 1996). Almost two thirds of the agricultural land is occupied by meadows and pastures, which represent an environmentally more favourable land use since they do not demand so much energy and material input to maintain. In European Union countries, meadowland accounts for only one third of all agricultural land.

The most favourable areas for the intensive cultivation of crops in Slovenia are the flatlands and the hilly regions of the Pannonian plain and other smaller consolidated areas at the bottom of basins and plains. More than a quarter of the agricultural land (28%) lies in the flatlands, while some 72% of the agricultural land occurs in regions with poor natural conditions: hilly and mountainous regions (28%), high-mountain regions (21%), karst regions (13%), and other regions (10%) (Erjavec et al. 1994). Among

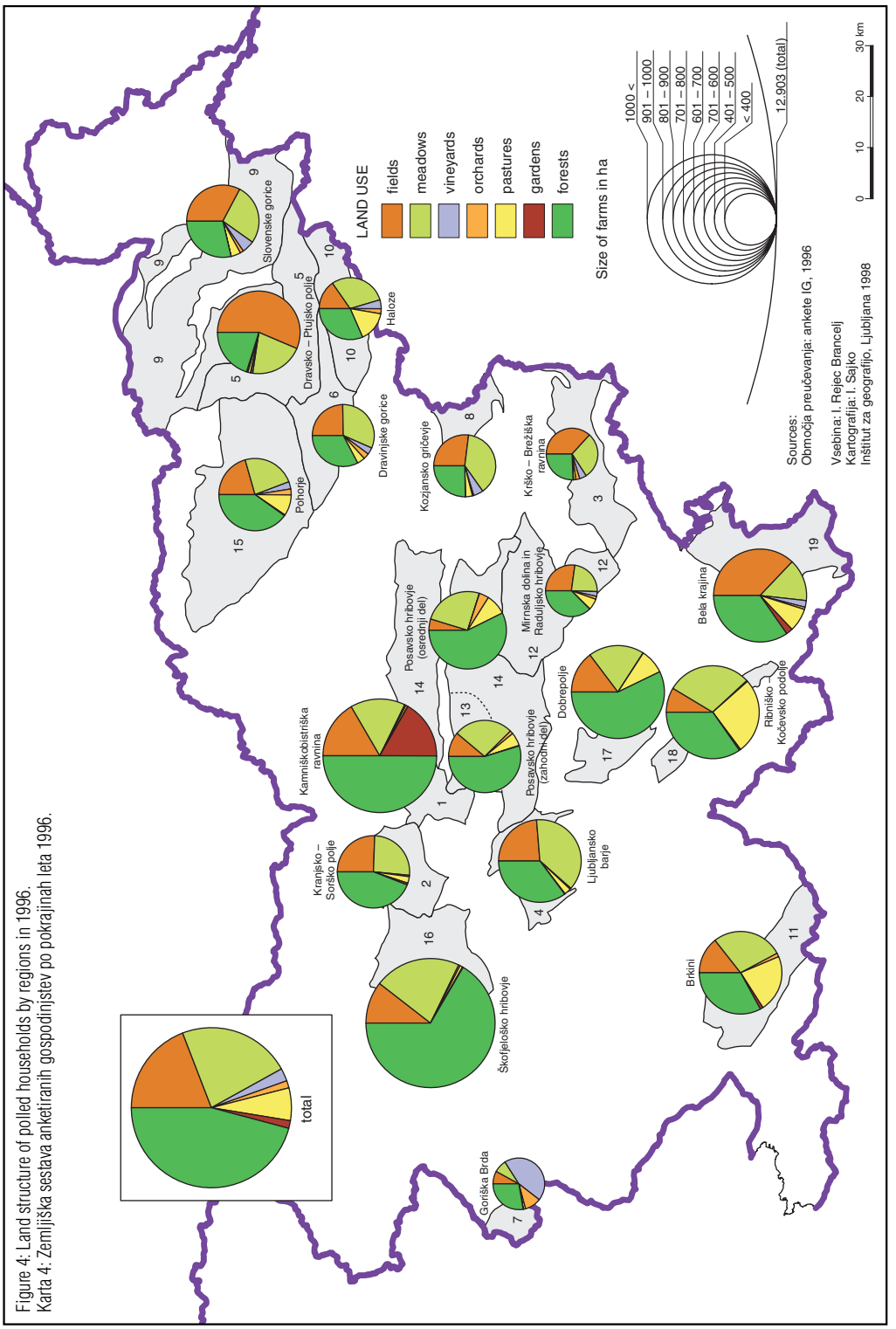


Figure 4: Land structure of polled households by regions in 1996.
Karta 4: Zemljiška sestava anketiranih gospodinjstev po pokrajinah leta 1996.

the land categories in the flatlands, fields account for 40% of all land, and forests 20%. The reverse is true in mountainous and karst regions where fields account for about 8% and forest for almost 60% (Gabrovec, Kladnik 1996). Agricultural pollution is greatest in the flatlands and at the bottom of basins; however, these regions comprise only about one tenth of Slovene territory (Perko 1991), while cultivated fields covered 11.6% of the entire surface in 1995 (Statistični letopis 1996). Nevertheless, it is evident at certain places in the flatlands that the pollution has already achieved local dimensions (the pollution of the water source in Skorba) and even regional dimensions, for example, the pollution of the groundwater in Dravsko-Ptujsko polje and Pomurje.

Figure 4 shows the land structure of the regions and farms we studied. The proportion of cultivated surface is greatest in flatland regions (63%) and hilly regions (65%) where their proportion on average amounts to about two thirds. The largest proportion of cultivated land is on the farms of Dravsko-Ptujsko polje (79%) and Krško-Brežiška ravnina (73%), while in the hilly regions, this proportion is greatest in Goriška Brda (73%) and Kozjansko gričevje (71%). The proportion of cultivated land is smallest on the farms of the hilly regions: Kamniškobistriška ravnina (50%), Kranjsko-Sorško polje (53%), and Haloze (53%). As we can see, cultivated land-the land producing agricultural pollution-occupies more than half of all land in both flatland and hilly regions, and in the Pannonian world even more than three quarters. Field crops cover the greatest part of the cultivated land.

On the farms of the mountainous regions, the proportion of cultivated land is much smaller (43%); in certain exceptional cases due to favourable natural conditions, it reaches as much as half, for example, in Pohorje (52%) and Mirnska dolina–Raduljsko hribovje (55%). The situation is similar in the karst regions where cultivated land accounts for about one third of all land. The most outstanding among the karst regions is Bela krajina where this proportion amounts to 55%. Among the cultivated areas, the predominant land use categories are meadows and pastures.

As mentioned, agricultural pollution is heaviest in field, vineyard, and orchard areas. However, relative to the proportion of each of them in the land structure, fields are the most important. On flatland farms, fields account for 32% of all land categories, more than half of all cultivated land (in Dravsko-Ptujsko polje, 70% of the cultivated land; in Krško-Brežiška ravnina, 51%; and in other flatland regions, less than a half). The proportion of fields is relatively high as well in the hilly regions where it accounts on average for one third (in Slovenske Gorice for almost half – 47%). Among the polled farms in the mountainous and karst regions, fields accounted for one third and one half, respectively, of all cultivated land.

Among the landscape types studied, the proportion of meadows does not differ as much as the proportion of fields. On average, meadows occupy from one fifth to one quarter of all farm land, and in hilly regions their proportion is only slightly larger than elsewhere. The proportion of meadows is greatest on farms in the mountainous and karst regions where it accounts for one half to two thirds of all cultivated land. In the hilly regions, farms use one half of the land as meadows. Among the flatland regions, the most outstanding are the farms on the Ljubljansko barje moor where meadows account for 61% of all cultivated land. The high proportion of meadows is a consequence of the specific natural conditions in Slovenia where the predominant relief type is the mountainous regions, which covers 46% of all land, and where the proportion of hilly regions (34%) is also quite large (Perko 1991). The large proportion (63%) of grass-covered land, both pastures and meadows, which is typical of Slovene agriculture and is twice larger than the average for European Union countries (Erjavec et al. 1997), can be seen as an advantage from the environmental protection standpoint. As we shall see later, as regards both energy and materials used, these areas are substantially less polluted than cultivated field areas. The average yearly use of mineral fertilizers on the fields of the farms studied amounts to 450 kg/ha, while on meadows it is about half smaller, amounting to 237 kg/ha.

Land use is a basis for further environmental assessment of agriculture. However, analyses of land use at the polled farms, as well as comparisons with Slovenia as a whole and with European Union countries, did not show this to be the main reason for agricultural pollution. The proportion of fields in the land use structure is-with the exception of flatlands and hilly landscapes-small, and it is on fields that production

is most intensive. Also small is the proportion of permanent plantations that like fields require intensive production. On the other hand, two thirds of the agricultural land is occupied by meadow areas where fertilizing is necessary to achieve a suitable level of production. From the environmental protection point of view, the features of land use-with the exception of flatland and karst regions-can not be characterized as problematic.

5. Agriculture in the light of environmental pollution

The intensiveness of agriculture or agricultural production determines the effects on the landscape. Intensiveness is reflected in yield per hectare, which is the result of various activities and processes during production. In addition to using high quality seeds, what matters particularly is appropriately supplying the plants with nutrients and the protection of plants from pests and disease. Quality seeds are ensured by the state through legislation and are available to farmers. In the private sector, however, the appropriate supply of plants with nutrients and plant protection are left to individuals. The methods of handling these substances in the landscape depend on the expertise and awareness of these individuals. The science of agronomy and, particularly in local conditions, the agricultural counselling service have contributed much to improving the expertise and awareness of farmers.

We were interested in the extent and level of the use of nutrients (both organic and mineral) and plant protection agents as well as in the practices followed by farmers in using these agents.

5.1. Use of manure and liquid manure

In fertilizing cultivated surfaces, farmers usually combine the use of manure and mineral fertilizers, and 87% of all the farmers polled use this combination of fertilizers. The proportion of farmers fertilizing exclusively with mineral fertilizers is small, only 4%, and this fertilizing method is more frequently used in Goriška Brda, Krško-Brežiška ravnina, and Kozjansko gričevje. Manure is used exclusively by 9% of the farmers polled, and this fertilizing method is important especially in Posavsko hribovje, Ribniško-Kočevsko podolje, and Škofjeloško hribovje.

We have already mentioned that livestock breeding plays an important role in the orientation of farm production in Slovenia. There are almost no farms not breeding livestock, and they all must cope with the problem of managing manure and liquid manure. For the agricultural pollution of the environment, two things are especially important: how much manure and liquid manure is there relative to the amount of cultivated land on which they are spread and how they are used.

At the farms studied, we questioned farmers about the quantities of manure and liquid manure used. We also calculated the quantities of manure based on the number of livestock on the farms, and the quantities differed by a quarter. The farmers reported quantities of manure and liquid manure larger by one quarter than those implied by the number of livestock. This difference may be a result of the calculation method based on »livestock units« that does not consider the manure and the liquid manure specifically or an error on the part of the farmers. In order to provide a young crop with nutrients effectively, the farmers must know the quantity and the content of the nutrients in both natural and mineral fertilizers so they can decide how to use them appropriately.

The average annual use of manure and liquid manure on the farms studied amounts to 9 m^3 of manure and 6 m^3 of liquid manure per hectare of cultivated land (Fig. 5 and 6). The highest use of organic fertilizers occurs in the flatlands where average use amounts to 12 m^3 of manure and 11 m^3 of liquid manure per hectare. However, there are great differences in the use of manure between individual flatland regions, primarily due to the farming orientation in these regions. The greatest use was found in Kranjsko-Sorško polje (25 m^3/ha), while in Dravsko-Ptujsko polje, Krško-Brežiška ravnina, and Ljubljansko barje, use var-

ied between 7 m^3/ha and 10 m^3/ha. The use of manure was smallest in Kamniškobistriška ravnina, where it amounted to 6 m^3/ha.

In the karst regions, use is smaller by a quarter, amounting to 9 m^3/ha of manure and 8 m^3/ha of liquid manure. Due to a pronounced orientation toward livestock breeding, the greatest use occurs in Ribniško-Kočevsko podolje, where it amounts to 11 m^3/ha of manure and 12 m^3/ha of liquid manure. Due to the large number of livestock, the use of manure is also large in Dobrepolje (11 m^3/ha). In contrast, the use of manure and liquid manure in Bela krajina is smaller by half (4 m^3/ha and 7 m^3/ha, respectively).

In the hilly and mountainous regions, the use of manure and liquid manure is similar. Manure use amounts to 7 m^3/ha in the hilly regions and 8 m^3/ha in the mountainous regions, while liquid manure use is 3 m^3/ha in the mountainous regions and 5 m^3/ha in the hilly regions. Distinguished by a use twice as high as the average, Škofjeloško hribovje stands out among the mountainous regions, and Dravinjske gorice among the hilly regions. On the other hand, Goriška Brda uses 3 m^3/ha, only half as much as the average; this is the smallest manure use among all the studied regions. The reason lies in the farming orientation and in the small number of livestock. As evident from the graphs, the mountainous regions have the smallest use of liquid manure of all the regions, primarily a consequence of its landscape characteristics (the more difficult use of suitable farm machinery) and the livestock-breeding orientation adapted to it (more pastured livestock and a greater orientation toward meat production).

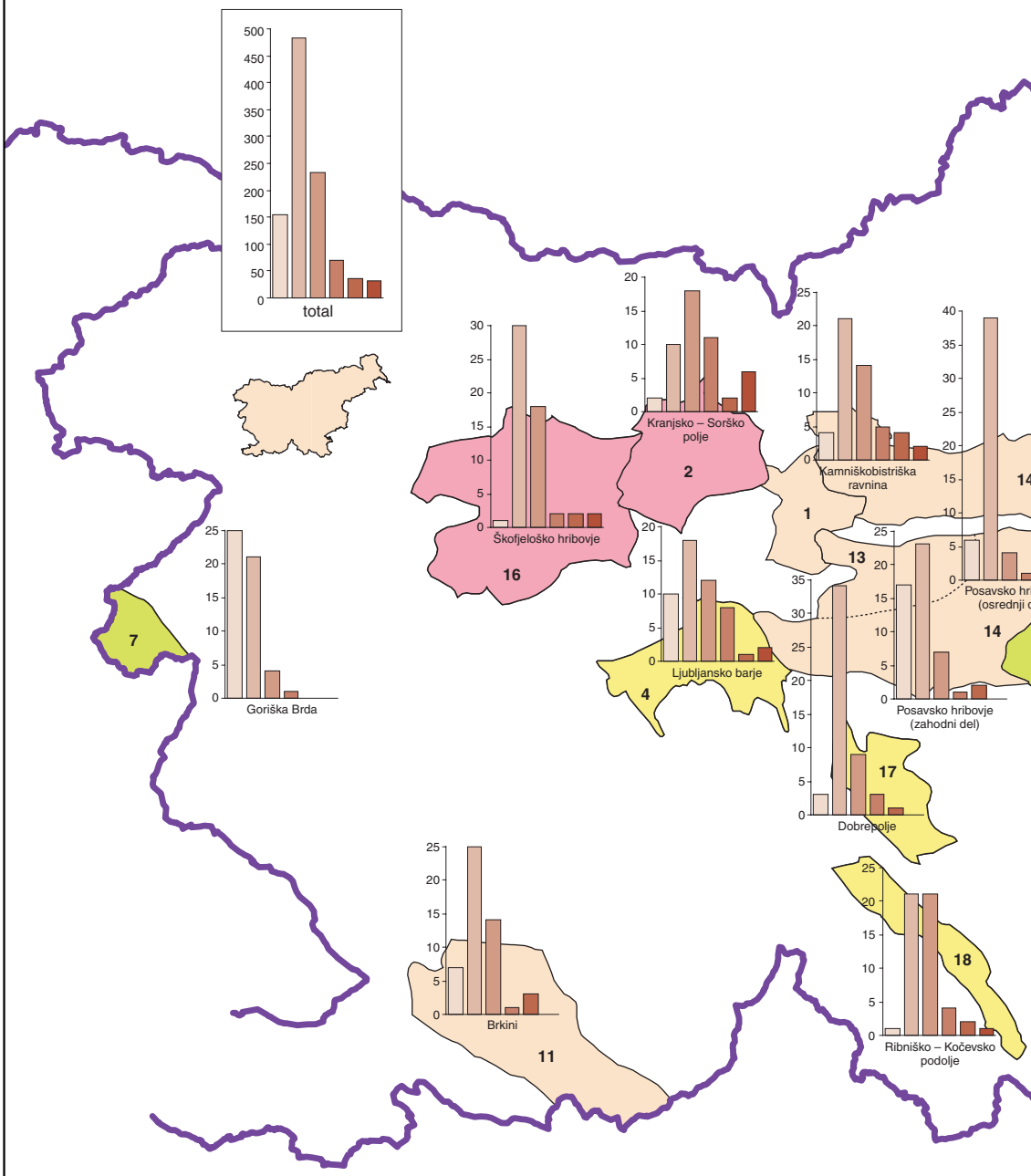
Sufficient quantities of manure and liquid manure reduce the need for mineral fertilizers. Because of the polycultural orientation (as well as the mixed-production orientation) of the majority of Slovene farms, the quantity of manure and liquid manure available played a positive environmental protection role. Exceptions are the intensively market-oriented farms and farms where the ratio between the number of livestock and the area cultivated is inappropriate. The quantity of manure alone should therefore not cause environmental protection problems, which are, as we shall see later, primarily the consequence of unsuitably arranged manure pits and the use of manure and liquid manure in water-protection zones. However, the farmers' inadequate knowledge of the dangers of nitrate pollution is a problem. In using nitrogenous fertilizers, it is necessary to consider the nutrients entering the soil with both organic and mineral fertilizers. It is therefore necessary to manage the nutrients appropriately, which requires knowledge of certain characteristics of these nutrients (leaching processes, accumulation), their appropriate use with individual cultures, and the physical geographic characteristics of individual landscapes (soil, water, etc.). The agricultural counselling service plays an important role here and has already organized individual seminars related to these problems.

5.2. Use of mineral fertilizers

As we have already mentioned, livestock breeding is an important characteristic of polyculturally-oriented Slovene farms, and we can therefore expect that mineral fertilizers mainly have the function of supplementary fertilizers. For the most part, mineral fertilizers represent a supplement in supplying plants with nutrients. As we have already mentioned, 79–94% of the farmers polled combine the use of organic and mineral fertilizers.

The average quantity of mineral fertilizers used on the farms studied amounted to 328 kg/ha of cultivated land. Farms in the flatlands and in the hilly regions lead according to quantities used (Fig. 7). The difference between them is small, as average use in the flatlands amounts to 439 kg/ha and in the hilly regions to 435 kg/ha of cultivated land. Production is intensive both in the flatlands (fodder plants) and in the hilly regions (special cultures), and in spite of the use of organic fertilizers, it is necessary to add larger quantities of mineral fertilizers. The differences within these regions are also significant. The smallest quantities of mineral fertilizers per hectare of cultivated land are used in Haloze (266 kg/ha), Krško-Brežiška ravnina (272 kg/ha), and Kamniškobistriška ravnina (296 kg). Among the largest users are the farms in Dravsko-Ptujsko polje (671 kg/ha), Goriška Brda (577 kg/ha), and Kranjsko-Sorško polje (575 kg/ha). In Goriška Brda, the high proportion of mineral fertilizers used could be attributed to the lack of organic

Figure 5: Use of stable manure in m^3/hectare on cultivated land on the farms studied and in landscape regions in 1996
Karta 5: Poraba hlevskega gnoja v m^3 na ha obdelovalnih zemljišč na anketiranih kmetijah in po pokrajinah leta 1996.



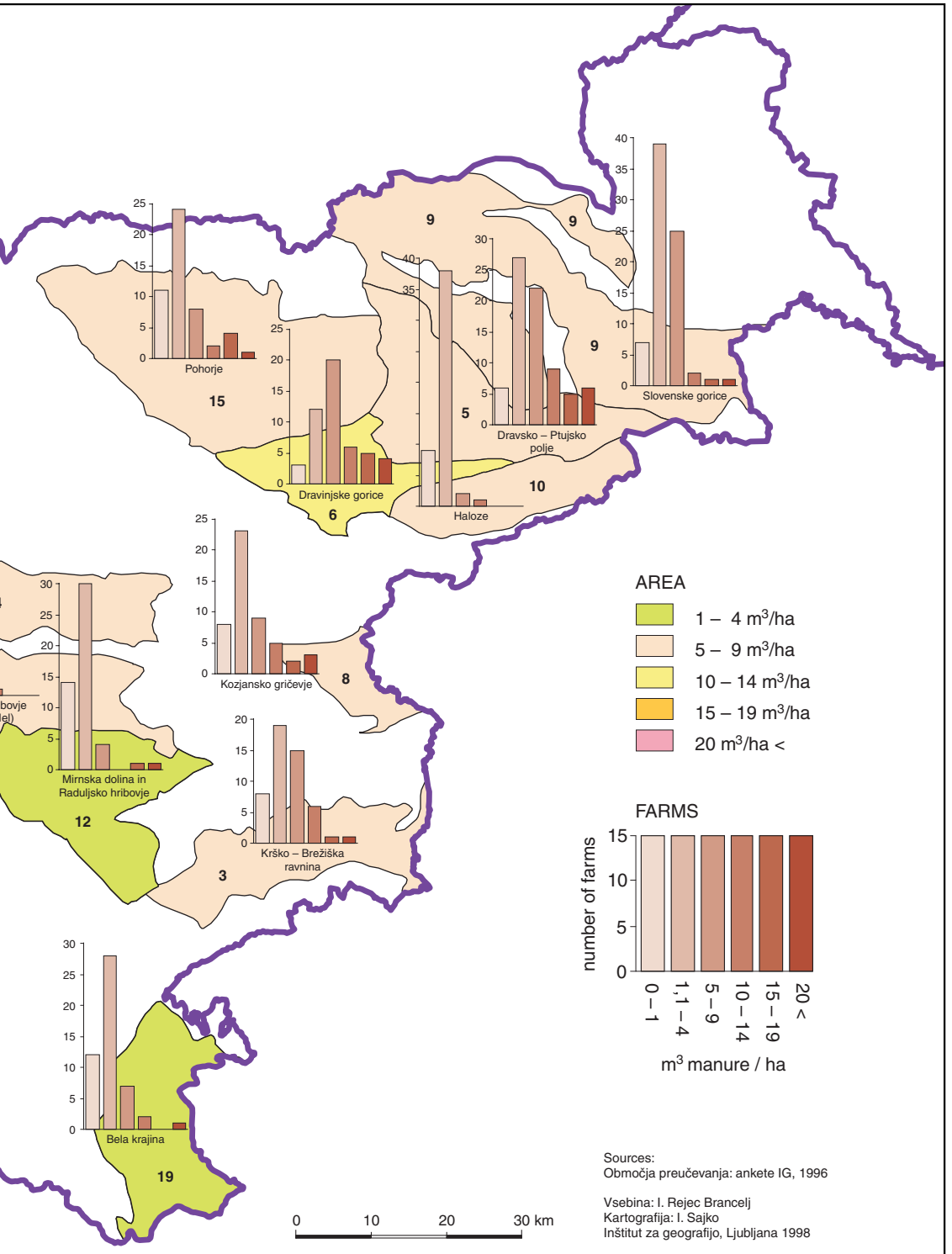
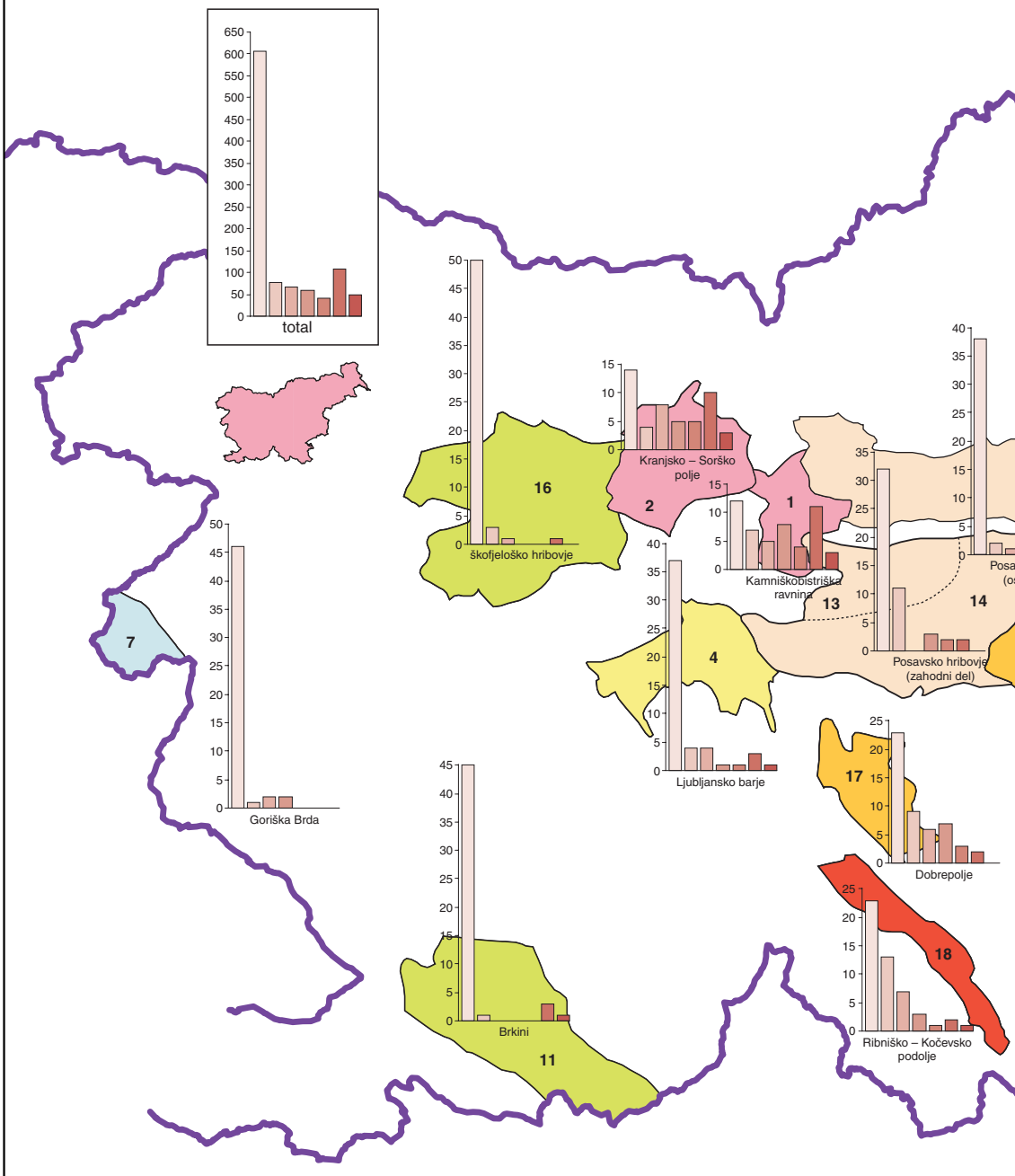

Pohorje
15
Dravinjske gorice
6
9
9
9
5
10
Haloze
Dravsko – Ptujsko polje
Slovenske gorice
Kozjansko gričevje
8
Mirnska dolina in Raduljsko hribovje
12
Krško – Brežiška ravnina
3
Bela krajina
19
AREA
1 – 4 m3/ha
5 – 9 m3/ha
10 – 14 m3/ha
15 – 19 m3/ha
20 m3/ha <
FARMS
number of farms
0 – 1
1,1 – 4
5 – 9
10 – 14
15 – 19
20 <
m3 manure / ha
0 10 20 30 km
Sources:
Območja preučevanja: ankete IG, 1996
Vsebina: I. Rejec Brancelj
Kartografija: I. Sajko
Inštitut za geografijo, Ljubljana 1998

Figure 6: Quantity of liquid manure used in m^3/hectare on cultivated land on the farms studied and in landscape regions in 1996.
Karta 6: Porabljena količina gnojevke v m^3 na ha obdelovalnih zemljišč na anketiranih kmetijah in po pokrajinah leta 1996.



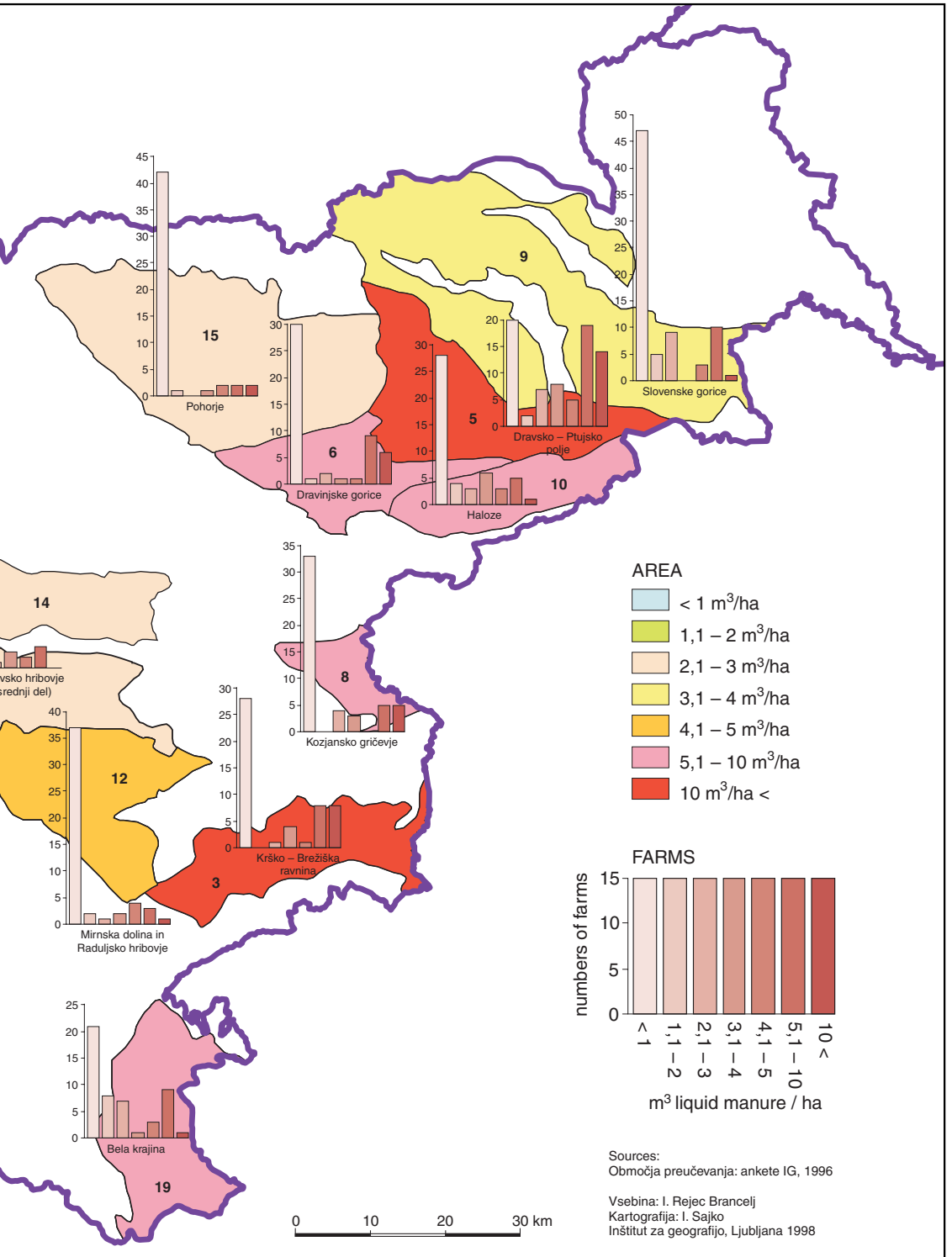

15
Pohorje
6
Dravinjske gorice
5
Haloze
9
Dravsko – Ptujsko polje
Slovenske gorice
10
14
vsko hribovje
srednji del)
8
Kozjansko gričevje
12
Mirnska dolina in Raduljsko hribovje
3
Krško – Brežiška ravnina
Bela krajina
19
0 10 20 30 km
AREA
< 1 m3/ha
1,1 – 2 m3/ha
2,1 – 3 m3/ha
3,1 – 4 m3/ha
4,1 – 5 m3/ha
5,1 – 10 m3/ha
10 m3/ha <
FARMS
numbers of farms
< 1
1,1 – 2
2,1 – 3
3,1 – 4
4,1 – 5
5,1 – 10
10 <
m3 liquid manure / ha
Sources:
Območja preučevanja: ankete IG, 1996
Vsebina: I. Rejec Brancelj
Kartografija: I. Sajko
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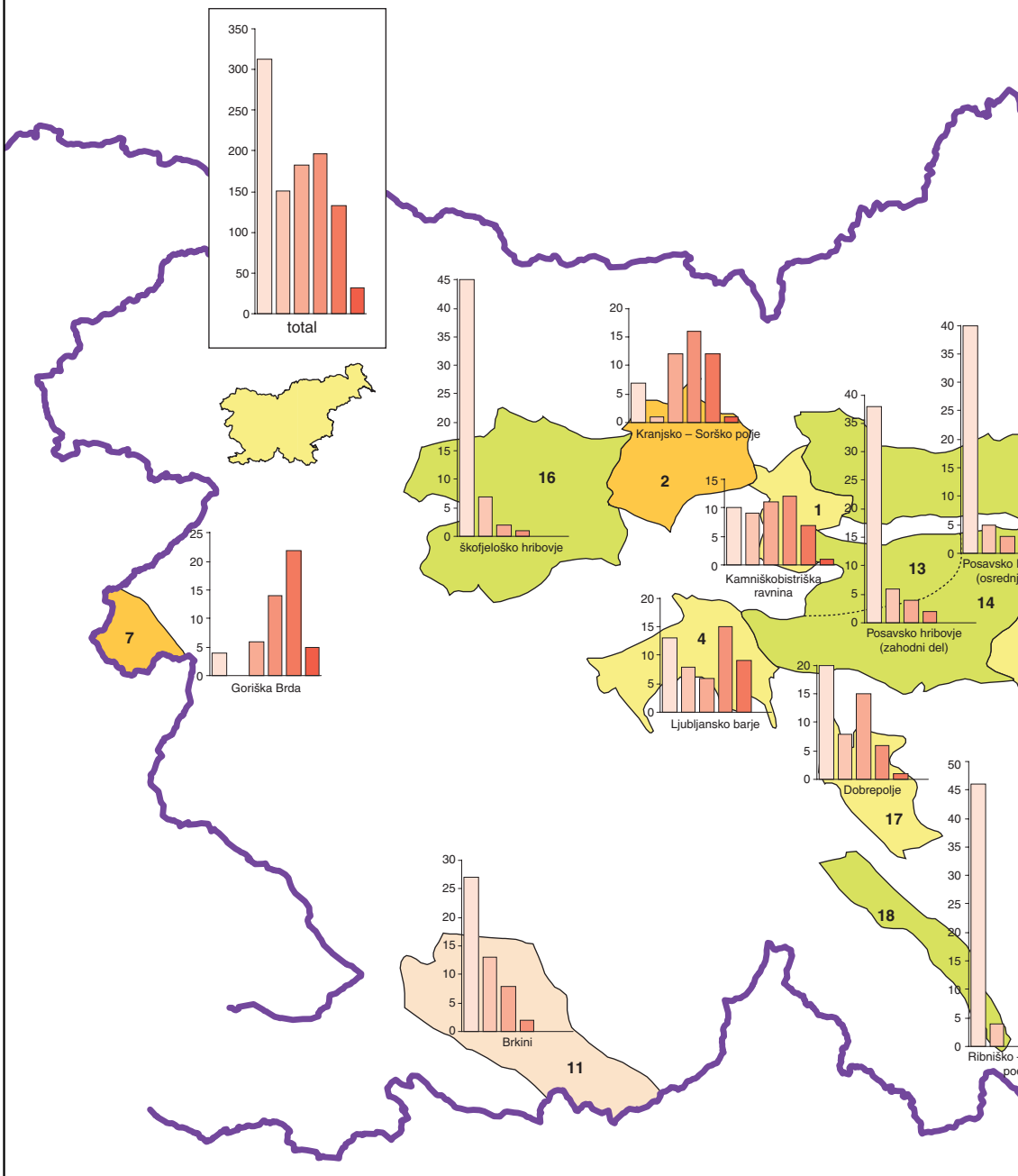
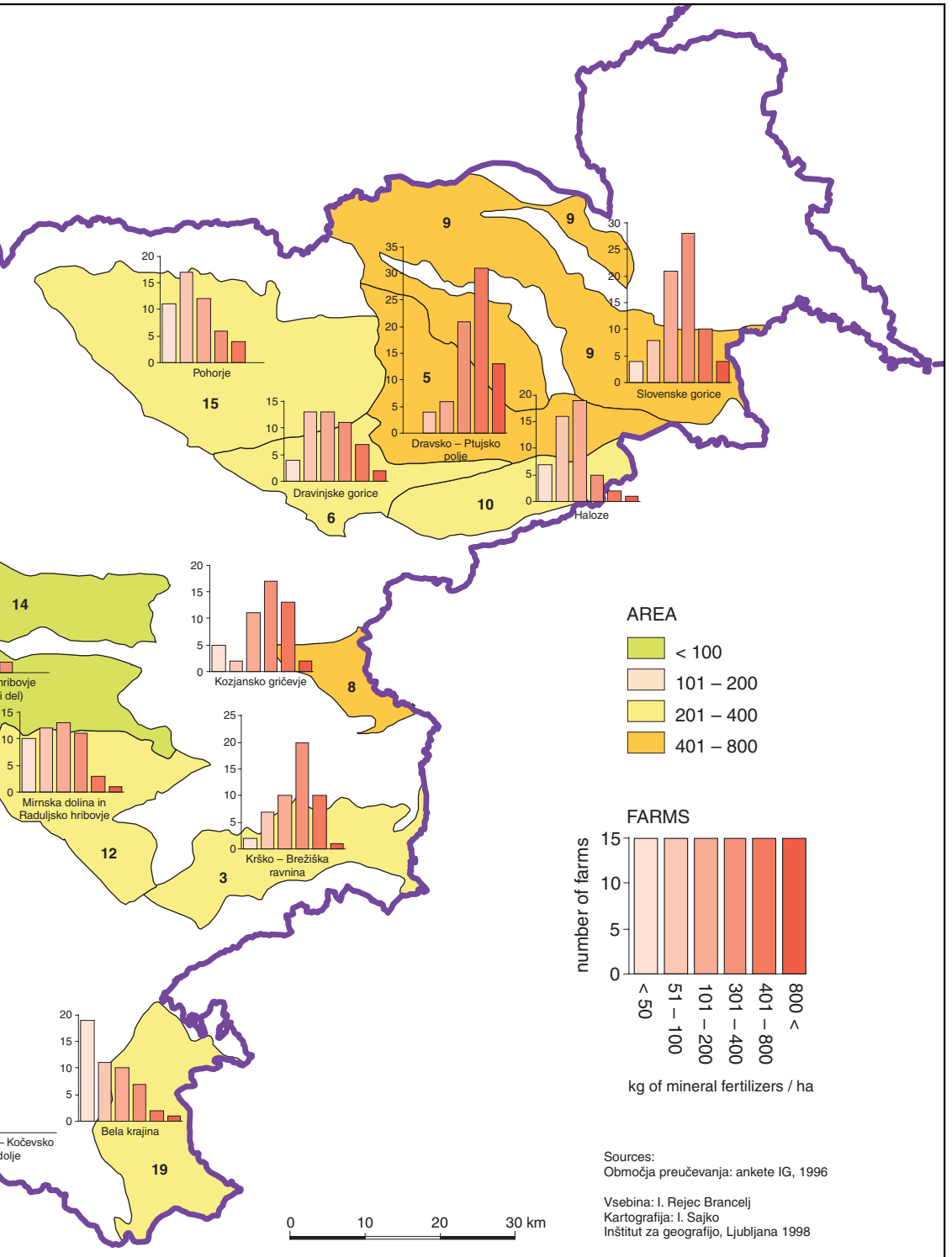
Figure 7: Quantity of mineral fertilizers used in m^3/hectare on cultivated land on the farms studied and in landscape regions in 1996.
Karta 7: Porabljena količina mineralnih gnojil v kg Na ha obdelovalnih zemljišč na anketiranih kmetijah in po pokrajinah leta 1996.





Sources:
Območja preučevanja: ankete IG, 1996

Vsebina: I. Rejec Brancelj
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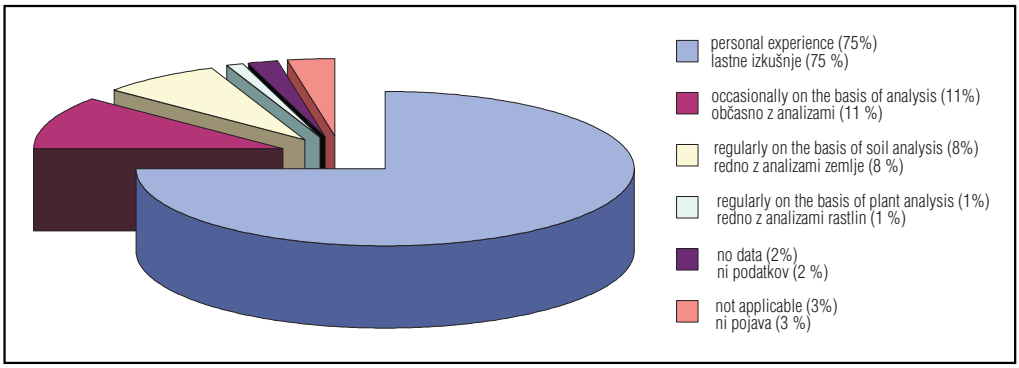
fertilizers, which, however, is not the case with the other two regions where the reason lies primarily in the intensiveness of production. In Dravsko-Ptujsko polje (with the agricultural land-exploitation system based on root crops and grains) and Kranjsko-Sorško polje (with the agricultural land-exploitation system based on root crops and fodder), the use of both organic and mineral fertilizers is high. The intensiveness here is certainly among the highest among the Slovene landscape regions.

The quantity of mineral fertilizers used is smaller by half in the karst regions (averaging 219 kg/ha), and smaller by two thirds in the mountainous regions (150 kg/ha). The smallest average quantity of mineral fertilizers used was found on the farms of Ribniško-Kočevsko podolje (75 kg/ha) and the central part of Posavsko hribovje (79 kg/ha).

More than half of the mineral fertilizer is used on cultivated fields (55%), one third on meadows (35%), 7% on vineyards, and 3% on orchards. Of course, there are differences between individual regions and landscape types resulting from the individual crop orientations. In the flatlands, the proportion of mineral fertilizers used on fields is 64%, and on meadows 34%. Only 2% of mineral fertilizers are used for other agricultural categories, which are only marginally present here. In the hilly regions, 45% of the mineral fertilizers are used on fields, and 32% on meadows. Here, the most widespread categories are vineyards and orchards, on which an average 19% and 5% of mineral fertilizers are used respectively. Among the studied regions, Goriška Brda stands out with its orientation toward orchards and vineyards, and the proportion of mineral fertilizers used in vineyards is 67% and in orchards 23%. In the mountainous regions, 40% of the mineral fertilizers are used on fields, 54% on meadows, and 6% for other cultures. In the three karst regions, the conditions are quite varied. In Dobrepolje and Ribniško-Kočevsko podolje, the greater proportion of mineral fertilizers is used on meadows, and in Bela Krajina on cultivated fields.

The majority of mineral fertilizers are used in the field and meadow categories. Average use amounts to 451 kg/ha for fields and 237 kg/ha for meadows. As expected, the differences between individual landscape region types are significant. The use of mineral fertilizers is greatest on the fields and meadows of the flatlands where the quantity of mineral fertilizers used on farms was 578 kg/ha for fields and 377 kg/ha for meadows. The use on mountainous region farms was found to be only slightly smaller, averaging 535 kg/ha for fields and 272 kg/ha for meadows. Other farms use much smaller quantities. In the karst regions, farms use 244 kg/ha on average for fields, and in the mountainous regions 187 kg/ha. For meadows, the karst farms use 189 kg/ha, and the mountainous region farms 137 kg/ha.

According to agronomy experts, fertilizing causes no environmental side effects if the nutrients are correctly applied and measured. This demands appropriate decisions about fertilizing cultivated land, which as a rule are based on the expertise of the farmers and on analyses of the soil and the crops. Foreign experience recounts the general problems of improving fertilizing practices and describes as promising the



Graph 1: Proportions of farmers according to how they decide to fertilize cultivated land, in % (Source: IG questionnaire, 1996).
Graf 1: Delež kmetovalcev po načinu odločanja glede gnojenja obdelovalnih zemljišč v % (Vir: Anketa GI, 1996).

Danish approach where there is mandatory documentation of plant rotation and requests for fertilizers on all production units (Germon 1989).

During the study, we determined that the farmers largely base their fertilizing decisions on personal experience, as 75% of all the farmers polled decide on this basis (Graph 1); 11% of the farmers polled base their fertilizing decisions on occasional soil analyses, and 8% on regular soil analyses.

There are no major differences relative to individual landscape region types. 83% of the farmers in the hilly regions, 80% in the karst regions, 73% in the flatland regions, and 69% in the mountainous regions base their fertilizing decisions on personal experience. 17% of the farmers in the flatland regions, 11% in the hilly regions, 9% in the mountainous regions, and 5% in the karst regions fertilize with the help of occasional analyses. Only 7% of the farmers in the flatland regions, 3% in the hilly regions, 11% in the mountainous regions, and 13% in the karst regions rely on regular soil analyses. The proportion of farmers basing their fertilizing decisions on occasional analyses was found to be greatest in Kranjsko-Sorško polje (33%), Goriška Brda (25%), Dravsko-Ptujsko polje (20%), Brkini (18%), and in the central part of Posavsko hribovje (16%). 28% of the farmers in Ribniško-Kočevsko podolje, 24% of the farmers in Škofjeloško hribovje, and 22% of the farmers in the western part of Posavsko hribovje were found to rely on regular analyses. It is surprising that analyses are used more frequently in the regions with a livestock-breeding and mixed farming orientation, and less frequently used in those with a field crop orientation.

The survey of the type and quantity of mineral fertilizers used revealed that the farmers use about seven different types of mineral fertilizer on average. For the most part, these are complex fertilizers nitrogen – phosphate – potassium (NPK), urea, and mould. As regards quantities, the prevalent type is the complex fertilizer with equal proportions of nutrients (nitrogen – phosphate – potassium 15 : 15 : 15), which shows that the farmers are afraid that their crops will decrease if they do not fertilize abundantly and that they decide according to the method »a bit of everything can do no harm« that we encountered frequently in our field interviews.

We were interested in whether the farmers recorded the quantities used and the types of organic and mineral fertilizers they spread on their cultivated land. The answer, with rare exceptions, was negative. Quite exceptionally, we did find cases of exemplary bookkeeping on farms in individual regions; however, these were usually only records of expenses. This situation with the farmers is also not the most promising in the light of the *Regulations on the Input of Dangerous Substances and Plant Nutrients in Soil* (Official Gazette RS, No 68/96), which prescribes their management.

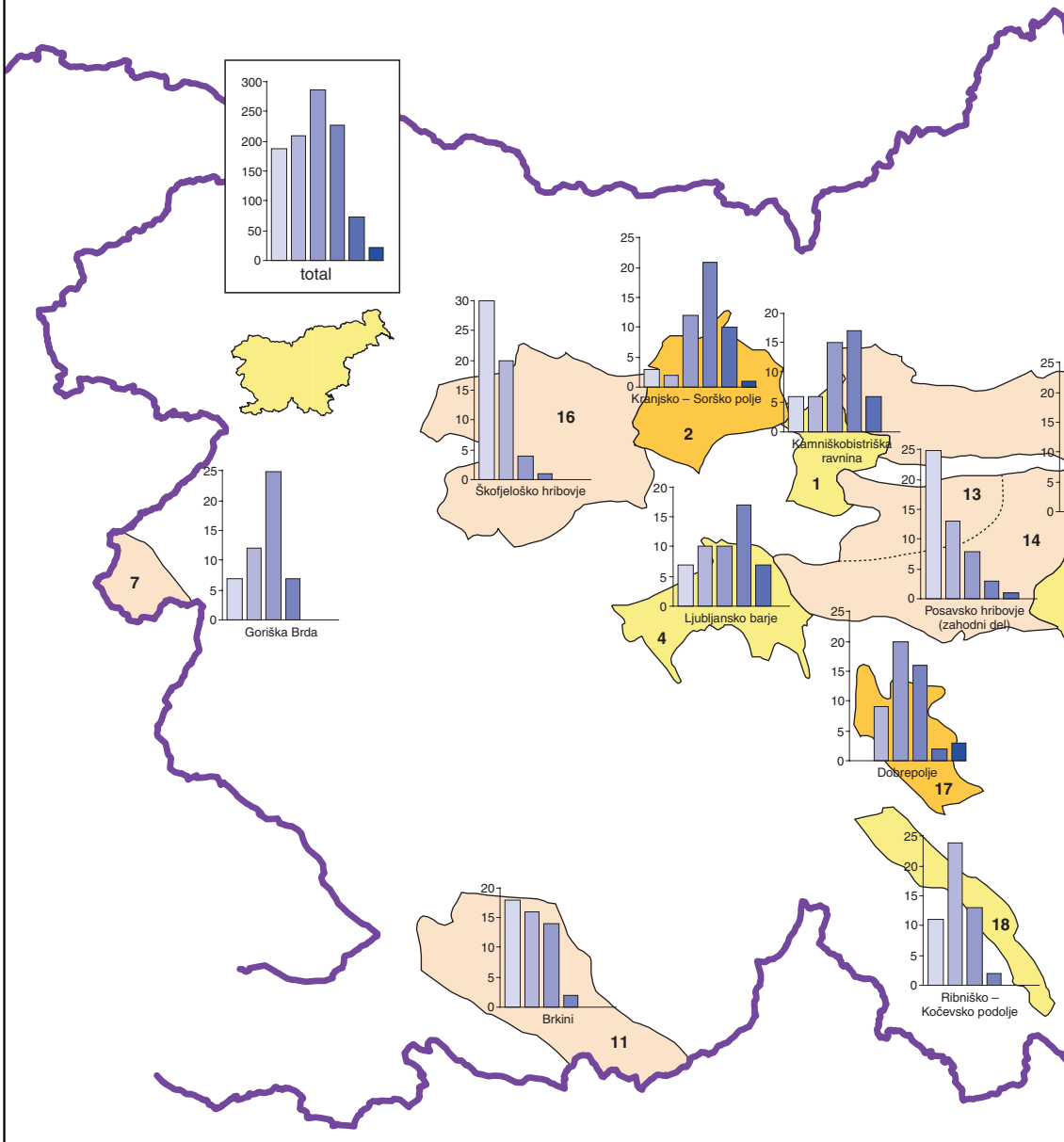
Along with the exaggerated quantity of fertilizers added, a further reason for environmental pollution by nutrient substances is the timing of their application relative to the requirements of the plants being cultivated. With appropriate management, the nutrients are not leached away and lost. In order to determine the farmers' awareness of the importance of the appropriate quantities and timing for fertilizing, we asked when they executed basic and supplementary fertilizing of the plants they cultivate. The vast majority of farmers (73%) do only the basic fertilizing during sowing or immediately before it. Only 27% of farmers do supplementary fertilizing as well.

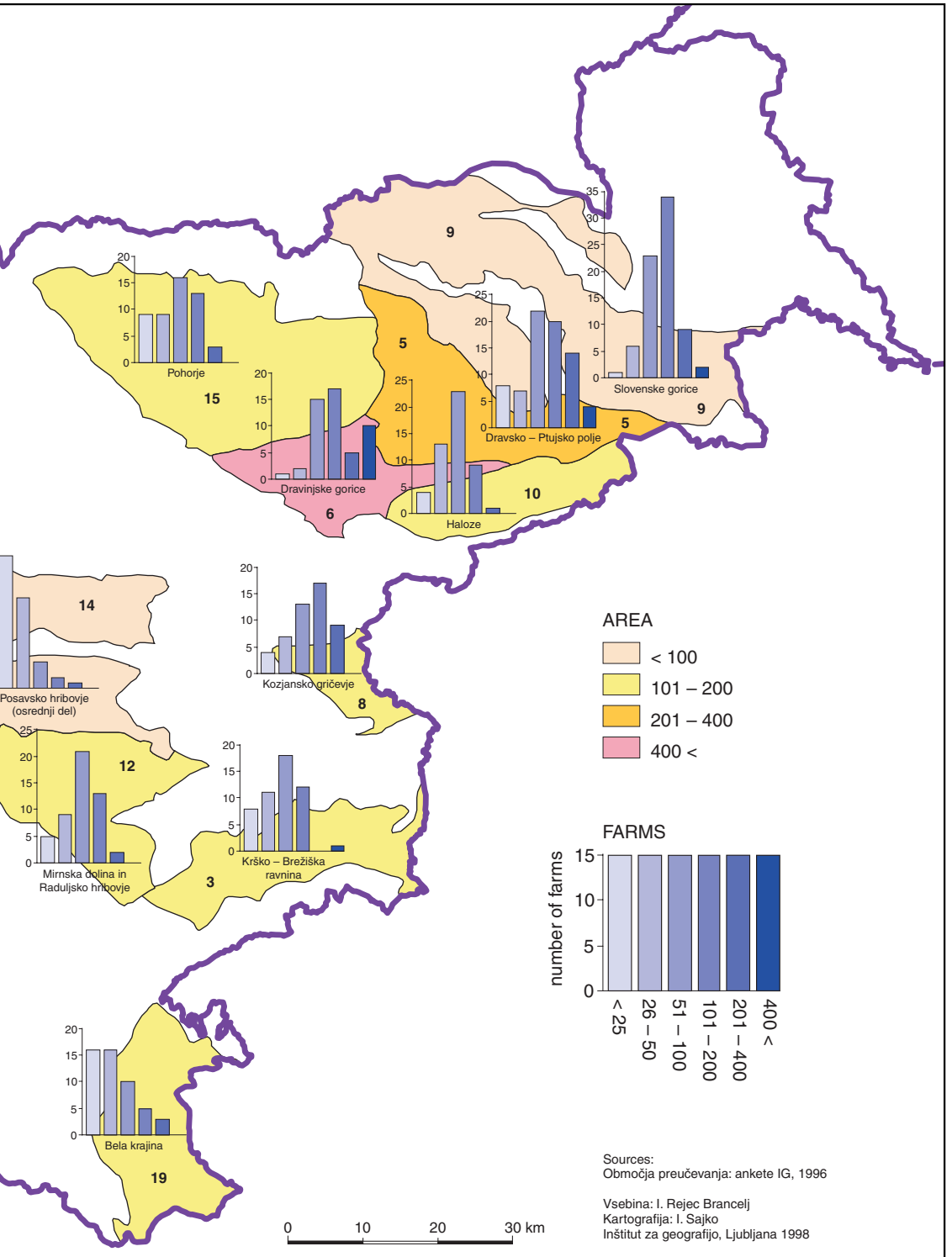
The poll results show poor fertilizing practices among our farmers. Their awareness of the need for the precise application of fertilizers is not yet high enough. Consequently, the water and soil are certainly polluted on occasion, which is also reflected by data gathered during the regular observation of the quality of waters (Kakovost voda … 1997).

5.3. Nitrogen pollution

The inappropriate addition of organic and mineral fertilizers in agriculture is the source of one of our main environmental problems: the disturbed nitrogen balance, a consequence of which is polluted soils and waters, especially of groundwater.

Figure 8: Introduction of nitrogen in m^3/hectare on cultivated land on the farms studied and in landscape regions in 1996.
Karta 8: Vnos dušika v kg Na ha obdelovalnih zemljišč na anketiranih kmetijah in po pokrajinah leta 1996.




Pohorje
15
Dravinjske gorice
6
5
Dravsko – Ptujsko polje
10
Haloze
9
Slovenske gorice
9
5
14
Posavsko hribovje
(osrednji del)
12
Mirnska dolina in
Raduljsko hribovje
Kozjansko gričevje
8
Krško – Brežiška
ravnina
3
Bela krajina
19
AREA
< 100
101 – 200
201 – 400
400 <
FARMS
number of farms
< 25
26 – 50
51 – 100
101 – 200
201 – 400
400 <
0 10 20 30 km
Sources:
Območja preučevanja: ankete IG, 1996
Vsebina: I. Rejec Brancelj
Kartografija: I. Sajko
Inštitut za geografijo, Ljubljana 1998

Farmers introduce nitrogen into the landscape with animal and mineral fertilizers. The ratio between the two in the majority of regions leans toward animal fertilizers, which means that the farms studied still introduce more nitrogen with stable manure and to a lesser extent liquid manure than with mineral fertilizers. The only exceptions are Goriška Brda, where the proportion of nitrogen originating from animal fertilizers is 17%, and Kozjansko gričevje, where the proportion is 48%. In fact, the only landscape type that stands out is the flatlands, where the proportion of nitrogen originating from animal fertilizers is just slightly over one half. It is only here that the ratio is almost 1 : 1; in other landscape types, the ratio of almost 8 : 2 strongly favours nitrogen originating from animal fertilizers. All farms studied introduce two thirds of the nitrogen with animal fertilizers and one third with mineral fertilizers (Graph 2). Matičič and his colleagues (1995) report similar figures for conditions on Slovene farms.

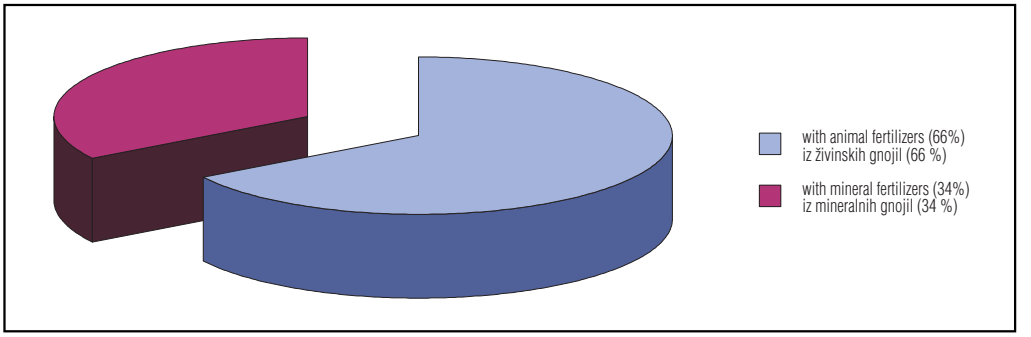
However, there are obvious differences between individual regions and landscape types. The average proportion of nitrogen introduced through animal fertilizers according to individual landscape types was as follows. There is only a small difference between the average in the flatlands (55%) and the average in the hilly regions (57%); however, the diversity within the hilly regions is great. The nitrogen input in the mountainous regions (72%) and the karst regions (74%) was half again greater. The inverse ratio of nitrogen input with mineral fertilizers was found to be 45% in the flatlands, 43% in the hilly regions, 28% in the mountainous regions, and 26% in the karst regions.

Relative to nitrogen input per hectare of cultivated land, the individual regions were classified into the following classes. Input greater than 400 kg N/ha was found only in Dravinjske gorice: 800 kg N/ha due to a greater number of poultry breeders. Regions with up to 400 kg N/ha include Dravsko-Ptujsko polje, Kranjsko-Sorško polje, and Dobrepolje. The majority or nine regions were ranked in the class of between 101 and 200 kg N/ha: Pohorje, Haloze, Kozjansko gričevje, Mirnska dolina–Raduljsko hribovje, Krško-Brežiška ravnina, Bela krajina, Ribniško-Kočevsko podolje, Ljubljansko barje, and Kamniškobistriška ravnina. The following regions were classified in the group with inputs up to 100 kg N/ha: Slovenske Gorice, Posavsko hribovje, Škofjeloško hribovje, Brkini, and Goriška Brda. It is characteristic of the latter that relatively large quantities of mineral fertilizers are introduced during agricultural production; however, the prevailing winegrowing orientation in recent years has relied on the knowledge of agricultural experts that the quantity of nitrates and the quantity of grapes produced are inversely proportional to quality (Šikovec 1992).

If we look at the density of the nitrogen input per hectare of cultivated land by individual regions and landscape types, we establish the following: the input is greatest in the hilly regions and totals 258 kg N/ha. This can be attributed to the orientation of the agriculture in these areas where the crop farming and livestock breeding are joined by special cultures: fruit orchards and winegrowing. Among the hilly regions studied, Dravinjske gorice stands out strongly, where, as we have mentioned, the survey showed that one fifth of the farms breed hens and chickens. Without Dravinjske gorice, the average would be lower than in the flatland and karst regions, amounting to 121 kg N/ha. The hilly regions are followed by the flatland regions, where the input amounts to 188 kg N/ha, the karst regions with 179 kg N/ha, and the mountainous regions with 100 kg N/ha. The average on the farms studied amounted to 190 kg N/ha.

As the *Regulations on the Input of Dangerous Substances and Plant Nutrients in Soil* (1996) prescribe a limit on the annual nitrogen input of 210 kg/ha, we can also consider the inputs on the farms studied in this light. Nitrogen inputs through animal and mineral fertilizers exceed 210 kg of nitrogen per hectare in Dravinjske gorice (806 kg N/ha, due to the greater number of poultry breeders), Kranjsko-Sorško polje (297 kg N/ha), and Dobrepolje (279 kg N/ha). Regions quite close to the limit include Dravsko-Ptujsko polje (204 kg N/ha), Kozjansko gričevje (194 kg N/ha), Ljubljansko barje (176 kg N/ha), and Bela krajina (151 kg N/ha). We have already mentioned that one third of the nitrogen comes from mineral fertilizers and two thirds from animal fertilizers. In Slovenia, the deposit of nitrogen from the atmosphere amounts to 20 kg N/ha yearly, and its contribution is small (Matičič et al. 1995).

Comparisons of the nitrogen inputs studied with previous research done on larger Slovene regions (ibid.) show that although the more detailed studies do complete the picture, at the same time they draw atten-



Graph 2: Nitrogen input with animal and mineral fertilizers on the polled farms in 1996.
Graf 2: Vnos dušika z živinskimi in mineralnimi gnojili na anketiranih kmetijah leta 1996.

tion to the inadequacy of using average values in Slovenia where the landscape is extremely diverse. Matičič and his colleagues (1995) report an average value for all nitrogen of 137 kg/ha, 90 kg N/ha from animal fertilizers and 47 kg N/ha from mineral fertilizers. As we have mentioned, the average total input on the farms studied amounts to 190 kg N/ha. The total input per hectare is greatest in the hilly regions, amounting to 258 kg, smaller by a third in the flatlands (188 kg) and the karst regions (179 kg), and smallest in the mountainous regions (100 kg). According to European Union standards, a particular region is vulnerable to the leaching of nitrates when the nitrogen is greater than 100 kg/ha (ibid.). This value is exceeded in more than two thirds of regions studied: all flatland regions; all karst regions; Dravinjske gorice, Kozjansko gričevje, and Haloze among the hilly regions; and Mirnska dolina–Raduljsko hribovje and Pohorje among the mountainous regions.

Figure 8 shows the distribution of the individual farms polled by classes according to the input of nitrogen per hectare of cultivated land. Two thirds of the farms in the flatlands and the hilly regions, almost half of the farms in the karst regions, and a third of the farms in the mountainous regions can be classified according to nitrogen inputs in the middle two classes where inputs are between 51 and 100 kg N/ha and between 101 and 200 kg N/ha. 15% of the farms in the flatlands, 13% of the farms in the hilly regions, 5% of the farms in the karst regions, and 2% of the farms in the mountainous regions introduce more than 200 kg N/ha. The input is smallest, less than 50 kg N/ha, on 64% of the farms in the mountainous regions and on 51% of the farms in the karst regions. In the flatlands, the input of nitrogen is lower than 50 kg N/ha on one quarter of all farms, and in the hilly regions on one fifth of the farms.

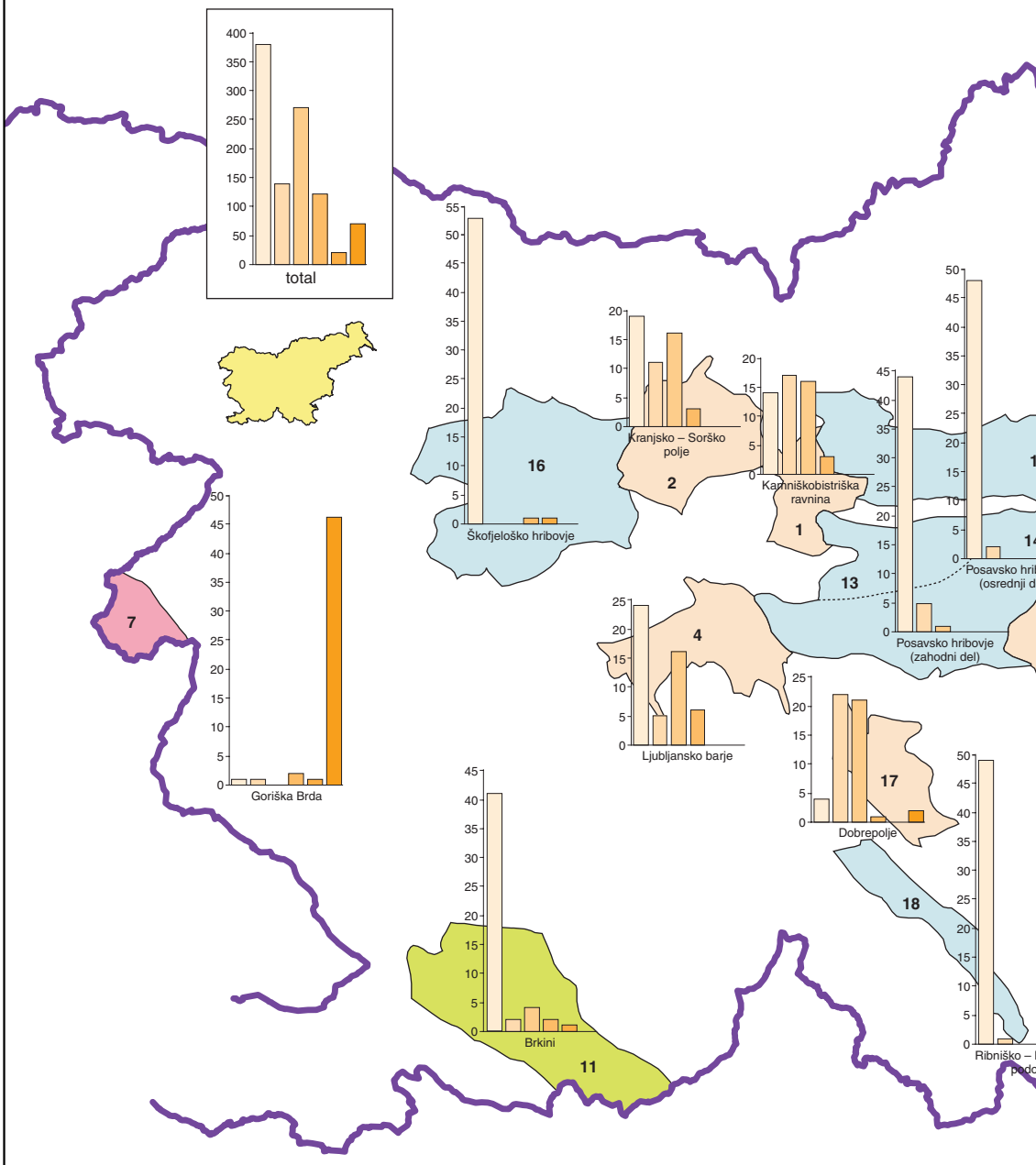
5.4. Use of plant protection agents

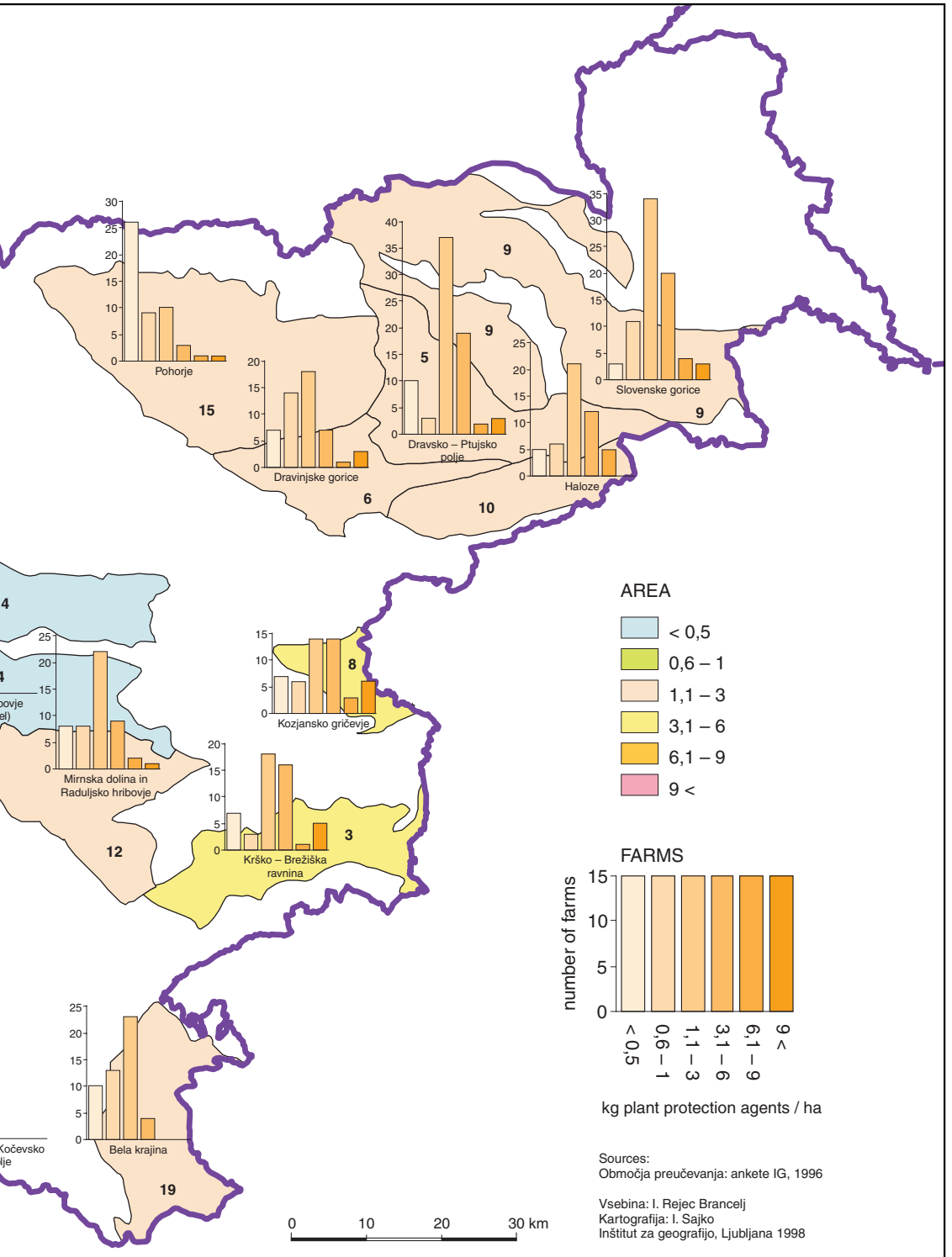
Nowadays, it is almost impossible to imagine agriculture without the use of plant protection agents. 93% of the farmers polled use such agents, and only 7% do not. The differences between individual regions are small; only in the mountainous region did a somewhat smaller use of such agents appear.

The average use of plant protection agents on the farms studied was 3.42 kg/ha. The use was greatest in the hilly regions, 9 kg/ha of cultivated land, which is primarily a consequence of the orientation of these regions toward fruit orchards and winegrowing and the larger quantities of fungicides used. In the flatland regions, the use amounted to 2 kg/ha, and in the karst regions to 1 kg/ha. The use was smallest in the mountainous regions where it amounted to 0.88 kg/ha.

Figure 9 shows the quantity of plant protection agents used by regions and their internal structure. The use of these agents is greatest in Goriška Brda where it amounts to 35.2 kg per hectare of cultivated land, a consequence of this region's pronounced orientation toward winegrowing. Up to 6 kg of plant protection agents per hectare, the average use for the farms studied, is used in Krško-Brežiška ravnina (4.8 kg/ha) and Kozjansko gričevje (4.4 kg/ha). The majority of the regions studied (11) use up to 3 kg

Figure 9: Quantity of plant protection agents used in m^3/hectare on cultivated land on the farms studied and in landscape regions in 1996.
Karta 9: Porabljena količina sredstev za varstvo rastlin v kg Na ha obdelovalnih zemljišč na anketiranih kmetijah in po pokrajinah leta 1996.





Sources:
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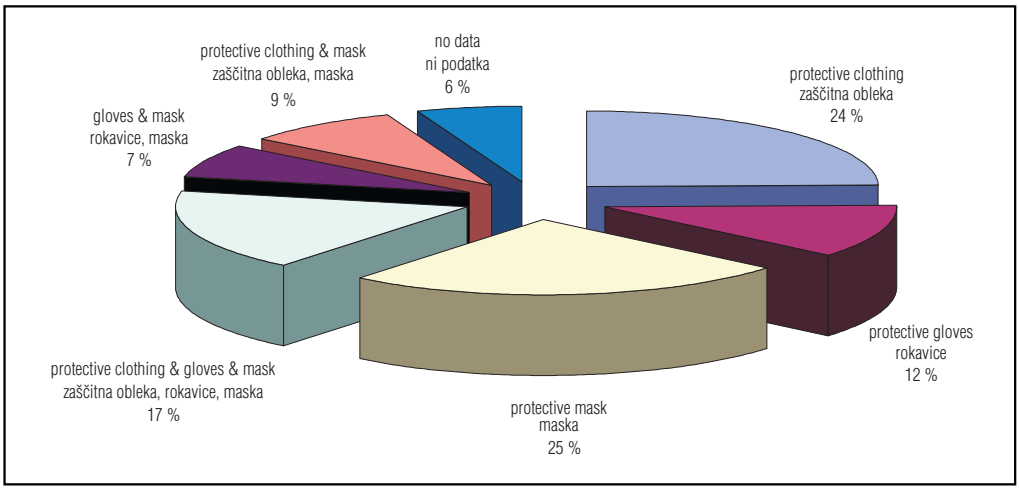
per hectare. In Brkini, the use amounts to 0.6 kg per hectare, while the use is smallest in Škofjeloško hribovje (0.3 kg/ha), Posavsko hribovje (0.2 kg/ha), and Ribniško-Kočevsko podolje (0.1 kg/ha).

The internal diversity relative to the use of plant protection agents within individual regions is great; however, the regions can be roughly divided into two groups. In the first group are the regions with a small use of plant protection agents, where the farmers with the smallest use also dominate in the internal structure and other classes are correspondingly less represented (Škofjeloško hribovje, Posavsko hribovje, Ribniško-Kočevsko podolje, Brkini). In the second group are the regions with a greater use of these agents, where farmers using more than 9 kg of plant protection agents per hectare constitute one half or more in the internal structure.

A survey of the types of agents used showed that all the farmers combined used 110 different plant protection agents. The greatest variety of agents, 38 different types, were used in the hilly regions. In the flatlands, 30 different types of plant protection agents were used, and 22 types were employed in both the mountainous and karst regions. Dravinjske gorice (45), Goriška Brda (44), and Haloze (42) used the largest number of protection agents, undoubtedly a consequence of their orientation toward winegrowing and fruit orchards and the subsequent larger and more diversified need for such agents. The number of agents used was smallest in Škofjeloško hribovje (10) and Ribniško-Kočevsko podolje (11).

In using plant protection agents, almost half of the farmers (47%) followed the manufacturer's instructions, one fifth relied on both personal experience and the manufacturer's instructions, and 13% relied only on personal experience. Only 5% of the farmers based their decisions on the advice of agricultural counsellors; however, it must be said that our field interviews revealed the influence of the agricultural counselling service is more evident in many places, as this answer reflects. In recent years, the counselling service has done much to develop the population's awareness on these matters, although there are still considerable differences between the regions. For the most part, however, the decisions on such an important issue of agriculture are still left to the farmer's initiative, and this is not particularly positive from the environmental protection point of view. Cases came to our attention in Bela krajina and Dravsko-Ptujsko polje where farmers use the most pesticides whose use on karst soils or on shallow and light soils is not allowed at all.

Since the majority of farmers follow the instructions of manufacturers when it comes to spraying, we were interested in their knowledge of the waiting period concept. 79% of all farmers know it, 12% gave an unclear



Graph 3: Proportion of farmers using protective clothing while spraying plant protection agents in 1996 (Source: IG questionnaire).
Graf 3: Deleži kmetovalcev po načinu zavarovanja ob škropljenju s sredstvi za varstvo rastlin leta 1996 (Vir: Anketa IG).

answer, and only 4% of them either did not know the notion or gave a wrong answer. The farmers in the flatlands were most familiar with the concept, which is positive from the environmental protection point of view since the flatlands and the hilly regions are where these agents are most widely used.

We tried to assess the awareness of the need to use these agents correctly with two other questions: the protective clothing used during spraying and the disposal of leftover materials. A third of the farmers use no protective clothing when applying these agents, somewhat less than one fifth wore protective clothing, and about the same number wore a protective mask. 12% of the farmers use all three items of protective clothing when applying agents: protective clothing, gloves, and mask. We estimate that the use of such protective clothing is still at an inappropriate and unsatisfactory level, and the differences between individual regions are not large.

72% of the farmers polled have no leftover plant protection agents after spraying. One twelfth of the farmers polled dump the leftovers on the ground, and 1% into the water. The differences between individual regions relative to this answer are small as well; however, it is certainly less than desirable that 10% of the farmers polled in the flatlands and 13% of the farmers polled in the karst regions dump the leftover agents on the ground.

Through counselling, organizing courses, and introducing the repair of spraying devices at authorized repair centers, the agricultural counselling service has played an important role in various areas in raising awareness among farmers regarding the methods and dangers of spraying (Kmetijska svetovalna služba 1996, 1997, 1998). The general awareness among the professional community is also greater, as the recent organization of conferences organized recently shows (*Dušik – naravovarstvena paradigma / Nitrogen – the Environmental Protection Paradigm*, 1996; *Kmetijstvo, ki ohranja biološko raznovrstnost / Agriculture that Maintains Biological Diversity*, 1996). Nevertheless, it is clear from the results of this study that the level of awareness achieved among Slovene farmers regarding the environmental influences of farming is not satisfactory.

6. Conclusion

The research we have done has confirmed that dispersed agricultural activity is an important source of environmental pollution. In Slovenia, where the landscape is very diverse, conditions change rapidly within a short distance. The study results show that it was justified to divide the regions into individual landscape types and that the differences between them are significant. The landscape regions in the forefront of agricultural pollution are undoubtedly the flatlands, immediately followed by the hilly regions. It will be necessary to devote even more detailed research to these two regions and take regular year-round samples from the waters to help shed additional light on the effects of agricultural pollution. In the measures intended to reduce agricultural environmental pollution, it is necessary to consider the particular socioeconomic features of agricultural production in Slovenia: a dominant proportion of mixed farms, the dominant proportion of multi-generation households relative to their age structure, the predominant professional training of farmers (which is only rarely connected with the agricultural professions), and the great fragmentation of agricultural land.

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8. Summary in Slovene – Povzetek

Okoljevarstveni vidiki kmetijstva slovenskih pokrajin

Irena Rejec Brancelj

1. Uvod

Dosedanje preučitve kažejo, da vpliva kmetijstva na obremenjevanje pokrajine tudi v Sloveniji ne moremo več zanemarjati. Poleg onesnaževanja iz točkovnih virov, kjer so bile doslej v ospredju predvsem živinske farme in ribogojnice, se v zadnjem času posveča več pozornosti tudi onesnaževanju iz netočkovnih, razpršenih virov. To je še toliko bolj pomembno, saj je ena od temeljnih značilnosti našega kmetijstva nadpovprečna razdrobljenost posesti in zemljišč. Sodobno kmetijstvo, ki je v pridelavi prevzelo značilnosti industrijske pridelave, se je s svojo tehnologijo in filozofijo razširilo tudi na kmetije. Današnje kmetije lahko z uporabo agrokemičnih sredstev močno posegajo v pokrajinsko zgradbo in povzročajo učinke, ki se širijo preko njihovih meja. Učinki tovrstne pridelave pa se kažejo tudi v obremenjevanju prsti in voda.

Pokrajinska raznolikost Slovenije je povzročila raznolikost tudi v kmetijski dejavnosti. Ta je v preteklosti imela predvsem samooskrbni značaj in se je v veliki meri prilagajala lokalnim razmeram (sadjarstvo v gričevnatem, živinoreja v hribovskem svetu). Na kmetijah sta bili energetska in snovna poraba uravnoteženi s procesi, ki so zagotavljali obnovo zalog. Zaradi sodobnih potreb pa je prišlo do prerazporeditve kmetijstva, ko se je npr. živinoreja preselila v ravninski svet. To je povzročilo spremembe v strukturi kmetij (v setveni sestavi zemljišč, pretoku in bilanci snovi, energetskih značilnostih idr.). V preteklosti je bila pomemben omejitveni dejavnik pridelave na kmetiji količina gnoja. Pridelava se ni mogla intenzivirati, če ni bilo mogoče zagotoviti večje količine hranilnih snovi. S pojavom mineralnih gnojil pa se je uravnoteženost teh razmerij porušila. Zaradi preobremenjenosti obdelovalnih površin z živino (prevelike živinorejske gostote) prihaja do neuravnotežene bilance gnoja na kmetijah, gnoja je preveč in predstavlja lahko tudi okoljski problem.

Osnovno pokrajinsko raznolikost v Sloveniji povzročata pestra kamninska sestava in relief. Ob upoštevanju pedoloških značilnosti in vplivov človeka v pokrajini zaobjamemo sestavine, ki so najpomembnejše tudi za vrednotenje vplivov kmetijstva. Pokrajinska različnost kmetijskih pokrajin zahteva raziskovanja po posameznih tipih. Glavni pokrajinski tipi so kraški svet, ravnine, gričevja, hribovja in visokogorje. Vsak od njih ima določene skupne značilnosti, ki so pomembne tudi za njihovo okoljsko občutljivost. Kakšna je kmetijska dejavnost po posameznih tipih in kakšne so njene okoljske značilnosti bomo prikazali v nadaljevanju. Ker sta gnojenje obdelovalnih površin in uporaba sredstev za varstvo rastlin z vidika okolja najbolj obremenjujoča procesa jima bomo v nadaljevanju posvetili največ pozornosti.

2. Metode dela

Za preučevanje kmetijskega obremenjevanja slovenskih pokrajin so bila vzorčna območja izbrana s pomočjo naslednjih kriterijev:

a) zastopani naj bodo vsi tipi pokrajinskih enot v Sloveniji,
b) upoštevane naj bodo njihove gospodarske značilnosti,
c) zastopani naj bodo različni kmetijski sistemi,
d) različni naselbinski tipi in
e) izbrana naj bodo socialnoekonomsko različna naselja v pokrajini.

Pri izboru vzorčnih območij po zgornjih kriterijih so bile uporabljene v literaturi že uveljavljene tipologije slovenskih geografov (Gams, Orožen, Kladnik, 1995; Vrišer, 1994; Drozg, 1995; in Ravbar, 1995). Na tej osnovi je bilo izbranih 19 regij (prikazuje jih karta 1), kamor so bila usmerjena preučevanja.

Anketirana naselja so izbrana iz vsakega izmed navedenih družbenogospodarskih tipov naselij, njihovo število izraža zastopanost posameznih tipov naselij v obravnavani pokrajini. Izbrana so naselja s 100 do 200 prebivalci, ker v slovenski strukturi prevladujejo (Perko, 1995). V vsaki pokrajini je bilo izbranih 10 družbenogospodarsko različnih naselij, kjer je potekalo terensko delo in v vsakem naselju je bilo naključno opravljenih pet anket. Ker so bile v štirih pokrajinah (Dravsko-Ptujsko polje, Slovenske gorice, Kranjsko-Sorško polje in Škofjeloško hribovje) opravljene dodatne kontrolne ankete, je število v analizo vključenih naselij in anket v teh pokrajinah večje. Skupaj je bilo anketiranih 210 naselij in opravljenih 1006 anket.

S pomočjo neposrednega anketiranja kmetovalcev smo skušali ugotoviti regionalne značilnosti glede družbenogospodarske sestave kmetij, zemljiške sestave, usmerjenosti kmetije, tržnosti pridelave, opremljenosti s kmetijskimi stroji, načina obdelave kmetijskih zemljišč, količine, vrste in razširjenosti uporabe mineralnih gnojil ter sredstev za varstvo rastlin, gnojilnih navad kmetovalcev, načina odmerjanja uporabljenih agrokemičnih sredstev, zavarovanja ob njihovi uporabi, zaznav o vplivu teh sredstev na okolje, števila živine, opremljenosti s hlevi in kanalizacijo, energetskih značilnosti kmetij (porabe mineralnih gnojil, sredstev za varstvo rastlin, močnih krmil, goriv, električne energije) in pridelkov.

3. Osnovne značilnosti obravnavanih območij

Med ravninskimi kmetijskimi pokrajinami so bile v raziskavo vključene 3 pokrajine iz osrednje Slovenije (Kamniškobistriška ravnina, Kranjsko-Sorško polje in Ljubljansko barje), 1 iz jugovzhodne (Krško-Brežiška ravnina) in 1 iz severovzhodne Slovenije (Dravsko-Ptujsko polje). Njihovo kamninsko zgradbo sestavljajo predvsem prodne odkladnine (Kamniškobistriška ravnina in Kranjsko-Sorško polje imata kar 78 % karbonatnega proda, Krško-Brežiška ravnina 36 % in Dravsko-Ptujsko polje 76 % silikatnega proda) in glina ter melj (Krško-Brežiška ravnina 47 %, Dravsko-Ptujsko polje 24 %, Kamniškobistriška ravnina in Kranjsko-Sorško polje pa po 3 % gline in melja) (Preglednice …, 1995). Izjema je Ljubljansko barje z 69 % gline in melja, 16 % karbonatnega proda in 10 % kremenovega peščenjaka in konglomerata. Prodna območja so bolj sušna in z več njivami, ilovnata območja pa bolj mokrotna, zato so bile na njih marsikje izvedene obsežne hidromelioracije. Skupne so jim še nekatere hidrografske značilnosti, lega ob večjem vodotoku in možnosti za namakanje ter območja podtalnice, podobnosti so v zemljiški rabi, tipu naselij, idr.

V raziskavo je bilo vključenih 5 kmetijskih pokrajin v gričevju in sicer 1 iz zahodne Slovenije (Goriška brda), 1 iz vzhodne Slovenije (Kozjansko gričevje) in 3 iz severovzhodnega dela Slovenije (Dravinjske gorice, Slovenske gorice in Haloze). Večji del površja v obravnavanih pokrajinah leži v nadmorski višini pod 400 m, višinski pas 200–299 m pa zavzema največji delež (Dravinjske gorice 51 %, Slovenske gorice 74 %, Haloze 47 % in Kozjansko gričevje 38 %), izjema so Goriška brda s 40 % površja v nadmorskih višinah 100–199 m. Kamninsko osnovo v glavnem predstavljajo terciarni sedimenti (v Goriških brdih je 66 % fliša, drugod je najbolj razširjena kamnina lapor: v Halozah 70 %, v Slovenskih goricah 43 %, v Kozjanskem gričevju 37 % in v Dravinjskih goricah 17 %) in glina ter melj (Dravinjske gorice 64 %, Slovenske gorice 33 %, Kozjansko gričevje 21 %, Haloze 18 % in Goriška brda 12 %). Kozjansko gričevje se od drugih razlikuje zaradi večje zakraselosti, saj zavzemata 20 % apnenec in 15 % dolomit. Prevladuje površinski vodni odtok, številni so majhni vodni izviri, večjih sklenjenih območij talne vode pa tukaj ni. Zaradi svoje lege in odprtosti, obravnavane pokrajine dosegajo vplivi sosednjih, toplejših podnebij: submediteranskega in panonskega. Veliko skupnega imajo še v zemljiški rabi, saj imajo v naštetih pokrajinah pomemben delež vinogradi in sadovnjaki.

Med hribovskimi pokrajinami smo jih v obravnavo zajeli 5: Brkini, Mirnska dolina in Raduljsko hribovje, Posavsko hribovje, Pohorje in Škofjeloško hribovje. Zanje je značilna velika kamninska in klimatska raznolikost. V Brkinih z dolino Reke flišne kamnine gradijo tri četrtine površja, pomemben pa je njihov delež še v Mirnski dolini in Raduljskem hribovju (30 %), dobrih 15 % površja zavzemajo v obeh pokrajinah apnenci in v Mirnski dolini in Raduljskem hribovju več kot polovico (55 %) dolomit. Na Pohorju zavzemajo metamorfne kamnine 61 %, globočin je 12 % in 11 % karbonatni prod, grušč, til, konglomerat, breča in tilit. Bolj raznoliko zgradbo imata Posavsko hribovje in Škofjeloško hribovje. V Posavskem hribovju je 35 % dolomita, 22 % kremenovega peščenjaka in konglomerata in po 10 % glinovca in me-

ljevca ter apnenca. V Škofjeloškem hribovju pa je 28 % glinovca in meljevca, 26 % dolomita, 16 % kremenovega peščenjaka in konglomerata ter 15 % apnenca.

V ospredju proučevanja so bile tudi 3 kraške pokrajine iz jugovzhodnega dela Slovenije: Bela krajina, Dobrepolje in Ribniško-Kočevsko podolje. Vsem trem je skupna kamninska zgradba, saj prevladuje apnenec (Bela krajina 66,6 %, Dobrepolje 70,9 % in Ribniško-Kočevsko podolje 48 %), skoraj petino površja gradi dolomit (Bela krajina 9,6 %, Dobrepolje 20,4 % in Ribniško-Kočevsko podolje 16,4 %), po deležu površja tvorita tretjo skupino glina in melj (Bela krajina 19,9 %, Dobrepolje 8,3 % in Ribniško-Kočevsko podolje 32,4 %). Skupna jim je prevladujoča dinarska zasnovanost v smeri od severozahoda k jugovzhodu, povezujoče pa so tudi hidrografske značilnosti. Za Ribniško-Kočevsko podolje, ki leži na sredi med drugima dvema pokrajinama je značilna vertikalna bifurkacija. Del voda odteka podzemsko v sosednje Dobrepolje in v izvire Krke, drugi del pa v Belo krajino in izvire Kolpe. Zaradi prepustnosti kraškega sveta in vodooskrbnega pomena nekaterih izvirov je še posebej pomembno, kakšna so dogajanja v njihovem zaledju.

4. Značilnosti kmetijske rabe zemljišč

Osnovna značilnost kmetijskega obremenjevanja je ploskovnost in kot posledica značilne zemljiške razdrobljenosti v Sloveniji tudi razpršenost. Radinja (1997) ugotavlja, da lahko obseg agrarnega obremenjevanja istovetimo s površino kmetijskih zemljišč in zlasti obdelovalnih zemljišč. Slovenija se uvršča med evropske države z najmanjšima deležema kmetijskih (43 %) in obdelovalnih (32 %) zemljišč. Z okoljevarstvenega vidika lahko to označimo kot prednost, saj več kot polovico površin (54 %) zaseda gozd. Gozdne površine se v zadnjih desetletjih povečujejo, kar je tudi v evropskih razmerah izjemen proces. To je posledica značilne razpršene poselitve in načina izkoriščanja zemljišč – raztrganost gozdne odeje (Erjavec et al. 1997). Zaraščanje nekdanjih kmetijskih površin lahko okoljevarstveno označimo kot pozitiven proces, saj se s tem zmanjšuje neposredno odtekanje padavinske vode, zmanjšuje se nevarnost poplav, blažijo se vplivi s sosednjih obdelovalnih zemljišč (gozd nudi zavetišče živalim), itd. V zadnjih desetih letih se je zmanjšala površina kmetijskih zemljišč za skoraj 10 %, predvsem po zaslugi zaraščanja z gozdom in urbanizacije, v državah Evropske zveze pa za 4 % (ibid.).

Najintenzivnejša kmetijska pridelava poteka na njivskih, vinogradniških in sadjarskih zemljiščih, zato so te površine najbolj podvržene agrarnemu obremenjevanju. V državah Evropske zveze je delež njiv od skupne kmetijske zemlje skoraj 55 %, v Sloveniji pa manj kot tretjina – 30 % (ibid.). Njive so torej omejene na majhne površine, njihov delež v Sloveniji pa je, poleg Irske, je najmanjši med državami Evropske zveze. Na prebivalca Slovenije imamo 0,12 ha njiv, kar predstavlja kritično mejo za zagotovitev prehranske samooskrbe (Gabrovec, Kladnik, 1996). Skoraj dve tretjini kmetijskih zemljišč pa zavzemajo travniki in pašniki, ki so okoljevarstveno ugodnejša oblika rabe zemljišč, saj ne zahtevajo tolikšnih energetskih in snovnih vnosov za njihovo ohranjanje. V državah Evropske zveze je delež travniških zemljišč od kmetijskih le tretjina.

Najugodnejša območja za intenzivno poljedelsko pridelavo v Sloveniji so ravnine in gričevja v Panonskem svetu in druga manjša sklenjena območja na dnu kotlin in ravnin. V nižinah je več kot četrtina kmetijskih zemljišč – 28 %, kar 72 % kmetijskih zemljišč pa je v predelih s slabimi naravnimi razmerami: gričevnato-hribovska – 28 %, gorsko-višinska – 21 %, kraška – 13 %, idr. območja 10 % (Slovensko kmetijstvo v številkah, 1994). Med zemljiškimi kategorijami na ravninah zavzemajo njive 40 % od vseh, gozd pa 20 %. Obratno je v hribovskih in kraških območjih, kjer je njiv okoli 8 % in gozda skoraj 60 % (Gabrovec, Kladnik, 1996). V ravninah in na dnu kotlin je agrarno obremenjevanje največje, vendar ta območja zavzemajo le desetino zemljišč v Sloveniji. Ravninskega sveta je v Sloveniji 10 % (Perko, 1991) in njivskih zemljišč leta 1995 11.6 % skupne površine (Statistični letopis, 1996). Kljub temu pa vidimo, da v ravninah obremenjevanje ponekod že dobiva lokalne razsežnosti (onesnaženje vodnega vira v Skorbi) in celo regionalne npr. Dravsko-Ptujsko polje in Pomurje (onesnaženje podtalnice).

Zemljiško sestavo obravnavanih pokrajin in kmetij nam prikazuje karta 4. Največ obdelovalnih površin je v ravninskih (63 %) in gričevnatih pokrajinah (65 %), kjer njihov delež v povprečju znaša okoli dve tret-

jini. Največji delež obdelovalnih zemljišč imajo kmetije na Dravsko-Ptujskem polju (79 %), Krško-Brežiški ravnini (73 %), med gričevji pa v Goriških brdih (73 %) in Kozjanskem gričevju (71 %). Najmanjši delež obdelovalnih zemljišč pa imajo kmetije na Kamniškobistriški ravnini (50 %), Kranjsko-Sorškem polju (53 %) in v Halozah med gričevji (53 %). Kot lahko vidimo, je tako v ravninskih kot tudi v gričevnatih pokrajinah obdelovalnih zemljišč, in s tem zemljišč z agrarnim obremenjevanjem, več kot polovica in v Panonskem svetu tudi več kot tri četrtine. Med obdelovalnimi površinami izstopajo njive.

Na kmetijah v hribovskih pokrajinah je delež obdelovalnih zemljišč precej nižji (43 %), izjemoma pa se, zaradi ugodnih naravnih razmer, povzpne do polovice npr. Pohorje (52 %) in Mirnska dolina in Raduljsko hribovje (55 %). Podobne so razmere tudi v kraških pokrajinah z deležem obdelovalnih zemljišč okoli tretjine. Med njimi izstopa Bela krajina s 55 % deležem. Prevladujoči zemljiški kategoriji med obdelovalnimi površinami sta: travniki in pašniki.

Agrarno obremenjevanje je največje, kot smo že omenili, na njivskih, vinogradniških in sadjarskih površinah. Vendar so njive glede na njihov delež v zemljiški sestavi najpomembnejše. Na ravninskih kmetijah zavzemajo njive 32 % vseh zemljiških kategorij ali več kot polovico obdelovalnih zemljišč (na Dravsko-Ptujskem polju 70 % obdelovalnih zemljišč, na Krško-Brežiški ravnini 51 %, v drugih ravninskih pokrajinah pa manj kot polovico). Sorazmerno visok je delež njiv tudi v gričevju, saj v povprečju znaša tretjino (v Slovenskih goricah skoraj polovico – 47 %). Med anketiranimi kmetijami v hribovju in kraških pokrajinah je znašal delež njiv od obdelovalnih zemljišč tretjino oz. polovico.

V deležu travnikov med obravnavanimi pokrajinskimi tipi ni tolikšnih razlik kot so pri njivah. Travniki zavzemajo v povprečju petino do četrtino vseh zemljišč, njihov delež je v gričevju le nekoliko večji kot drugod. Največji delež travnikov je na kmetijah v hribovitih in kraških pokrajinah, kjer je njihov delež od obdelovalnih zemljišč polovica do dve tretjini. V gričevju imajo kmetije že polovico zemljišč v travniški rabi. Med ravninskimi pokrajinami izstopajo kmetije na Ljubljanskem barju z 61 % travnikov od obdelovalnih zemljišč. Visok delež travnikov je posledica specifičnih naravnih razmer v Sloveniji, kjer med reliefnimi enotami prevladuje hribovski svet s 46 %, velik pa je tudi delež gričevij 34 % (Perko, 1991). Velik delež travinja – tako pašnikov kot travnikov (63 %), ki je značilen za slovensko kmetijstvo in je dvakrat večji od povprečja drugih držav Evropske zveze (Erjavec et al. 1997), lahko z okoljevarstvenega vidika označimo kot prednost. Omenjene površine so, kot bomo videli kasneje, energetsko in snovno bistveno manj obremenjene od njivskih. Povprečna letna poraba mineralnih gnojil na njivah analiziranih kmetij je bila 450 kg/ha in na travnikih dvakrat manj – 237 kg/ha.

Zemljiška raba je osnova za nadaljnje okoljsko vrednotenje kmetijstva. Analize zemljiške rabe na anketiranih kmetijah, kot tudi primerjave s Slovenijo kot celoto in drugimi državami Evropske zveze pa niso pokazale, da bi bila le-ta glavni vzrok za obremenjevanje s strani kmetijstva. Delež njiv v strukturi rabe je, z izjemo ravnin in gričevij, majhen in tu se odvija najintenzivnejše pridelovanje. Majhen je tudi delež trajnih nasadov, ki podobno kot njive zahtevajo intenzivno pridelavo. Dve tretjini kmetijskih zemljišč pa zavzemajo travniške površine, kjer je za ustrezen pridelek potrebno gnojenje. Z okoljevarstvenega vidika značilnosti rabe zemljišč, z izjemo ravninskih in kraških območij, ne moremo označiti kot problematično.

5. Kmetijstvo v luči obremenjevanja okolja

Intenzivnost kmetijstva oz. kmetijske pridelave določa, kakšni so učinki v pokrajini. O intenzivnosti pričajo hektarski donosi, ki so posledica različnih dejavnosti oz. postopkov med pridelavo. Poleg kvalitetnih semen sta pomembna zlasti skrb za primerno oskrbo rastlin s hranilnimi snovmi in varstvo rastlin pred škodljivci in boleznimi. Kvalitetna semena zagotavlja, preko zakonskih določil, država in so na voljo kmetovalcem. Skrb za primerno oskrbo s hranilnimi snovmi in varovanje rastlin pa je v zasebnem sektorju prepuščena posameznikom. Od njihovega znanja in osveščenosti je odvisen način ravnanja s temi snovmi v pokrajini. K dvigovanju znanja in osveščenosti kmetovalcev je veliko prispevala agronomska znanost in zlasti v lokalnih razmerah pospeševalna služba.

Zanimalo nas je, kakšna sta obseg in stopnja uporabe hranilnih snovi (organskih in mineralnih) in sredstev za varstvo rastlin ter kakšne so navade kmetovalcev pri uporabi teh sredstev.

5.1. Uporaba gnoja in gnojevke

Pri gnojenju obdelovalnih površin kmetovalci večinoma kombinirajo uporabo gnoja in mineralnih gnojil. Kombinirano gnoji 87 % vseh vprašanih kmetovalcev. Delež kmetovalcev, ki gnojijo izključno z mineralnimi gnojili je majhen, le 4 % in takšen način je pogostejši v Goriških brdih, na Krško-Brežiški ravnini in v Kozjanskem gričevju. Izključno z gnojem gnoji 9 % vprašanih in pomemben je zlasti v Posavskem hribovju, Ribniško-Kočevskem podolju in Škofjeloškem hribovju.

Omenili smo že, da ima pri usmerjenosti kmetijske pridelave v Sloveniji pomembno mesto živinoreja. Kmečkih gospodarstev, ki ne bi redila živine skoraj ni in zato se vsa srečujejo tudi s problemom gospodarjenja z gnojem in gnojevko. Za agrarno obremenjevanje okolja je zlasti pomembno dvoje: koliko je gnoja in gnojevke v primerjavi z obdelovalnimi zemljišči, kjer se uporabljata in kako se uporabljata.

Na obravnavanih kmetijah smo kmetovalce spraševali o porabljeni količini gnoja in gnojevke. naredili smo tudi izračun količin gnoja na osnovi staleža živine na kmetijah in vrednosti so se razlikovale za četrtino. Kmetovalci so navedli za četrtino višje količine gnoja in gnojevke kot sledijo iz staleža živine. To je lahko posledica načina izračuna iz GVŽ (glav velike živine), ki ne upošteva posebej gnoja in gnojevke, ali pa napake v odgovoru kmetovalcev. Za gospodarno oskrbovanje posevkov s hranili morajo kmetovalci poznati tako količino, kot vsebnost hranil v naravnih in mineralnih gnojilih, da se lahko odločajo za ustrezno rabo.

Letna poraba hlevskega gnoja in gnojevke znaša na obravnavanih kmetijah 9 m^3 gnoja in 6 m^3 gnojevke na ha obdelovalnih zemljišč (karta 5 in karta 6). Največ organskih gnojil se porabi na ravninah, kjer znaša povprečje 12 m^3 hlevskega gnoja in 11 m^3 gnojnice. Vendar so med ravninskimi pokrajinami velike razlike v porabi gnoja, kar gre pripisati predvsem usmeritvi kmetijstva na teh območjih. Največja poraba je bila ugotovljena na Kranjsko-Sorškem polju (25 m^3/ha), na Dravsko-Ptujskem polju, Krško-Brežiški ravnini in na Ljubljanskem barju pa se poraba giblje med 7 in 10 m^3/ha. Na Kamniškobistriški ravnini je bila s 6 m^3/ha poraba najmanjša.

Za četrtino nižja je poraba v kraških pokrajinah in znaša 9 m^3/ha gnoja in 8 m^3/ha gnojnice. Zaradi izrazite usmerjenosti v živinorejo je največja poraba v Ribniško-Kočevskem podolju, saj znaša 11 m^3/ha gnoja in 12 m^3/ha gnojnice. Zaradi velikega števila živine je velika poraba gnoja tudi v Dobrepolju 11 m^3/ha. Za polovico manjša poraba gnoja in gnojnice pa je v Beli krajini (4 in 7 m^3/ha).

V gričevnatih in hribovskih pokrajinah je poraba hlevskega gnoja in gnojevke podobna. Hlevskega gnoja porabijo 7 m^3/ha v gričevju in 8 m^3/ha v hribovju, gnojnice pa 3 m^3/ha v hribovju in 5 m^3/ha v gričevju. Z dvakrat višjo porabo od povprečne izstopata med hribovskimi pokrajinami Škofjeloško hribovje in med gričevnatimi Dravinjske gorice. Za polovico nižjo porabo od povprečne pa imajo Goriška Brda – 3 m^3/ha kar je najnižja poraba gnoja med vsemi obravnavanimi pokrajinami. Vzrok za to je v kmetijski usmeritvi in nizkemu številu živine. V hribovju je, kot je razvidno iz grafov, med vsemi pokrajinami najmanjša poraba gnojnice, kar je predvsem posledica pokrajinskih značilnosti (težja uporaba ustreznih strojev) in temu prilagojeni usmeritvi živinoreje (več je pašne živinoreje in usmerjenosti v pridelavo mesa).

Zadostne količine gnoja in gnojevke zmanjšujejo potrebo po mineralnih gnojilih. Zaradi polikulturne usmerjenosti (tudi mešane proizvodne usmerjenosti) večjega dela slovenskih kmetij je razpoložljiva količina gnoja in gnojevke odigrala okoljevarstveno ugodno vlogo. Izjema so intenzivne tržne kmetije in farme, kjer je razmerje med številom živine in obdelovalnimi površinami neustrezno. Sama količina gnoja zato ne bi smela povzročati okoljevarstvenih problemov, ki so, kot bomo videli kasneje, predvsem posledica neustrezno urejenih gnojnih jam in uporabe gnoja in gnojevke v vodovarstvenih območjih. Problem pa predstavlja tudi nezadostno poznavanje problematike onesnaževanja z nitrati s strani kmetovalcev. Pri rabi dušičnih gnojil je potrebno upoštevati hranila, ki se v tla vnašajo tako z organskimi kot tudi z mine-

ralnimi gnojili. Potrebno je torej ustrezno gospodarjenje s hranilnimi snovmi, za katerega je nujno poznavanje nekaterih značilnosti teh hranil (spiranje, kopičenje), poraba po posameznih kulturah in fizičnogeografskih značilnosti posameznih pokrajin (prsti, voda, …). Pomembno vlogo pri tem imajo pospeševalne službe, ki že organizirajo posamezne seminarje povezane s to problematiko.

5.2. Uporaba mineralnih gnojil

Kot smo že omenili je reja živine pomembna značilnost slovenskih, polikulturno usmerjenih, kmetij in tako lahko pričakujemo, da so mineralna gnojila predvsem v funkciji dognojevanja. Mineralna gnojila predstavljajo večinoma dodatek pri preskrbi rastlin s hranilnimi snovmi. Kombinirano gnoji, z organskimi in mineralnimi gnojili, kot smo že omenili, 79–94 % vprašanih kmetovalcev.

Povprečna porabljena količina mineralnih gnojil na obravnavanih kmetijah je bila 328 kg/ha obdelovalnih zemljišč. Po količini uporabljenih mineralnih gnojil prednjačijo kmetije na ravninah in v gričevju (karta 7). Razlike med njimi so majhne, saj znaša povprečna poraba na ravninah 439 kg/ha in v gričevju 435 kg/ha obdelovalnih zemljišč. Tako na ravninah (krmne rastline) kot tudi v gričevju (specialne kulture) je pridelava intenzivna in kljub uporabi organskih gnojil je potrebno dodajati še večje količine mineralnih gnojil. Razlike so pomembne tudi med naštetimi pokrajinami. Haloze z 266 kg/ha, Krško-Brežiška ravnina z 272 kg/ha in Kamniškobistriška ravnina z 296 kg mineralnih gnojil na ha obdelovalnih zemljišč so najmanjši porabniki le teh. Med največjimi porabniki pa so kmetije na Dravsko-Ptujskem polju (671 kg/ha), v Goriških Brdih (577 kg/ha) in na Kranjsko-Sorškem polju (575 kg/ha). V Goriških Brdih bi lahko visok delež uporabljenih mineralnih gnojil pripisali pomanjkanju organskih gnojil, kar pa ne moremo trditi za drugi dve pokrajini, kjer gre vzrok iskati predvsem v intenzivnosti pridelave. Na Dravsko-Ptujskem polju (okopavinsko-žitni sistem kmetijske rabe zemljišč) in na Kranjsko-Sorškem polju (okopavinsko-krmni sistem kmetijske rabe zemljišč) sta visoki tako uporaba organskih kot tudi mineralnih gnojil. Intenzivnost je tod gotovo med najvišjimi med slovenskimi pokrajinami.

Za polovico manjša je porabljena količina mineralnih gnojil v kraških pokrajinah (povprečje je 219 kg/ha) in za dve tretjini manjša v hribovskih pokrajinah (150 kg/ha). Najmanjša povprečna količina porabljenih mineralnih gnojil je bila ugotovljena na kmetijah Ribniško-Kočevskega podolja (75 kg/ha) in osrednjega dela Posavskega hribovja (79 kg/ha).

Več kot polovica mineralnih gnojil se porabi za gnojenje njiv (55 %), tretjina za gnojenje travnikov (35 %), 7 % za gnojenje vinogradov in 3 % za sadovnjake. Seveda so razlike med posameznimi pokrajinami in pokrajinskimi tipi, ki so posledica usmeritev v kmetijski pridelavi. V ravninah je delež mineralnih gnojil porabljenih za gnojenje njiv 64 % in travnikov 34 %. Le 2 % mineralnih gnojil se porabi za druge kmetijske kategorije, ki so tu le malenkostno prisotne. V gričevju je porabljenih mineralnih gnojil za njive 45 % in 32 % za travnike. Tu sta najbolj razširjeni kategoriji vinogradov in sadovnjakov za kateri se porabi 19 % in 5 % mineralnih gnojil. Med obravnavanimi pokrajinami izstopajo Goriška brda s sadjarsko-vinogradniško usmeritvijo, ker je delež mineralnih gnojil porabljenih v vinogradih 67 % in v sadovnjakih 23 %. V hribovskih pokrajinah se 40 % mineralnih gnojil porabi za gnojenje njiv in 54 % za gnojenje travnikov, za druge kulture se porabi še 6 % mineralnih gnojil. V treh kraških pokrajinah so razmere zelo raznolike. Na Dobrepolju in Ribniško-Kočevskem podolju večji delež mineralnih gnojil porabijo za gnojenje travnikov in v Beli krajini za gnojenje njiv.

Njivske in travniške kategorije so tiste, kjer se porabi večina mineralnih gnojil. Povprečna poraba znaša 451 kg/ha za njive in 237 kg/ha za travnike. V skladu s pričakovanji so pomembne razlike med posameznimi pokrajinskimi tipi. Največja poraba mineralnih gnojil je na njivah in travnikih v ravninah. Količina porabljenih mineralnih gnojil na ravninskih kmetijah je bila 578 kg/ha za njive in 377 kg/ha za travnike. Le malo manjša je bila poraba na hribovskih kmetijah, kjer je bilo povprečje za njive 535 kg/ha in za travnike 272 kg/ha. Druge kmetije po porabljeni količini zaostajajo. V kraških pokrajinah porabijo kmetije za njive v povprečju 244 kg/ha in v hribovskih 187 kg/ha. Za travnike porabijo kraške kmetije 189 kg/ha in hribovske 137 kg/ha.

Po mnenju agronomske stroke ob pravilni uporabi in odmerjanju hranilnih ne prihaja do stranskih učinkov na okolje pri gnojenju. Za to je pomembno ustrezno odločanje o gnojenju obdelovalnih zemljišč, ki praviloma temelji na znanju kmetovalcev, na analizah prsti in pridelkov. Tuje izkušnje govorijo o splošnih težavah pri izboljševanju prakse gnojenja in kot obetajoč navajajo pristop Danske, kjer se obvezno dokumentira menjavo rastlin in zahteve po gnojilih na vseh proizvodnih enotah (Germon, 1989).

Pri proučevanju smo ugotovili (graf 1), da se kmetovalci za gnojenje večinoma odločajo na osnovi lastnih izkušenj. Tako se odloča 75 % vseh vprašanih kmetovalcev. Za gnojenje s pomočjo občasnih analiz se odloča 11 % vprašanih in 8 % s pomočjo rednih analiz zemlje.

Tudi po posameznih pokrajinskih tipih ni večjih razlik. Na osnovi lastnih izkušenj se odloča za gnojenje 83 % kmetovalcev v gričevju, 80 % kmetovalcev v kraških pokrajinah, 73 % kmetovalcev v ravninah in 69 % kmetovalcev v hribovju. Ob pomoči občasnih analiz gnoji 17 % kmetovalcev v ravninah, 11 % kmetovalcev v gričevju, 9 % kmetovalcev v hribovju in 5 % kmetovalcev v kraških pokrajinah. Za redne analize zemlje pa se odloča le 7 % kmetovalcev na ravninah, 3 % v gričevju, 11 % v hribovju in 13 % na krasu. Največji delež kmetov se je občasno odločal za analize na Kranjsko-Sorškem polju 33 %, v Goriških brdih 25 %, na Dravsko-Ptujskem polju 20 %, v Brkinih 18 % in v osrednjem delu Posavskega hribovja 16 %. Redne analize zemlje pa je opravljalo 28 % kmetovalcev Ribniško-Kočevskega podolja, 24 % kmetovalcev Škofjeloškega hribovja in 22 % kmetovalcev iz zahodnega dela Posavskega hribovja. Preseneča, da so analize pogostejše v pokrajinah z živinorejsko in mešano usmeritvijo kmetovanja in manj v tistih s poljedelsko.

Analiza vrste in količine porabljenih mineralnih gnojil je pokazala, da kmetovalci uporabljajo povprečno okoli 7 različnih vrst mineralnih gnojil. Večinoma so to kompleksna gnojila (npk), urea in kan. Količinsko prevladuje uporaba kompleksnega gnojila z enakim deležem hranilnih snovi (npk 15 : 15 : 15), kar kaže na to, da se kmetovalci bojijo zmanjšanja pridelkov, če ne bodo obilno gnojili in da se odločajo po metodi »vsakega po malo ne more škoditi«, kar smo često srečevali pri terenskih razgovorih.

Zanimalo nas je ali si kmetovalci zapisujejo porabljene količine in vrste organskih in mineralnih gnojil, ki jih trosijo po obdelovalnih površinah. Odgovor je bil, z redkimi izjemami, negativen. Res izjemoma smo v posameznih pokrajinah naleteli na primere vzornega knjigovodstva na kmetijah, a običajno so bili to le zgolj stroškovniki. Opisane razmere pri kmetovalcih niso najbolj obetavne tudi v luči Uredbe o vnosu nevarnih snovi in rastlinskih hranil v tla (UL RS, št. 68/96), ki predpisuje tudi gospodarjenje z njimi.

Za preobremenjevanje okolja s hranilnimi snovmi je poleg pretirane količine dodanih gnojil, problematično tudi, kdaj jih dodajamo glede na potrebe kulturnih rastlin. Ob ustreznem gospodarjenju z njimi ne prihaja do izpiranja in izgub teh hranil. Da bi ugotovili, kakšna je osveščenost kmetovalcev o pomenu ustrezne količinske in časovne gnojilne prakse, smo jih spraševali, kdaj opravljajo osnovno in kdaj dopolnilno gnojenje kulturnih rastlin. Največji del kmetovalcev (73 %) opravlja zgolj osnovno gnojenje ob setvi ali tik pred njo. Le 27 % kmetovalcev se odloča za dopolnilno gnojenje.

Rezultati ankete kažejo na slabo gnojilno prakso naših kmetovalcev. Njihova ozaveščenost o potrebnem natančnem odmerjanju gnojil še ni dovolj visoka. Zato gotovo prihaja do občasnih preobremenitev voda in prsti na kar kažejo tudi podatki rednega spremljanja kakovosti voda (Kakovost voda …, 1997).

5.3. Obremenjevanje z dušikom

Neprimerno dodajanje organskih in mineralnih gnojil v kmetijstvu sta vir enega od osrednjih okoljskih problemov: neuravnotežene dušične bilance, katere posledica so onesnažene prsti in vode, med njimi zlasti podtalnica.

Dušik kmetovalci vnašajo v pokrajino z živinskimi in mineralnimi gnojili. Razmerje med obema je v večini pokrajin v prid živinskih gnojil, kar pomeni, da obravnavane kmetije še vedno več dušika vnesejo z gnojem in v manjši meri z gnojevko, kot z mineralnimi gnojili. Izjema sta le Goriška brda, kjer je delež

dušika iz živinskih gnojil 17 % in Kozjansko gričevje, kjer je delež 48 %. Med pokrajinskimi tipi pravzaprav izstopajo le ravnine, kjer je delež dušika iz živinskih gnojil le nekaj več kot polovica. Le tu je razmerje skoraj 1 : 1, v drugih pokrajinskih tipih pa se razmerje močno prevesi v prid dušiku iz živinskih gnojil in znaša skoraj 8 : 2. Za vse obravnavane kmetije velja (graf 2), da vnesejo dve tretjini dušika z živinskimi gnojili in eno tretjino z mineralnimi. Podobne zaključke o razmerah na slovenskih kmetijah navaja tudi Matičič s sodelavci (1995).

Med posameznimi pokrajinami in pokrajinskimi tipi pa so razlike očitne. Povprečni delež dušika, vnesen z živinskimi gnojili, je bil po posameznih pokrajinskih tipih naslednji. Le majhne razlike so bile med povprečjem na ravninah 55 % in v gričevju 57 %, vendar je pri gričevnatih pokrajinah velika notranja raznolikost. Za polovico večji je bil vnos dušika v hribovju 72 % in v kraških pokrajinah 74 %. Obratno sorazmeren je vnos dušika z mineralnimi gnojili, kjer je na ravninah znašal 45 %, v gričevju 43 %, v hribovju 28 % in v kraških pokrajinah 26 %.

Posamezne pokrajine pa so se glede na vnos dušika na ha obdelovalnih zemljišč razvrstile v naslednje razrede. Več kot 400 kg N/ha je znašal vnos le v Dravinjskih goricah – 800 kg N/ha, zaradi večjega števila rejcev perutnine. Med pokrajine z do 400 kg N/ha spadajo Dravsko-Ptujsko polje, Kranjsko-Sorško polje in Dobrepolje. Največ – devet pokrajin se je uvrstilo v razred od 101 do 200 kg N/ha. To so Pohorje, Haloze, Kozjansko gričevje, Mirnska dolina in Raduljsko hribovje, Krško-Brežiška ravnina, Bela krajina, Robniško-Kočevsko podolje, Ljubljansko barje in Kamniškobistriška ravnina. V skupino z vnosi do 100 kg N/ha pa so se uvrstile Slovenske gorice, Posavsko hribovje, Škofjeloško hribovje, Brkini in Goriška Brda. Za slednja je značilno, da vnašajo sorazmerno velike količine mineralnih gnojil pri kmetijski pridelavi, vendar se pretežno vinogradniška usmeritev naslanja na spoznanja kmetijske stroke zadnjih let, da sta količina nitratov in količina pridelanega grozdja v obratnem sorazmerju s kakovostjo (Šikovčeva, 1992).

Če si ogledamo, kakšna je gostota vnosov dušika na hektar obdelovalnih zemljišč po posameznih pokrajinah in tipih ugotovimo naslednje: največji vnos se pojavlja v gričevju in znaša 258 kg N/ha. Pripisati ga moremo usmerjenosti kmetijstva v teh območjih, kjer se poljedelstvu in živinoreji pridružijo še specialne kulture: sadjarstvo in vinogradništvo. V obravnavanih pokrajinah močno izstopajo Dravinjske gorice, kjer smo, kot smo že omenili, zajeli v analizo petino kmetij, kjer so redili kokoši in piščance. Brez Dravinjskih goric bi bilo povprečje nižje od ravninskih in kraških pokrajin in bi znašalo 121 kg N/ha. Sledijo ravninske pokrajine z vnosom 188 kg N/ha, kraške pokrajine s 179 kg N/ha in hribovite pokrajine s 100 kg N/ha. Povprečje obravnavanih kmetij je bilo 190 kg N/ha.

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Čeprav Uredba o vnosu nevarnih snovi in rastlinskih hranil v tla (1996) predpisuje mejne vrednosti letnega vnosa dušika 210 kg/ha si oglejmo vnose na obravnavanih kmetijah še v tej luči. Vnosi dušika z živinskimi in mineralnimi gnojili presegajo 210 kg dušika na ha v Dravinjskih goricah (806 kg N/ha, kot posledica vključenega večjega števila rejcev perutnine), na Kranjsko-Sorškem polju (297 kg N/ha) in Dobrepolju (279 kg N/ha). Med pokrajinami, ki se mejni vrednosti precej približajo pa so še: Dravsko-Ptujsko polje (204 kg N/ha), Kozjansko gričevje (194 kg N/ha), Ljubljansko barje (176 kg N/ha) in Bela krajina (151 kg N/ha). Omenili smo že, da je dušika iz mineralnih gnojil tretjina in dve tretjini iz živinskih gnojil. Depozit dušika iz atmosfere znaša v Sloveniji letno 20 kg N/ha in njegov delež je majhen (Matičič s sodel., 1995).

Primerjava obravnavanih dušičnih vnosov z dosedanjimi študijami, ki so bile opravljene na večjih slovenskih pokrajinah pokažejo (ibid.), da podrobnejše študije sliko sicer dopolnjujejo, vendar hkrati opozarjajo na pomanjkljivost povprečnih vrednosti v pokrajinsko zelo raznoliki Sloveniji. Matičič s sodel. (1995) navaja povprečno vrednost skupnega dušika 137 kg/ha, 90 kg N/ha je iz živinskih gnojil in 47 kg N/ha je iz mineralnih gnojil. Na vseh obravnavanih kmetijah je skupni vnos, kot smo že omenili 190 kg N/ha. Največji hektarski skupni vnos je v gričevju, kjer znaša 258 kg, za tretjino manjši je v ravninah – 188 kg in v kraških pokrajinah – 179 kg ter najmanjši v hribovju – 100 kg. Po merilih Evropske skupnosti velja, da je določena pokrajina občutljiva na izpiranje nitratov takrat, ko je dušika več kot 100 kg/ha (ibid.). Te vrednosti presega več kot dve tretjini obravnavanih pokrajin: vse obravnavane ravninske pokrajine, vse obravnavane kraške pokrajine, med gričevnatimi pokrajinami Dravinjske gorice, Kozjansko gričevje in Haloze ter Raduljsko hribovje i Minsko dolino in Pohorje med hribovitimi pokrajinami.

Razvrstitev posameznih anketiranih kmetij po razredih glede na vnos dušika na ha obdelovalnih zemljišč nam kaže karta 8. Dve tretjini kmetij v ravninah in gričevju, skoraj polovica v kraških pokrajinah in tretjina kmetij v hribovju se glede na vnose uvrščajo v srednja dva razreda z vnosi 51 do 100 kg N/ha in 101 do 200 kg N/ha. Nad 200 kg N/ha porabi 15 % ravninskih kmetij, 13 % kmetij v gričevju, 5 % kmetij v kraških pokrajinah in 2 % v hribovju. Najmanjši vnos, manj kot 50 kg N/ha, je na hribovskih kmetijah – takšnih je 64 % kmetij in v kraških pokrajinah, kjer je tovrstnih 51 % kmetij. V ravninah je vnos dušika manjši od 50 kg N/ha na četrtini kmetij in v gričevju na petini.

5.4. Uporaba sredstev za varstvo rastlin

Danes si kmetovanja brez uporabe sredstev za varstvo rastlin skoraj ni mogoče več zamisliti. 93 % vprašanih kmetovalcev je uporabljalo ta sredstva in le 7 % jih ni uporabljalo. Razlike med posameznimi regijami so majhne, nekoliko manjši delež porabljenih sredstev so izkazovale le hribovske pokrajine.

Povprečna poraba sredstev za varstvo rastlin na obravnavanih kmetijah je bila 3,42 kg/ha. Največja je bila poraba v gričevnatih pokrajinah – 9 kg/ha obdelovalnih zemljišč, kar gre predvsem na račun usmeritve teh pokrajin v sadjarstvo in vinogradništvo in večjih količin porabljenih fungicidnih sredstev. V ravninskih pokrajinah je poraba znašala 2 kg/ha in v kraških pokrajinah 1 kg/ha. Najmanjša je bila v hribovskih pokrajinah, kjer je znašala 0,88 kg/ha.

Karta 9 nam prikazuje porabljeno količino sredstev za varstvo rastlin po regijah in njihovo notranjo strukturo. Največja poraba teh sredstev je v Goriških brdih, kjer znaša 35,2 kg Na ha obdelovalnih zemljišč in kar je posledica izrazite usmerjenosti te pokrajine v vinogradništvo. Do 6 kg sredstev za varstvo rastlin na ha, kolikor je tudi povprečna poraba vzorca kmetovalcev, imata še Krško-Brežiška ravnina (4,8 kg/ha) in Kozjansko gričevje (4,4 kg/ha). Večina pokrajin (11) ima porabo do 3 kg Na ha, v Brkinih poraba znaša 0,6 kg Na ha, najmanjša poraba pa je v Škofjeloškem hribovju (0,3 kg/ha), Posavskem hribovju (0,2 kg/ha) in Ribniško-Kočevskem podolju (0,1 kg/ha).

Notranja raznolikost glede porabe po pokrajinah je velika, vendar v grobem razlikujemo dve skupini pokrajin. V prvi skupini so pokrajine z nizko porabo sredstev za varstvo rastlin, kjer tudi v notranji strukturi prevladujejo kmetovalci z najnižjo porabo (Škofjeloško hribovje, Posavsko hribovje, Ribniško-Kočevsko podolje, Brkini), drugi razredi pa so ustrezno nižji. V drugi skupini so pokrajine z višjo porabo teh sredstev, kjer je v notranji strukturi polovica in več kmetovalcev, ki porabijo več kot 9 kg sredstev za varstvo rastlin na ha.

Analiza o vrstah porabljenih sredstev je pokazala, da so vsi kmetovalci uporabljali 110 različnih sredstev za varstvo rastlin. Največ so jih uporabili v gričevju, 38 različnih vrst. Na ravninah so uporabili 30 različnih vrst sredstev za varstvo rastlin in v hribovju in na krasu po 22 vrst. Dravinjske gorice (45), Goriška Brda (44) in Haloze (42) uporabljajo največje število zaščitnih sredstev, kar je nedvomno posledica njihove usmeritve v vinogradništvo in sadjarstvo in s tem večje in raznovrstnejše potrebe po teh sredstvih. Najmanj pa so jih porabili v Škofjeloškem hribovju (10) in Ribniško-Kočevskem podolju (11).

Pri uporabi sredstev za varstvo rastlin se je skoraj polovica kmetovalcev ravnala po navodilih proizvajalca – 47 %, petina je upoštevala lastne izkušnje in navodila proizvajalca in 13 % le lastne izkušnje. Po nasvetih pospeševalcev se je odločalo le 5 % kmetovalcev. Vendar je potrebno ob tem povedati, da je bilo ob razgovorih na terenu marsikje vplive svetovalne službe bolj čutiti, kot kaže omenjeni odgovor. Svetovalna služba je v zadnjih letih veliko storila za tovrstno ozaveščanje prebivalstva, čeprav so še vedno precejšnje razlike med pokrajinami. Še vedno pa je odločanje o tako pomembnem problemu v kmetijstvu povečini prepuščeno kmetovalčevi samoiniciativi, kar z okoljevarstvenega stališča ni najbolj ugodno. Na to so nas opozorili tudi primeri iz Bele krajine in Dravsko-Ptujskega polja, kjer so kmetovalci porabili največ pesticidov, katerih uporaba na kraških oziroma plitvih in lahkih prsteh sploh ni dovoljena.

Glede na to, da se kmetovalci pri škropljenju večinoma ravnajo po nasvetih proizvajalcev, nas je zanimalo, kakšno je med njimi poznavanje pojma karenca. Pozna ga 79 % vseh kmetovalcev, 12 % je odgovorilo nejasno in le 4 % pojma bodisi niso poznali, ali pa so napačno odgovorili. Najboljše poznavanje pojma so izkazali kmetovalci na ravninah, kar je z okoljevarstvenega vidika ugodno, saj so ravnine in gričevja tista, kjer je razširjenost uporabe teh sredstev največja.

Ozaveščenost o nujnosti pravilne rabe teh sredstev smo poskušali zajeti še preko dveh vprašanj: preko načina zavarovanja ob škropljenju in preko ravnanja z ostanki teh sredstev. Tretjina kmetovalcev ne uporablja zaščite ob nanosu teh sredstev, slaba petina uporablja zaščitno obleko in ravno toliko masko. 12 % kmetovalcev uporablja ob nanosu sredstev vse troje: zaščitno obleko, rokavice in masko. Ocenjujemo, da je tovrstna zaščita še vedno na neprimerni ravni in nezadostna. Razlike med posameznimi pokrajinami niso velike.

Ostankov sredstev za varstvo rastlin po nanosu nima 72 % vprašanih kmetovalcev. Dvanajstina vprašanih ostanke izlije na zemljo in 1 % v vodo. Razlike med posameznimi pokrajinami so tudi pri tem odgovoru majhne, manj primerno pa je da 10 % vprašanih na ravninah in 13 % vprašanih na krasu izlije ostanke na zemljo.

Pri ravnanju in osveščenosti kmetovalcev glede škropljenja so pomembno vlogo odigrale pospeševalne službe v različnih okoljih, s svetovanjem, prirejanjem tečajev in uvajanjem servisiranja škropilnic v pooblaščenih servisih (kmetijska svetovalna služba, 1996, 1997, 1998). Tudi splošna osveščenost strokovne javnosti je večja, na kar kažejo organizirani posveti v zadnjem času (Dušik – naravovarstvena paradigma, 1996, Kmetijstvo, ki ohranja biološko raznovrstnost, 1996). Kljub temu je iz rezultatov razvidno, da dosežena stopnja osveščenosti slovenskih kmetovalcev glede okoljskih vplivov kmetovanja ni zadostna.

6. Sklep

Opravljena raziskava je potrdila, da je razpršena kmetijska dejavnost pomemben vir obremenjevanja okolja. V pokrajinsko raznoliki Sloveniji se razmere na kratke razdalje hitro spreminjajo. Rezultati so pokazali, da je bila upravičena delitev pokrajin na posamezne pokrajinske tipe. Razlike med njimi so pomembne. V ospredju kmetijskega obremenjevanja so brez dvoma ravnine, za katerimi pa le malo zaostajajo gričevnate pokrajine. Obojim bi bilo potrebno v bodoče posvetiti še podrobnejša preučevanja in redna celoletna zajemanja vzorcev voda, kar bi dodatno osvetlilo učinke kmetijskega obremenjevanja. Prav tako je pri ukrepih za zmanjševanje obremenitev okolja zaradi kmetijstva potrebno upoštevati slovenske družbenogospodarske posebnosti pri kmetijski pridelavi: prevladujoč delež mešanih gospodinjstev, v starostni sestavi prevladujoč delež generacijskih gospodinjstev, prevladujočo poklicno izobrazbo kmetovalcev, ki pa je le izjemoma povezana s kmetijskimi poklici in veliko razparceliranost kmetijskih zemljišč.