THE IMPACT OF AGRICULTURE ON THE ENVIRONMENT IN GORENJSKE DOBRAVE FROM THE PERSPECTIVE OF ENERGY CONSUMPTION

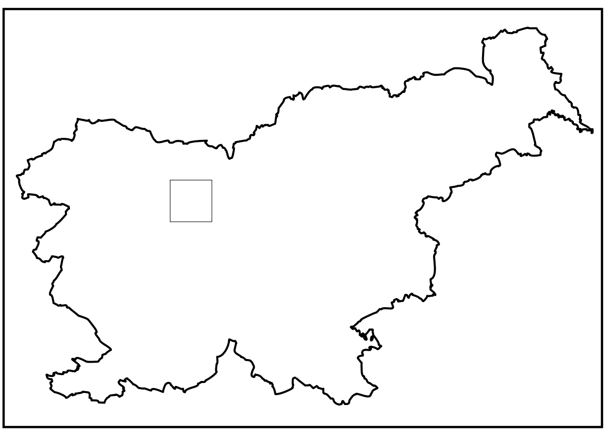
in the area of Goriče, Letenice, and Srednja vas

KMETIJSKO OBREMENJEVANJE OKOLJA NA GORENJSKIH DOBRAVAH V ENERGETSKI LUČI

na primeru naselij Goriče, Letenice in Srednja vas

Mimi Urbanc

Modern dairy farming is based on Holstein-Friesian cattle (photography Mimi Urbanc).
Krave holštajn-frizijske pasme so osnova moderne mlečne govedoreje (fotografija Mimi Urbanc).



Abstract UDC: 504.06:636.2

The impact of agriculture on the environment in Gorenjske Dobrave from the perspective of energy consumption in the area of Goriče, Letenice, and Srednja vas

KEY WORDS: rural geography, agriculture, environmental protection, energy inputs, Gorenjske Dobrave.

Under the influence of natural and social conditions, intensive dairy cattle breeding developed in the last decade in part of Gorenjske Dobrave, an area northwest of Ljubljana in the foothills of the Kamniške-Savinjske Alps. This rigorous specialization has brought exceptional yields but at the same time aroused concern due to its possible negative impact on the environment. This study attempts to evaluate the agriculture from the viewpoint of its effect on the landscape and to point to the possibilities for environmental pollution using a variety of indicators: yield per hectare, the impact of cattle breeding on the land, land use, and energy intensity. Today's agriculture with its modern agrotechnical processes and the use of chemicals increasingly approaches industrial methods of production and has a burdening effect on the environment due to its intensity. Agriculture burdens the environment with the use of mechanization, large energy inputs in the form of mineral and natural fertilizers, pesticides, and various land improvements. It pollutes important spheres of the human environment—air, soil, and water—but the contribution of agriculture is unclear due to the lack of research in this field and because it is difficult to determine the source of harmful materials in the environment, especially in densely settled regions where settling, traffic, industry, and agriculture are closely interwoven. It is clear, however, that with the intensification of agricultural production, the environmental impact and the possibilities for pollution increase. This study primarily points to the influences of agriculture on the environment and the potential possibilities for pollution. Finally, we attempted to show the actual pollution levels based on water and soil analyses.

Izvleček UDK: 504.06:636.2

Kmetijsko obremenjevanje okolja na Gorenjskih Dobravah v energetski luči na primeru naselij Goriče, Letenice in Srednja vas

KLJUČNE BESEDE: agrarna geografija, kmetijstvo, varstvo okolja, vnosi energije, Gorenjske Dobrave.

Pod vplivom naravnih in družbenih razmer se je v delu Gorenjskih Dobrav v zadnjem desetletju razvila intenzivna mlečna govedoreja, ki je s strogo specializacijo pripeljala do izrednih donosov, obenem pa zbuja pomisleke zaradi možnih negativnih vplivov na okolje. Članek poskuša ovrednotiti kmetijstvo z vidika vpliva na pokrajino in nakazati možnosti onesnaževanja okolja prek različnih pokazateljev, to je hektarskih donosov, živinorejske obremenjenosti tal, rabe tal in energijske intenzivnosti. Kajti današnje kmetijstvo se z modernimi agrotehničnimi procesi in kemizacijo vedno bolj približuje industrijskemu načinu pridelave in zaradi intenzivnosti deluje obremenjujoče na okolje. Kmetijstvo obremenjuje okolje z obdelavo z uporabo mehanizacije, velikimi vnosi energije predvsem v obliki mineralnih, naravnih gnojil in zaščitnih sredstev ter različnimi melioracijami. Onesnažuje pomembne sfere človekovega okolja: zrak, tla in vodo, vendar je delež kmetijstva nejasen, ker manjka tovrstnih raziskav in je težko določiti izvor škodljivih snovi v okolju, še zlasti v gosto naseljenih pokrajinah, kjer se poselitev, promet, industrija in kmetijstvo tesno prepletajo. Jasno pa je, da se z intenzifikacijo kmetijske pridelave obremenjevanje oz. možnost onesnaževanja stopnjuje. V članku so nakazani predvsem vplivi kmetijstva na okolje oz. potencialne možnosti onesnaženja, dejansko onesnaženje pa smo na koncu poskušali dokazati na osnovi analize voda in prsti.

Contents – Vsebina

Address – Naslov
Mimi Urbanc
Geografski inštitut Antona Melika ZRC SAZU
Gosposka 13
1000 Ljubljana
Slovenija
Phone – telefon: +386 (0)61 125 60 68
Fax – faks: +386 (0)61 125 77 93
E-mail – elektronska pošta: Mimi@alpha.zrc-sazu.si

1. Introduction

The burdening of the environment is a major issue in our everyday life important for our collective future. As a contributor to the overall impact on the environment, agricultural burdening is important, but there is insufficient research on the its effects. The attention of researchers has usually focused on densely populated industrial and urban agglomerations that were long considered the only source of pollution and whose effects were obvious. In contrast, agriculture was considered an activity in harmony with nature that helped preserve the environment, did not pollute it, and was therefore not problematic from the point of view of environmental protection. However, this was only true of extensive subsistence agriculture that preserved the cultural landscape.

With its modern agrotechnical processes and the use of chemicals, today's agriculture increasingly approaches industrial methods of production and has a burdening effect on the environment due to its energy intensity and spatial distribution. Individual examples of subsoil pollution indicate that Slovene agriculture, which according to hectare yield largely lags behind western European countries, also burdens the environment.

The primary focus of the study is the agriculture in part of Gorenjske Dobrave, an area northwest of Ljubljana in the foothills of the Kamniške-Savinjske Alps, specifically that around three villages below the Storžič mountain chain where extremely intensive dairy production has developed in the last decade. The object of the research was not the agriculture itself but rather its environmental protection aspects. We attempted to show the energy picture and evaluate it from the point of view of its impact on the landscape and indicate the possibilities for the pollution of the environment.

The aims of the research were the following:

1. quantitative survey of the intensity of the studied farms on the basis of hectare yields, energy balance, and the impact on the land due to cattle breeding;
2. survey, explanation, and evaluation of the structure of energy intensity;
3. survey of the characteristics of agriculture in the studied area;
4. survey of the transformation of the environment due to agricultural land use and the consequent burdening of the landscape;
5. establishing the possible consequences of the pollution of the natural environment due to the energy intensity of agriculture;
6. establishing the actual pollution levels based on water and soil analyses.

2. Work methods

For the geographic description of the studied area we used general sources supplemented with cartographic material and in this way roughly outlined the physical and geographical elements of the environment. We based our survey of sociogeographical factors on the official census of the population and households or occupations. The basic data on the agriculture was gathered using questionnaires in the field, while for the critical evaluation of this data, information from the Kranj Geodetic Bureau, Mercator Dairy Kranj, and the Naklo Agricultural Cooperative was of great help. On the basis of comparisons, the evaluation and supplementation of the data, and finally its presentation in quantitative form, the basic characteristics of the agriculture here became evident from which we can calculate the burden on the environment. Special attention was paid to the sources from the field of agriculture, the ecological conditions for agricultural land use, the effects of agriculture on the environment, and specific familiarization with the problems of dairy farming.

The information gathered was analyzed using statistical indexes including the index of the transformation of the environment due to agriculture and the coefficient of parceling and the average size of the parcels which indirectly indicates some of the properties of the agriculture and is interesting from the point of view of environmental protection. Further on, we attempted to evaluate the agriculture from the perspective of the impact on the landscape and to indicate possibilities for polluting the studied are using various indexes, specifically, hectare yield, the burden on the land due to cattle breeding, land use, and energy intensity. The analyses of the possible consequences of polluting the natural environment were supplemented with findings on the actual pollution based on water and soil analyses.

Twenty-six questionnaires were answered in the settlements of Goriče, Letenice, and Srednja vas. The sample included 52% of the households with an agricultural economy according to the 1991 census, that is, 89.6% of the households that have livestock as well as all the households and some others that send milk to the dairy. Two questionnaires were omitted from further analysis due to insufficient answers. The twenty-four questionnaires analyzed included the farms that have 97% of all the cattle in this area.

3. Some geographical characteristics

The villages in the study lie in the northern part of Gorenjske Dobrave on an alluvial fan surrounded by slightly undulating Tertiary hilly world of sandy and marl clay, marl, and sandstone. In the alluvial fan, poorly rounded gravel dominates that farther from the high mountain world becomes smaller and increasingly sorted (Šifrer, 1969). Streams have carved water channels though it, and the lowest bottoms are covered with Holocene alluvium in the form of clayey and sandy sediments originating in the nearby deeply weathered and less resistant rock. Wet soil occurred particularly at the transition from slope sediments to the inundated clayey plains in the valleys. Farther to the south, the surface descends toward the west where the bottoms of the valleys are about 15 to 20 meters lower and the streams have an almost insignificant gradient. Only part of the water therefore maintained its original course toward the south and the

Figure 2: The villages of Goriče, Letenice, and Srednja vas lie on an alluvial fan surrounded by a slightly undulating Tertiary hilly world (photography Mimi Urbanc).
Slika 2: Vasi Goriče, Letenice in Srednja vas ležijo na vršaju, obdanem z rahlo valovitim terciarnim gričevjem (fotografija Mimi Urbanc).

Figure 3: Individual cultivated fields are situated only in the eastern flat and dry area (photography Mimi Urbanc).
Slika 3: Redke njive ležijo samo na zahodnem uravnanem in sušnejšem svetu (fotografija Mimi Urbanc).

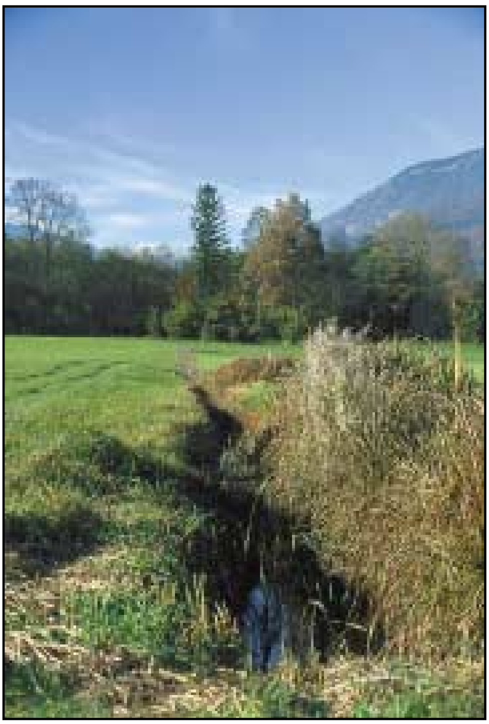


Figure 4: The eastern wetter and more undulating area is crisscrossed by numerous drainage channels (photography Mimi Urbanc).
Slika 4: Vzhodni mokrotnejši in bolj razgiban svet prepletajo številni kanali (fotografija Mimi Urbanc).

flow shifted westward. That is also the reason the eastern section, Goriško polje, is dry while the western section is marshy due to the low erosion capacity of the water, a fact confirmed by the names of local sites: *Na mlakah* (»at the pool»), *Trste* (»reeds»), *Ribjek* (»fish pond»), *V bajerju* (»in the pond»).

Goriče, Srednja vas, and Letenice make up the larger part of the local community of Goriče and are situated in the most northern or northwestern part of the Municipality of Kranj. They are about nine kilometers from the municipality center. They are located in the territory of two cadastral municipalities: Goriče, which lies entirely on flatland, and Srednja vas, which stretches onto the steep sunny slopes of the Kamniške Alps all the way to the ridge linking Zaloška gora (Tolsti vrh, 1715 m) in the west with Storžič (2132 m) in the east.

Agricultural land use depends on the following natural conditions (Jeršič, Pleško, 1975):
- pedological properties of the soil,
- climatic conditions,
- inclination and exposure to sun,
- altitude.

Pedological properties of the soil: the greatest proportion of agricultural production is on riverside eutric soils on alluvial sediment and fluvioglacial gravel that are gleyed in places. Cultivated fields are situated on the drier and deeper soil, as are meadows. Meadows are also partly situated on eutric hypogley on clay and silt and on eutric brown soil on grey siltstone. Approximately half of all the cultivable surface area is wet, which itself determines the land use, primarily presenting certain limitations in methods of cultivation, fertilizing, use of farm machinery, and scheduling of work.

Climatic conditions: the area falls in the temperate type of alpine climate, but due to the diversity of the relief, climate differences within short distances (horizontal and vertical) as a consequence of the site and the altitude. There is sufficient precipitation, and it is evenly distributed throughout the year with a primary maximum in November and a secondary maximum in the summer. The climate is more favourable than lower in Kranjsko polje, as the tables below reveal. There is less fog and more sunshine, and at the same time, the high mountain ridge protects the area from the cold north wind. The last day with frost

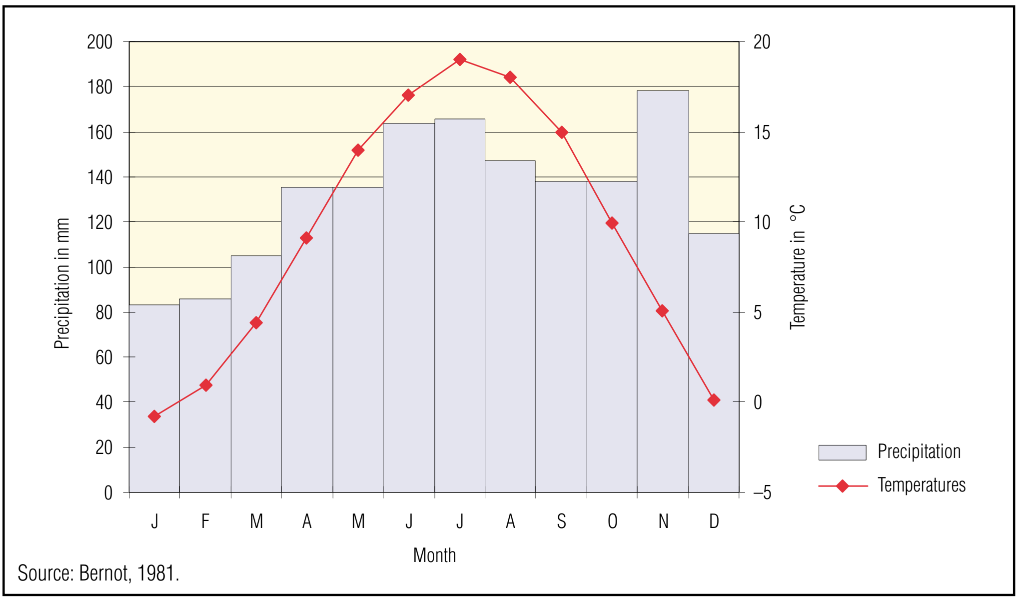


Figure 5: Mean monthly temperatures (C) and mean monthly amount of precipitation (mm) in Golnik for the 1956–1975 period.
Slika 5: Srednje mesečne temperature v °C in srednje mesečne višine padavin v mm na Golniku med letoma 1956 in 1975.

is April 11; in Brnik, May 1. There are 186 days without frost; in Brnik, 170. The sum of effective temperatures above 5° C is 3300; in Brnik, 2630. The number of days with temperatures above 5° C is 245; in Brnik, 225 (Gams, 1981). The meteorological station in Golnik was abandoned in 1975, and the data is therefore outdated.

TABLE 1: ABSOLUTE MINIMUM AIR TEMPERATURES (C) IN THE 1956–1975 PERIOD.
PREGLEDNICA 1: ABSOLUTNE MINIMALNE TEMPERATURE ZRAKA MED LETOMA 1956 IN 1975 V °C.

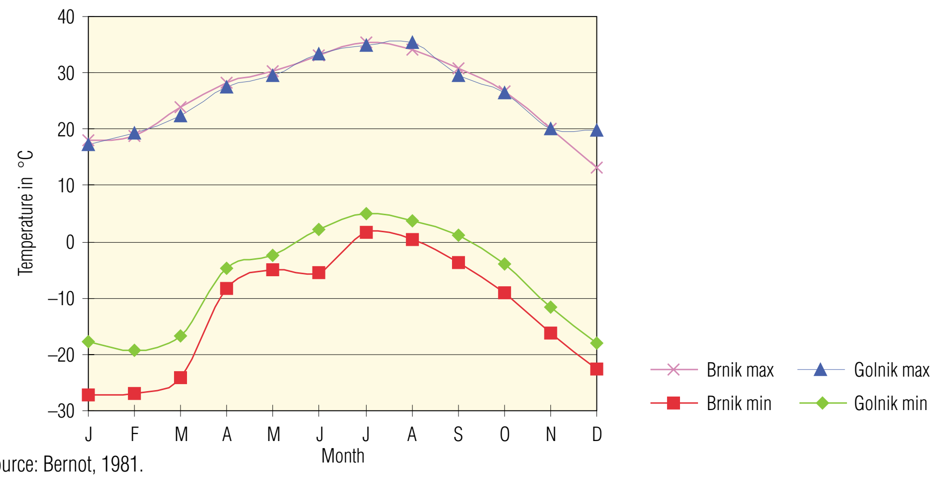
		J	F	M	A	M	J	J	A	S	O	N	D
Brnik	min	–27.2	–27	–24	–8.3	–5	–5.6	1.7	0.4	–3.8	–9	–16.3	–22.6
	d/y	23/63	15/56	1/63	9/65	8/57	11/56	9/69	20/68	18/71	27/73	25/65	30/68
Golnik	min	–17.8	–19.3	–16.6	–4.7	–2.5	2.3	5.1	3.6	1.2	–3.9	–11.7	–18
	d/y	28/58	10/56	1/63	9/56	8/57	10/62	24/60	27/66	30/59	22/72	25/65	19/63

d = day, y = year
Source: Bernot, 1981.

TABLE 2: MEAN MONTHLY AND YEARLY AIR TEMPERATURES (C) IN GOLNIK AND BRNIK IN THE 1956–1975 PERIOD.
PREGLEDNICA 2: SREDNJE MESEČNE IN LETNE TEMPERATURE ZRAKA NA GOLNIKU IN BRNIKU V °C MED LETOMA 1956 IN 1975.

Station	altitude	J	F	M	A	M	J	J	A	S	O	N	D	Average
Brnik	373 m	–2.6	–0.6	3	8.1	13	16	18	17	13	8	3.8	–1.4	8
Golnik	500 m	–0.8	0.9	4.4	9.1	14	17	19	18	15	9.9	5.1	0.1	9.2

Source: Bernot, 1981.



Source: Bernot, 1981.

Figure 6: Absolute maximum and absolute minimum temperatures in Golnik and Brnik in the 1956–1975 period.
Slika 6: Absolutne maksimalne in absolutne minimalne temperature na Golniku in Brniku med letoma 1956–1975.

Precipitation has a powerful influence since larger quantities are a limiting factor due to the retention capacity of the clay soil. In the event of stronger rains, the water stands on the surface and the soil in that period is actually unsuitable for cultivation. Wetter soil must be cultivated with care since the use of heavy farm machinery can cause great damage to the grass turf. At the same time, due to the poor permeability of the soil, farmers can later be affected by drought. Fertilization requires a certain amount of moisture, although too much results in the leaching of nutritive substances from liquid dung and mineral fertilizers that are therefore lost to the growing plants and simultaneously burden both underground and surface waters.

TABLE 3: MEAN MONTHLY AND YEARLY PRECIPITATION (MM) IN GOLNIK FOR THE PERIODS 1931–1960 AND 1956–1975.
PREGLEDNICA 3: SREDNJE MESEČNE IN LETNA VIŠINA PADAVIN (MM) NA GOLNIKU ZA OBDOBJI MED LETOMA 1931 IN 1960 TER 1956 IN 1975.

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Golnik 1931–1960	102	103	96	115	148	178	149	153	185	176	161	126	1692
Golnik 1956–1975	83	86	105	135	135	164	166	147	138	138	178	115	1590

Source: Bernot, 1981.

TABLE 4: MAXIMUM DAILY PRECIPITATION (MM) IN GOLNIK IN THE 1956–1975 PERIOD.
PREGLEDNICA 4: MAKSIMALNE DNEVNE VIŠINE PADAVIN (MM) NA GOLNIKU MED LETOMA 1956 IN 1975.

	J	F	M	A	M	J	J	A	S	O	N	D
Mm	63.2	57.6	88.3	65.3	71.7	93.5	75.9	67.2	82.2	114.5	109.2	59.9
d/y	21/58	27/58	20/73	10/73	16/61	30/74	11/64	22/69	23/58	9/64	2/58	7/61

d = day, y = year
Source: Bernot, 1981.

TABLE 5: MAXIMUM NUMBER OF DAYS WITH PRECIPITATION (DAILY PRECIPITATION 0.1 MM) IN GOLNIK IN THE 1965–1975 PERIOD.
PREGLEDNICA 5: MAKSIMALNO ŠTEVILO DNI S PADAVINAMI (DNEVNA VIŠINA PADAVIN 0,1 MM) NA GOLNIKU MED LETOMA 1956 IN 1975.

J	F	M	A	M	J	J	A	S	O	N	D	Year
10.1	9.6	12.1	13.4	13.4	15.1	12.9	13.3	10.0	9.2	14.4	10.3	143.8

Source: Bernot, 1981

Inclination and exposure to sun: The greater part of the agricultural land lies on flatland with inclinations of less than 6°. Goriško polje is flat, while the wetter area to the west is somewhat more undulating, although the use of farm machinery is still possible. Only the slopes above streams and the contact area between Tertiary hilly world and the gravelly flatland are steeper. Recently, some of these steeper surfaces have again been overgrown by forest. The entire area rises gently toward the north. The western section, Goriško polje, is particularly open toward the south and therefore more exposed to the sun. The western section of the area where individual meadows are encircled by forest is partly on the sunny side.

Altitude: the villages studied lie at altitudes between 440 and 500 meters. The cultivable land used by the farmers of the villages mostly lies below 480 meters. Only a few farmers have higher land.

Higher temperatures and greater exposure to sun along with less fog and frost are extremely important for the agriculture of the villages studied. Heavy clay soil is colder and warms more slowly than light sandy soil. In spite of the favourable temperature conditions, the farmers must plant earlier types of silage corn and do their sowing in dry weather.

4. Agriculture in the light of environmental impact

4.1. Main Characteristics of Agriculture

The undulating terrain with its dominant heavy clay and moist soil was most suited to cattle breeding. The proximity of Kranj with its strong industrialization and urbanization was significant for the development of agriculture and also for socioeconomic development in general. The regular sale of farm products was guaranteed, especially of meat and milk. Because of more immediate payment, milk production

Figure 7: Due to its general practicality, baling hay in plastic rolls is a common practice; however, it can spoil the appearance of a village (photography Mimi Urbanc).
Slika 7: Siliranje v okrogle bale je zaradi uporabnosti vse privlačnejše, obenem pa močno kvari izgled vasi (fotografija Mimi Urbanc).

became ever more important. Thus, in the last decade, farmers became oriented toward intensive dairy cattle breeding. Strict specialization brought about large yields that guaranteed survival in the changing economic situation. In Twenty-four households jointly produced 2,202,609 liters of milk in 1995 with some households exceeding 200,000 liters.

On the basis of socioeconomic analyses of the households surveyed, we get the following breakdown of households with farm economies: of twenty-four households, we have nine pure and two potentially pure farming households. There are five mixed households, and eight are supplementary. There are no aged households, although two households without heirs will fall into this category, one of which is today a pure farm, the other supplementary.[1]

The farms surveyed had a total of 466 hectares of their own land with an average size of around nineteen hectares. The greater part is forest; otherwise, meadows prevail while a few fields are devoted to growing corn. Farms are heavily burdened with mechanization, especially compared to the amount of property involved. The land shortage problem is solved through leasing, the purchase of fodder (especially corn and commercial fodder), and intensive fertilizing. Some further characteristics are shown in the figures and tables below.

[1] Socioeconomic types of farms; *pure farm*: all family members in the active life period work only on the farm or are maintained by it. *Potentially pure farm*: only those family members are employed outside the farm who do not belong to the nuclear family. *Mixed farm:* at least one of the productively active members of the nuclear family works exclusively on the farm while simultaneously at least one is regularly employed outside the farm. *Supplementary farm:* all productively active members of the family are employed outside the farm and work on the farm only in their free time. *Aged farm:* all the members of the family are older than 64 and are engaged in farming (Kovačič, 1983).

Figure 8: Modern dairy farming has increasingly replaced the traditional Slovene *kozolec* with new methods of drying and storing fodder (photography Mimi Urbanc).
Slika 8: V modernem kmetijstvu kozolce vse pogosteje nadomeščajo novi načini shranjevanja krme (fotografija Mimi Urbanc).

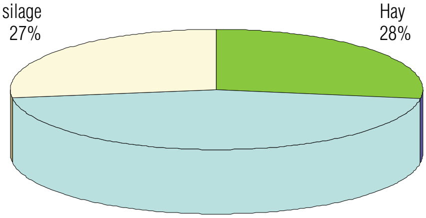


Figure 9: Proportion of individual types of fodder by weight.
Slika 9: Deleži posameznih vrst krme na osnovi teže.

TABLE 6: SURFACE AREAS AND PROPORTIONS OF LAND CATEGORIES IN 1983.
PREGLEDNICA 6: POVRŠINE IN DELEŽI POSAMEZNIH KATEGORIJ LETA 1983.

	Goriče		Srednja vas	
Category	ha	%	ha	%
Alpine meadows/pastures	5.6	1.5%	155.4	19.1%
Forest	169.5	44.3%	332.0	54.8%
Reed habitats	0	0%	0	0%
Barren	15.6	4.1%	17.9	2.9%
Fields	17.7	4.6%	20.6	3.4%
Meadows	148.9	38.9%	63.5	10.5%
Orchards	25.2	6.6%	16.0	2.6%
Total	382.5	100%	605.5	100%

Source: Kranj Geodetic Bureau.

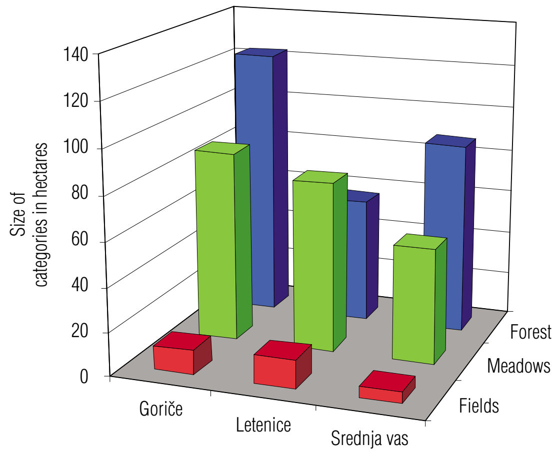


Figure 10: Land use on the farms surveyed.
Slika 10: Raba tal na anketiranih kmetijah.

TABLE 7: TOTAL SIZE AND SPECIFIC SIZE OF PROPERTIES BY HOUSEHOLDS.
PREGLEDNICA 7: SKUPNA VELIKOST POSESTI IN SPECIFIČNA VELIKOST POSESTI PO GOSPODINJSTVIH.

Type of farm		Total	Forest	Meadow	Field
		ha	ha	ha	ha
Pure	total	281	162.2	106	12.8
	per unit	25.5	14	9.6	1.2
Mixed	total	113	66	41	6
	per unit	22.6	13.2	8.2	1.2
Supplementary	total	71.4	40.2	29.3	1.9
	per unit	8.9	5.0	3.7	0.2
Total	all	465.4	268.4	176.3	20.7
	per unit	19.4	11.2	7.3	0.9

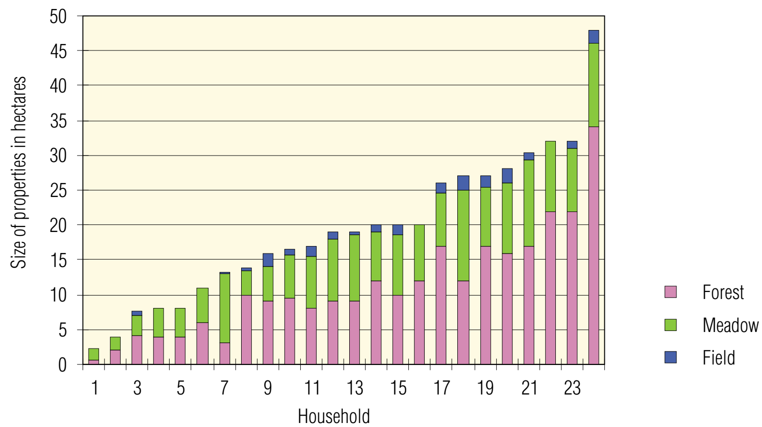


Figure 11: Size and structure of property belonging to individual households.
Slika 11: Velikost in struktura lastne posesti posameznih gospodinjstev.

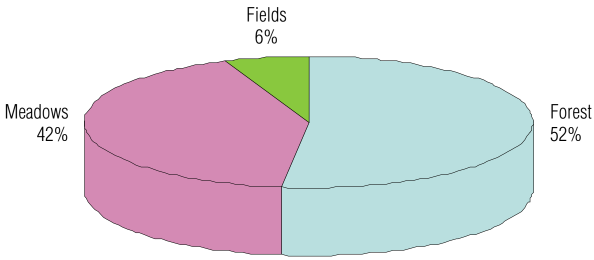


Figure 12: Structure of land use in the farms surveyed including leased land.
Slika 12: Struktura rabe tal na anketiranih kmetijah skupaj z najeto zemljo.

TABLE 8: COEFFICIENTS OF PARCEL DIVISION[2] AND AVERAGE SIZE OF PARCELS IN THE FARMS SURVEYED.
PREGLEDNICA 8: KOEFICIENTI RAZPARCELIRANOSTI IN POVPREČNE VELIKOSTI PARCEL NA ANKETIRANIH KMETIJAH.

	Parcel division			Average size in ha.		
Farms	farm land		used[3]	owned property		used
	total	cultivated		total	cultivated	
Pure	0.76	1.04	1.09	1.31	0.96	0.92
Mixed	0.70	0.91	0.96	1.43	1.09	1.04
Supplementary	0.99	1.25	1.22	1.01	0.80	0.82
Total	0.78	1.05	1.08	1.28	0.96	0.93

An important characteristic of the agriculture studied is the large average size of the parcels for Slovene conditions. The reasons are (possibly) the following:

- due to early industrialization, Gorenjska did not experience agrarian overpopulation and the pressure to divide the land was not as strong as elsewhere;
- the majority of the farms are protected, meaning that they can not be subdivided
- the farmers strive constantly to round off their property as much through purchase as by leasing. It is significant that those who border a parcel for sale have first purchase rights.

4.2. Intensity of Agriculture

In agriculture, only specialization and intensification of production ensure survival and an acceptable living standard. Large yields are enabled by sufficient amounts of fertilizer (domestic and purchased), pesticides, and fodder and fodder supplements, and larger yields mean lower costs per unit of product. Certain expenses are fixed (diesel fuel, amortization, labour) that with larger yields are distributed across many units.

Intensive fertilization is the basic characteristic of modern farming, and the area studied is no exception. However, the use of mineral fertilizers (836 kg/ha) is modest, especially when compared to the Slovene average of 975 kg/ha in 1987 (Ministry for Agriculture, cited by Lampič), and the average quoted by Radinja

[2] The parcel division coefficient is inversely proportional to the coefficient of the average size of the parcel.
[3] Used land is all cultivated land, owned, and leased, not including land leased to other farmers. It includes all the land the farmers cultivate.

for the surveyed farms is even lower, totaling 763 kg/ha (Radinja, 1991). The reason lies in the large quantities of natural manure (an annual total of 12,077 m^3 of liquid dung) produced through intensive cattle breeding with large cattle breeding density. From the energy viewpoint, natural manure represents more than half of what is shown in Figure 13, where because of the various measurement units relative to energy value based on nutrients it is converted into GER.[4] Natural manure equals 220 tons of mineral fertilizer, indicating that fertilization is extremely intensive.

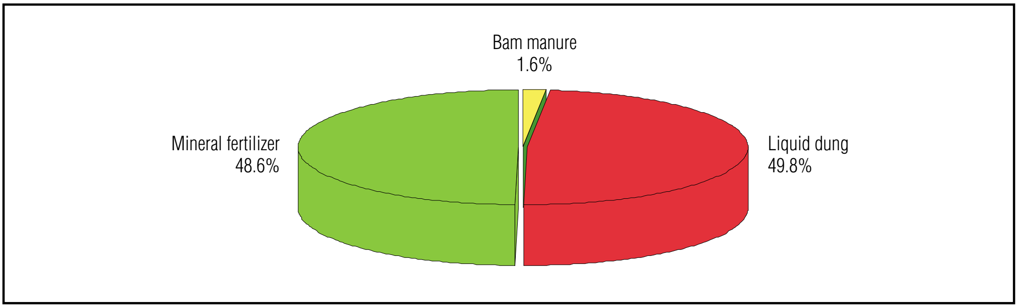


Figure 13: Proportion of natural and artificial fertilizers based on the energy value of the nutrients.
Slika 13: Delež naravnega in umetnega gnoja na osnovi energetske vrednosti hranil.

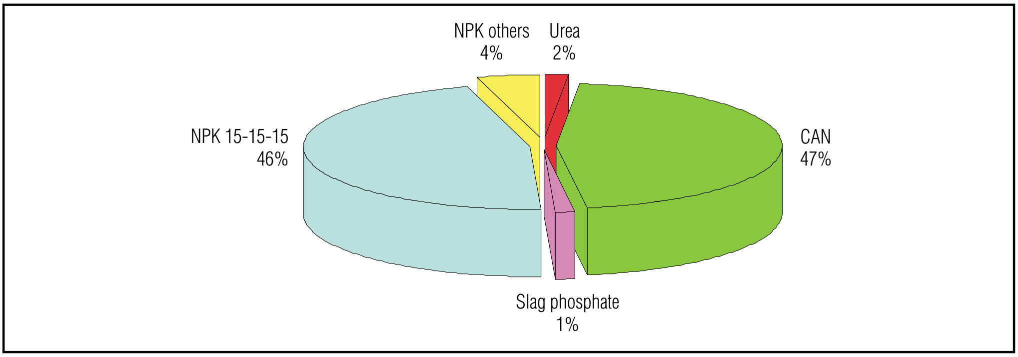


Figure 14: Proportion of individual types of mineral fertilizer according to weight.
Slika 14: Deleži posameznih vrst mineralnih gnojil glede na njihovo težo.

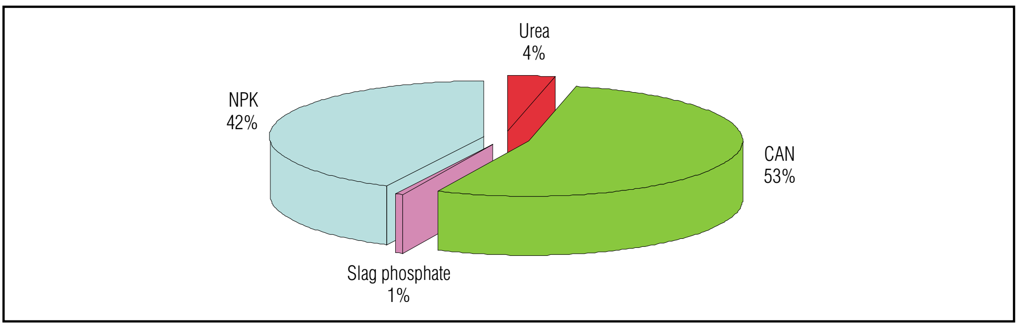


Figure 15: Structure of mineral fertilizers on the basis of energy value.
Slika 15: Struktura mineralnih gnojil na osnovi energetske vrednosti.

[4] Gross Energy Requirements

Due to the specific agricultural orientation, the use of pesticides is very small. Pests and disease do not (yet) threaten the meadows and fields of silage corn. From the energy viewpoint, the proportion of pesticides is quite small. Nevertheless, their influence on the living world greatly exceeds their quantity and energy value, and due to their toxicity we must pay great attention to them.

Diesel fuel is the basic source of power in agriculture since only a small proportion of agricultural machinery works on electricity. Among the oil derivatives, it is most important, while gasoline use is significant only in those households where farming is a supplementary activity.

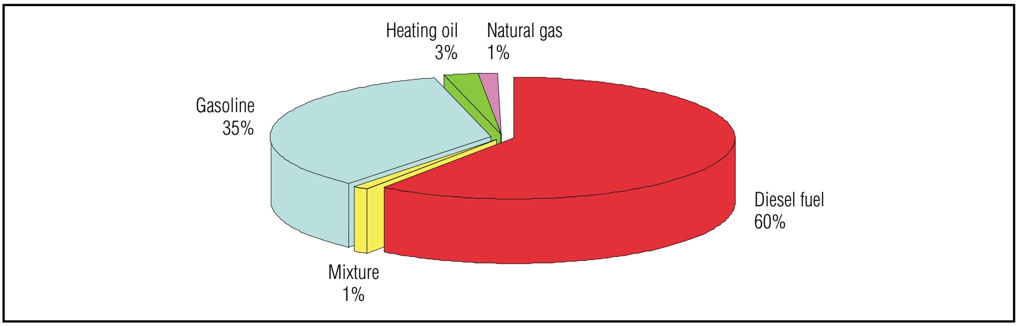


Figure 16: Structure of the use of oil derivatives.
Slika 16: Struktura porabe tekočih derivatov.

The specific use of diesel fuel per hectare of cultivable land is relatively small given the intensity of the agriculture. The minimum use is 43.4 l/ha, and the maximum 339.8 l/ha, an average of 194.3 l/ha, which is lower than the Slovene average (Radinja, 1991). The reasons are the following:

- low fragmentation of land; the average size of a parcel is about one hectare,
- proximity of other parcels,
- the largest users have a wide range of tractors of varying power,
- silage corn and grass silage in round rolls require only a few working hours,
- the number of hours for drying hay is minimized by the forced drying of hay with electric ventilators and solar energy,
- regular delivery of milk to the dairy and the delivery of fodder and mineral fertilizers to farms is provided.

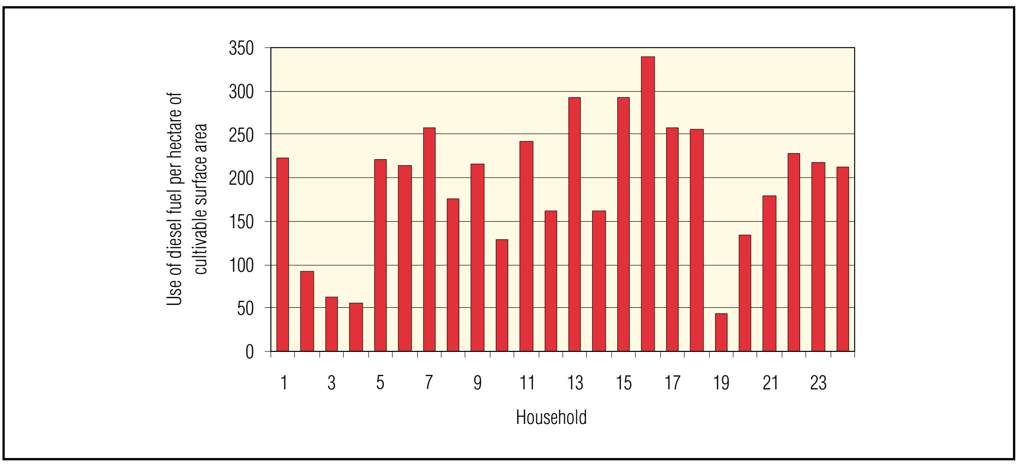


Figure 17: Use of diesel fuel per hectare of cultivable surface area.
Slika 17: Struktura porabe tekočih derivatov po tipu gospodinjstev.

In contrast to the rest of Slovenia where the number of livestock has decreased in recent decades, in the studied settlements the number of livestock has increased, especially in the last five years, particularly on pure farms. In 1995, there were altogether 830 head of dairy cattle; other species are modestly represented (Figure 18) as their numbers have decreased steadily.

TABLE 9: INDEXES OF THE INCREASE OF LIVESTOCK IN THE STUDIED SETTLEMENTS IN THE 1985–1995 PERIOD (1985 = 00).
PREGLEDNICA 9: INDEKSI RASTI ŽIVINE V IZBRANIH NASELJIH MED LETOMA 1985 IN 1995 (LETO 1985 = 00).

	Cattle	Pigs
1989	112.2	60
1995	140.9	60

Source: Naklo AC, 1996 questionnaire.

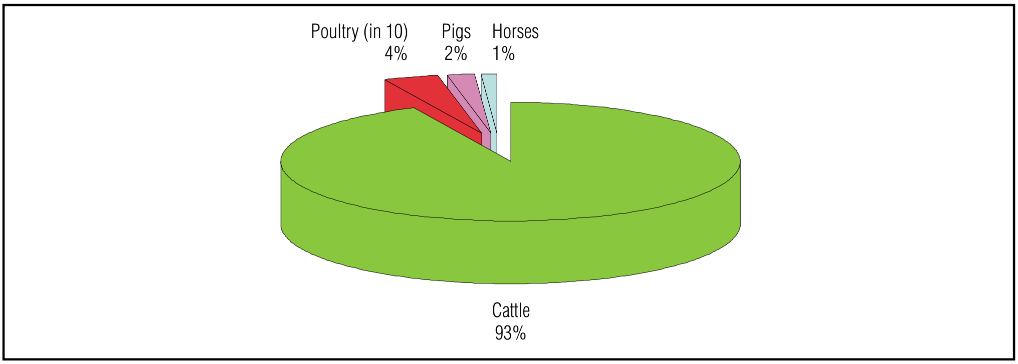


Figure 18: Structure of livestock in the studied settlements in 1995.
Slika 18: Struktura živine v izbranih naseljih v letu 1995.

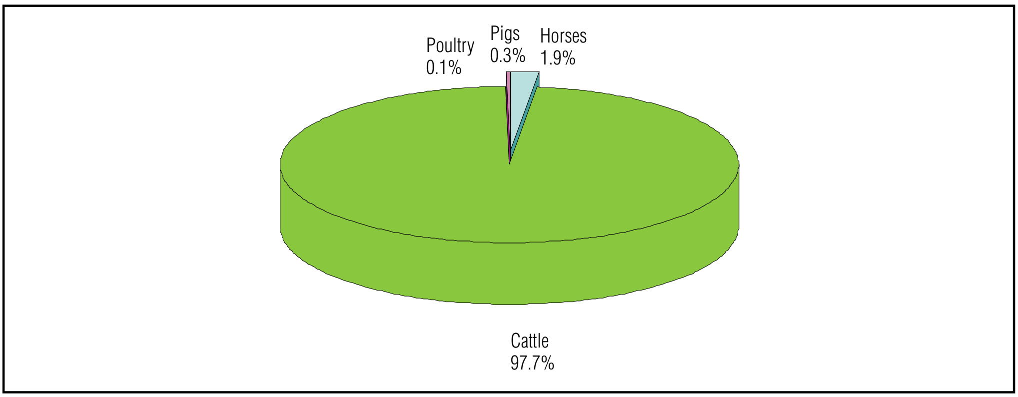


Figure 19: Proportion of individual types of animals in LU (Livestock Units).
Slika 19: Deleži posameznih vrst živali, izraženi v GNŽ.

Among other things, the intensity of cattle breeding is indicated by the cattle breeding density[5] which simultaneously shows where the concentration of production occurs and the resulting greater burdening of the environment due to larger inputs of energy and large quantities of natural manure. The average cattle breeding density for the farms surveyed is 2.53, substantially higher than the Slovene average (Statistics Annual,

[5] Number of animals per hectare of cultivable surface area

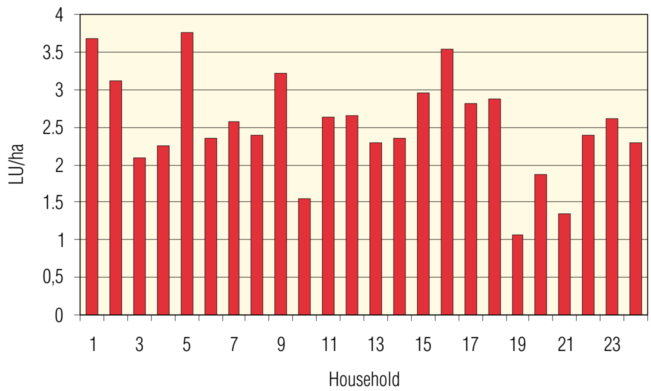


Figure 20: Households according to cattle breeding density.
Slika 20: Gospodinjstva po živinorejski gostoti.

1986, 1993), which is 0.9 LU/ha of cultivable surface area. There are large differences among individual households: The lowest density is 1.1 LU/ha and the highest 3.8 LU/ha.

The highest acceptable cattle breeding density is three LU/ha. At this density, organic manure can be used on the available surface area without negative effects (Leskošek, 1993). Higher densities, however, mean burdening the environment with organic remains. A good fifth of the households exceed this limit, on average by 0.5 LU/ha, and 26.5% of all the cultivable surface area (55 ha) is overburdened. We get a slightly different picture if we also consider the summer pastures for young cattle, although 48 hectares or 19.6% of all cultivable surface area still remains overburdened.

A high cattle breeding density means that the fodder the farms produce does not cover all their requirements; therefore, part of the fodder, fodder additives, and silage corn, as well as hay to a lesser extent, must be purchased. Figure 21 shows the structure of the fodder relative to weight, but we get a different picture if the specific types are suitably converted into Grain Units.[6] Silage corn maintains the largest proportion,

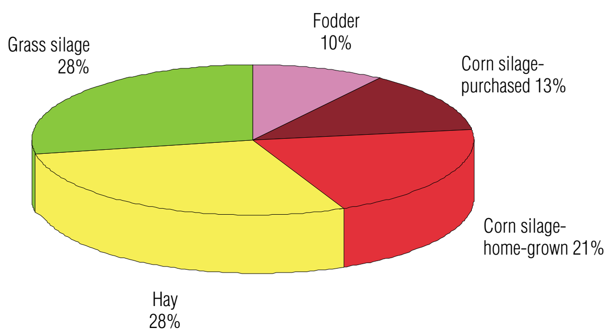


Figure 21: Structure of fodder by weight.
Slika 21: Struktura krme glede na njihovo težo.

[6] Number of Grain Units 100 kg or 100 l

Number of Grain Units	100 kg or 100 l
8	veal meat
1.2	milk
0.9	silage corn

while the proportion of hay is diminishing and the proportion of fodder increasing. This structure is typical for dairy cattle breeding farms where to achieve high milk production it is necessary to ensure not only a sufficient but also a balanced diet with certain qualitative properties provided by silage and fodder[7].

Detailed information about hectare yields in the narrower sense of the term is hard to get because basic cultures, that is, grass and corn, are intended exclusively as animal feed. The only indicator of the yields is milk production, which in the years following independence replaced the loss of income from forestry when the farmers greatly reduced cutting due to the fall in wood prices. Work in the forest was limited to the prepa-

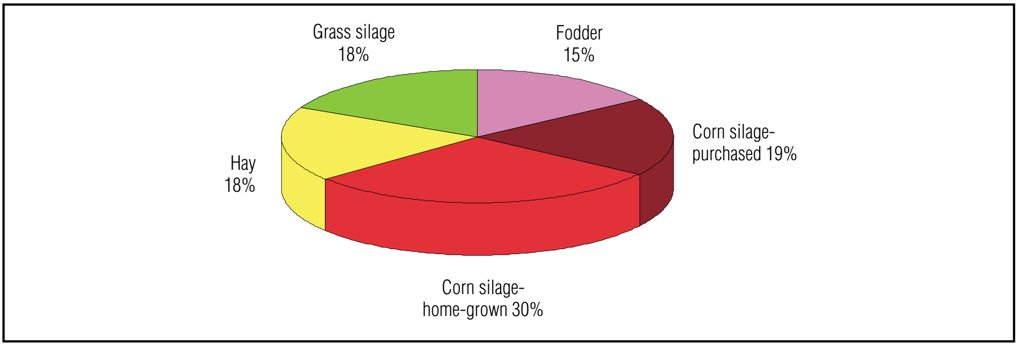


Figure 22: Structure of fodder on the basis of value in grain units.
Slika 22: Struktura krme na osnovi vrednosti v žitnih enotah.

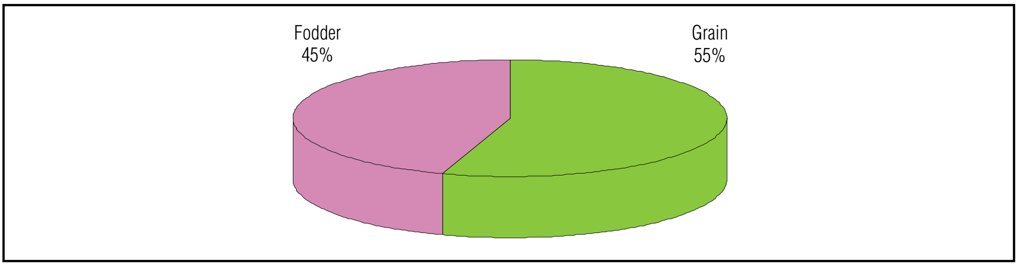


Figure 23: Structure of fodder additives by weight.
Slika 23: Struktura krmnih dodatkov glede na njihovo težo.

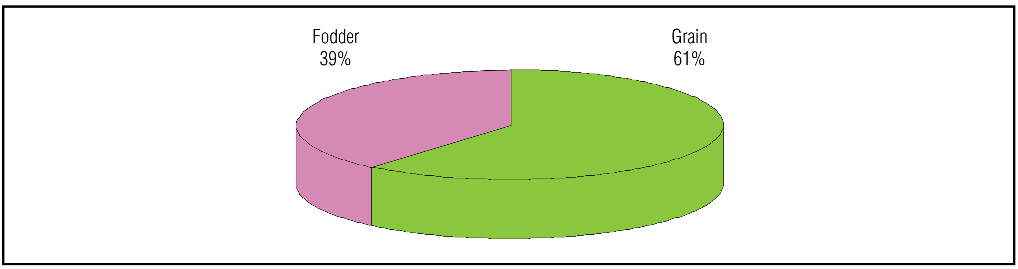


Figure 24: Structure of fodder additives by energy value.
Slika 24: Struktura krmnih dodatkov glede na energetsko vrednost.

[7] Fodder is divided into grain and fodder mixtures. Grain includes various types of wheat and other field crops: corn, barley, soy, sunflower husks, beet shreds, cotton, and molasses. Farmers mix and grind these themselves, producing energy-rich fodder full of carbohydrates and proteins. The second group includes various fodder mixtures based on various grains in different ratios, thermally processed and therefore easily digestible, with added vitamins, proteins, and minerals.

ration of firewood for domestic use and forest maintenance chores. Additional income is provided by calves and meat as a side product of milk production, while brandy making like wood has lost its significance. All other crops are primarily intended for home use. Milk production dictates the method of farming and its intensity. In 1995, they produced 2,201,609 liters of milk, of which 90% came from pure farms.

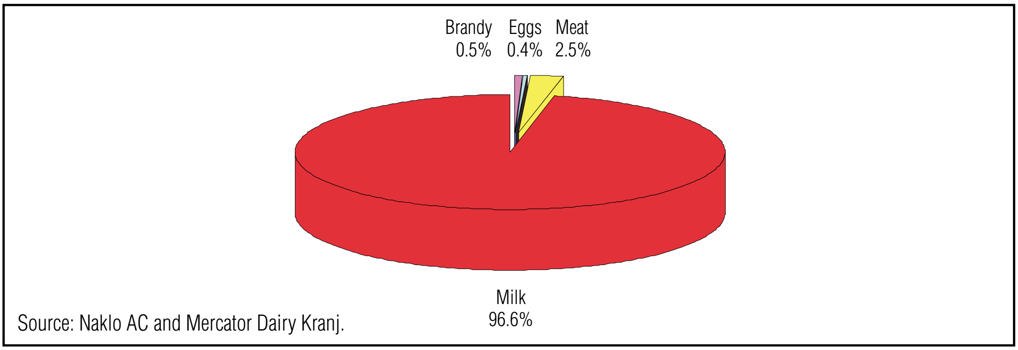


Figure 25: Structure of market maximums.
Slika 25: Struktura tržnih viškov.

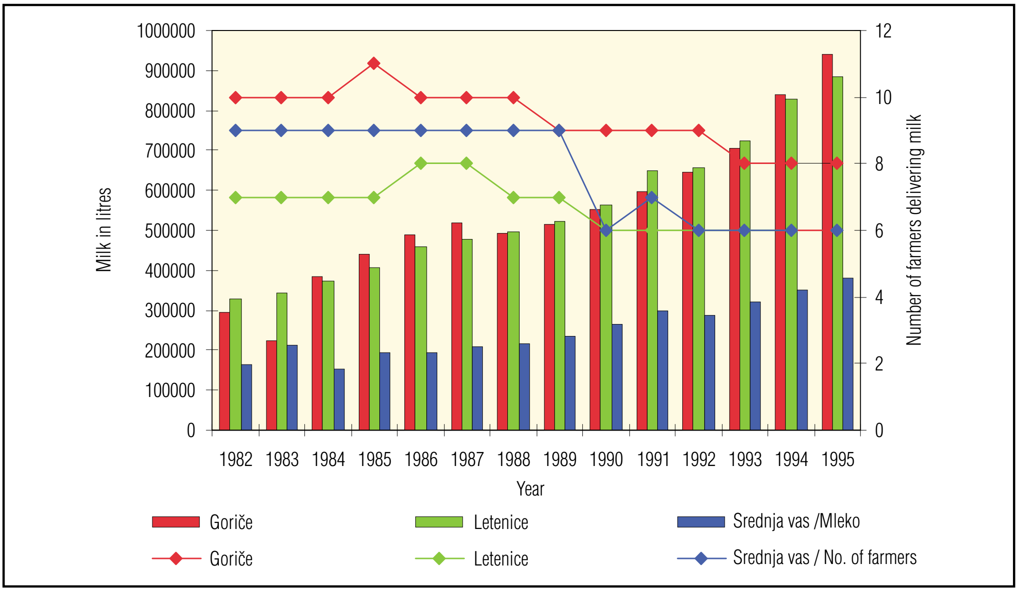


Figure 26: Growth of milk production and decrease in the number of farmers delivering milk in the studied settlements between 1982 and 1995.
Slika 26: Rast pridelave mleka in upadanje števila kmetov, ki mleko oddajajo v izbranih naseljih, od leta 1982 do 1995.

The increase in milk production occurred due to:

- specialization in dairy cattle breeding,
- increasing the size of herds,
- increasing the proportion of Holstein-Friesian cattle,
- leasing of new cultivable areas,
- larger hectare yields due to greater use of mineral fertilizers
- feeding cattle with fodder additives,
- new technologies in stable construction and milking methods.

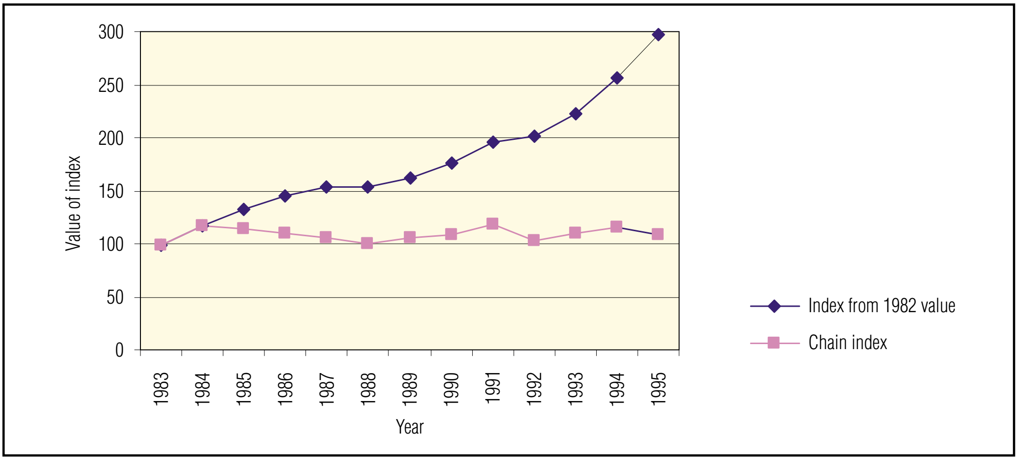


Figure 27: Indexes of the growth of milk production from 1982 to 1995.
Slika 27: Indeksi rasti pridelave mleka v letih od 1982 do 1995.

Milk production is one of the important indicators of the intensity of agriculture. The mean value is 5525 liters per cow, and the highest above 8000 liters, a remarkable achievement for Slovene conditions. The specific yield of milk per hectare is just as high, totaling 8591 liters and on pure farms, 9993 liters per hectare. Expressed in grain units, the yields are on average almost twice as high as those in Kranjsko polje (Lampič, 1994). That milk production is above all linked with large inputs of energy (ignoring expertise and technology) in the form of fertilizers, electricity, oil derivatives, fodder, and fodder additives is indicated by the correlation coefficient (0.71) between milk production and the fodder used.

4.3. Energy Inputs on the Studied Farms

The various types of energy that we have so far treated separately will be now compared and treated cumulatively. All the inputs in the form of mineral and organic fertilizers, electric energy, oil derivatives, fodder, and fodder additives will be converted to GER on the basis of their energy value. Their influence will be evaluated according to the criteria applied in Western Europe. According to Slesser, the limit at which their influence begins start to spread beyond the farm is 15 GJ/ha, while agriculture acquires features of industrial production at inputs above 40 GJ/ha. The upper limit is set at 60 GJ/ha of cultivable surface area.

Considering all direct inputs[8] per farm, we realize that the households achieve very high inputs of energy, as Table 10 shows. Altogether they introduce 20,424 GJ of direct energy: the most 1729 GJ, the least 122 GJ, and 851 GJ on average. We get a better picture of inputs if we link them to cultivable surface area. The limit of 15 GJ/ha is exceeded on all the studied farms, only one remains below 40 GJ/ha, and on average they reach 79 GJ/ha with a range from 30 to 108 GJ/ha.

TABLE 10: HOUSEHOLDS ACCORDING TO ABSOLUTE VALUES OF ENERGY.
PREGLEDNICA 10: GOSPODINJSTVA PO ABSOLUTNIH VNOSIH ENERGIJE.

Absolute inputs in GJ	<200	201–500	501–1200	201–1800	>1801
Number of households	3	5	6	8	2
Proportion in %	12.5	20.8	25	33.3	8.3

[8] All direct inputs include mineral and organic fertilizers, electric energy, pesticides, fodder additives and oil derivatives.

TABLE 11: HOUSEHOLDS ACCORDING TO ALL DIRECT INPUTS PER HECTARE OF CULTIVABLE LAND.
PREGLEDNICA 11: GOSPODINJSTVA PO VSEH NEPOSREDNIH VNOSIH NA HEKTAR OBDELOVALNE POVRŠINE.

GJ/ha	<35	36–50	51–65	66–80	81–100	>101
Number of households	1	2	1	7	10	3
Proportion in %	4.2	8.3	4.2	29.2	41.2	12.5

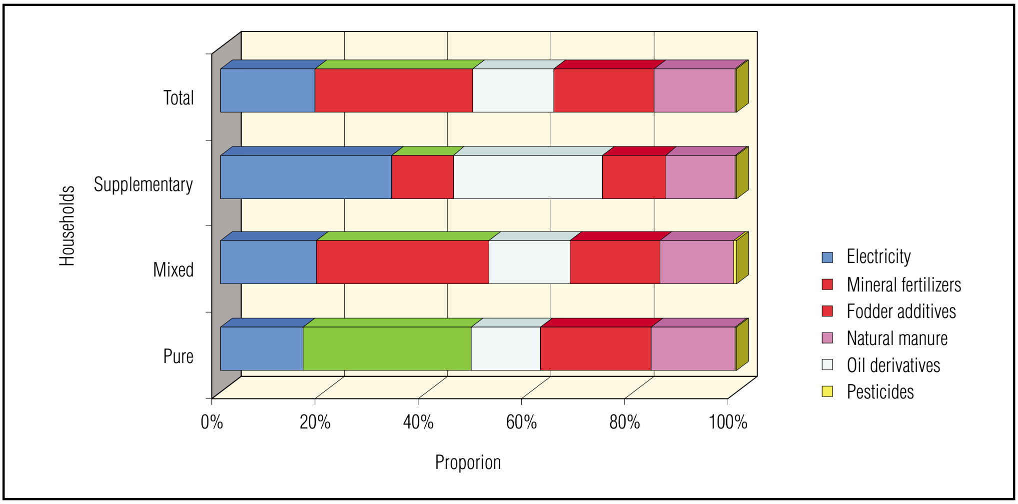


Figure 28: Structure of all direct energy inputs according to types of household.
Slika 28: Struktura vseh neposrednih energetskih vnosov po tipih gospodinjstva.

It is possible to exclude the use of electric energy, which does not pollute the environment where it is used but rather creates pollution where it is produced, particularly in the case of thermoelectric plants. Omitting electric energy input, we obtain 30% lower values on average for direct energy inputs per hectare of cultivable land. The mean value of inputs is now 66 GJ/ha, ranging from 24 to 89 GJ/ha, and the majority still exceeds Slesser's 40 GJ/ha critical limit.

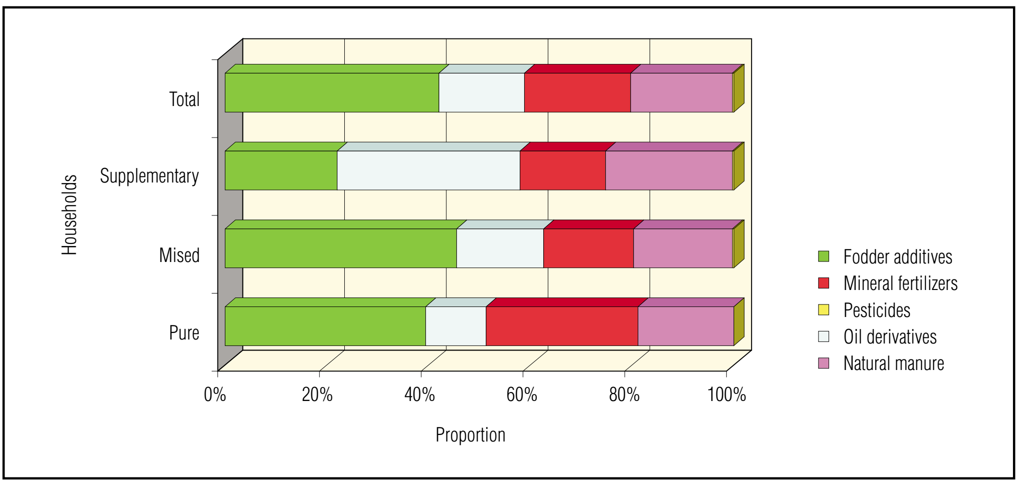


Figure 29: Structure of direct energy inputs without electric energy according to type of household.
Slika 29: Struktura neposrednih energetskih vnosov brez električne energije po tipih gospodinjstva.

TABLE 12: HOUSEHOLDS ACCORDING TO DIRECT INPUTS PER HECTARE OF CULTIVABLE SURFACE AREA EXCLUDING ELECTRICITY.
PREGLEDNICA 12: GOSPODINJSTVA PO NEPOSREDNIH VNOSIH NA HEKTAR OBDELOVALNE POVRŠINE BREZ ELEKTRIKE.

Inputs in GJ/ha	<25	26–40	41–55	56–70	71–85	>86
Number of households	1	4	3	8	6	2
Proportion in %	4.2	16.7	12.5	33.3	25	8.3

From the environmental protection point of view, the most urgent issue is the use of mineral fertilizers, oil derivatives, and pesticides that directly pollute the environment. Fodder additives certainly represent a large energy input but do not present a direct danger to the environment. Figure 30 shows a fundamentally different structure than the one for the surveyed Slovene farms cited by Radinja (1991), who established that the largest proportion falls to oil derivatives, on the average almost two thirds, while one third goes to mineral fertilizers. One of the peculiarities of the studied area is the large quantity of liquid dung, which represents a danger of pollution. Taking liquid dung reasonably into consideration, we obtain a structure of energy inputs that describes the actual danger to the environment.

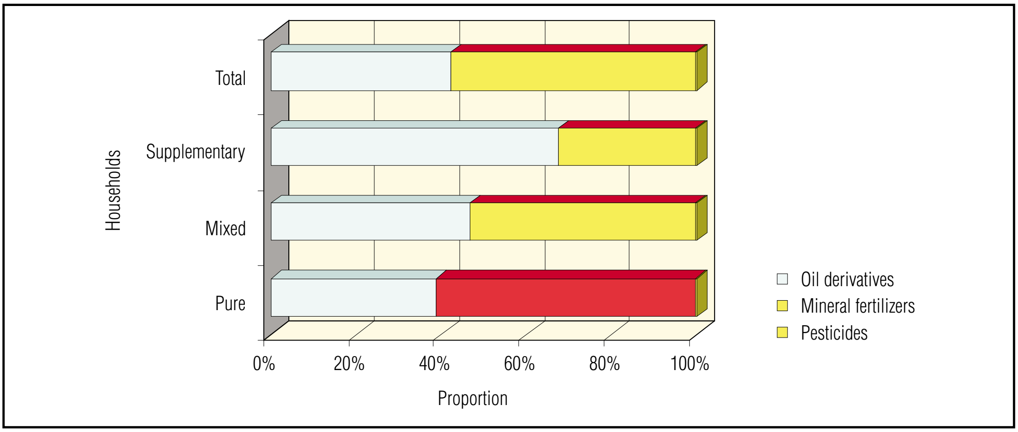


Figure 30: Structure of direct energy inputs of oil derivatives, mineral fertilizers, and pesticides.
Slika 30: Struktura neposrednih energetskih vnosov tekočih derivatov, mineralnih gnojil in zaščitnih sredstev.

TABLE 13: HOUSEHOLDS ACCORDING TO DIRECT ENERGY INPUTS OF OIL DERIVATIVES, MINERAL AND NATURAL FERTILIZERS, AND PESTICIDES.
PREGLEDNICA 13: GOSPODINJSTVA PO NEPOSREDNIH ENERGETSKIH VNOSIH TEKOČIH DERIVATOV, MINERALNEGA IN NARAVNEGA GNOJA TER ZAŠČITNIH SREDSTEV.

Inputs in GJ	<100	101–250	251–500	501–800	>801
Number of households	3	5	5	10	1
Proportion in %	12.5	20.8	20.8	41.7	4.2

TABLE 14: HOUSEHOLDS ACCORDING TO SPECIFIC ENERGY INPUTS OF OIL DERIVATIVES, MINERAL AND NATURAL FERTILIZERS, AND PESTICIDES IN GJ/HA.
PREGLEDNICA 14: GOSPODINJSTVA PO SPECIFIČNIH ENERGETSKIH VNOSIH TEKOČIH DERIVATOV, MINERALNEGA IN NARAVNEGA GNOJA TER ZAŠČITNIH SREDSTEV V GJ/HA.

Inputs in GJ/ha	<20	21–30	31–40	41–50	>51
Number of households	1	1	11	10	1
Proportion in %	4.2	4.2	45.8	41.7	4.2

Even if we do not consider the input of electric energy and fodder additives, we still get extremely high specific inputs of energy per hectare of cultivable surface area. Only one household is under the 15 GJ/ha limit (14.8 GJ/ha), eleven households have inputs less than 40 GJ/ha, and one is on the limit. Eleven households exceed the 40 GJ/ha limit, on average by 4.9 GJ/ha; for one household, the inputs are greater than 50 GJ/ha.

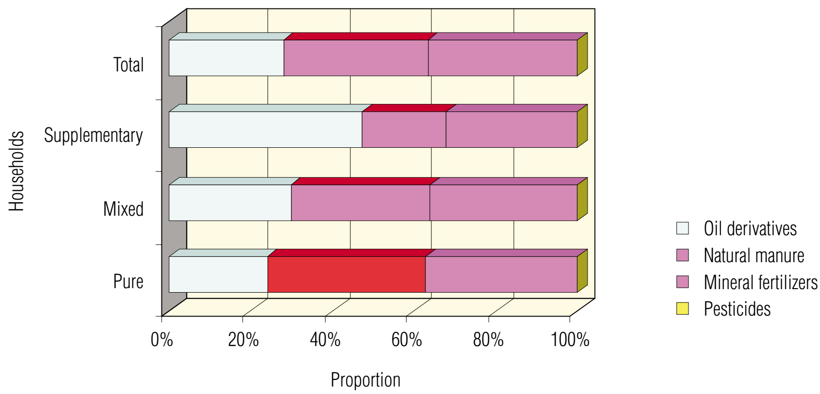


Figure 31: Structure of direct energy inputs of oil derivatives, mineral and natural fertilizers, and pesticides.
Slika 31: Struktura neposrednih energetskih vnosov tekočih derivatov, mineralnega in naravnega gnoja in zaščitnih sredstev.

I compared energy inputs with hectare yields and took into consideration only pure farms where the results are much more realistic than on mixed or supplementary farms where the deviations are large. The correlation coefficient of 0.77 indicates a relatively large interdependence of phenomena, but there are considerable deviations. Milk production not only requires large inputs of energy but also a great deal of expertise. Large yields relative to energy input can be partly attributed to the purchase of hay and corn silage, which is not included in the energy picture, and farms with a larger proportion of wet ground show too small inputs. According to Radinja (1990), 3.5 MJ of energy are required per kilogram of milk; on the farms studied, the amount is 8.7 MJ. This is another side of the large amounts of milk produced.

In energy inputs per hectare of cultivable surface area, the households are relatively uniform, the ratio between the largest and the smallest reaching 1:3.6 at most. The differences between yields are much larger, with ratios of 1:41.4 or 1:21.6****. Therefore, households with more land and more intensive farming get their unit of input energy back to a much greater extent of hectare yield than supplementary households with little land.

TABLE 15: RATIO BETWEEN MINIMUM AND MAXIMUM INPUTS OF ENERGY PER HECTARE OF CULTIVABLE SURFACE AREA AND HECTARE INPUTS IN GRAIN UNITS.
PREGLEDNICA 15: RAZMERJA MED MINIMALNIM IN MAKSIMALNIMI VNOSI ENERGIJE NA HEKTAR OBDELOVALNE POVRŠINE IN HEKTARSKIH DONOSOV V ŽITNIH ENOTAH.

Inputs in GJ/household	Average	Maximum	Minimum	Ratio
Energy 1*	79	108	30	1:3.6
Energy 2**	60	89	24	1:3.7
Energy 3***	38	53	15	1:3.5
Yield in GU/ha	90	183	4.42	1:41.4
Yield****	89.9	183	8.5	1:21.6

* Specific inputs in the form of electricity, pesticides, fodder additives, organic and mineral fertilizers, and oil derivatives
** Specific inputs as above, without electricity
*** Specific inputs as above, without fodder additives
**** A further comparison was made for the second smallest yield because the first calculation was not realistic. The farmer raises bull calves and sells them every other year, making the figures for the 1995 yield too low.

5. The impact of agriculture on the environment

Along with important positive effects, the intensification of agricultural production also has negative effects on the environment. Agriculture burdens the environment—the air, soil, and water—mainly through the use of mechanization, large inputs of energy, and various land improvement works. The environment was also burdened by self-sufficiency agriculture—let us recall the cases of various diseases caused by nitrates in the water—but naturally the intensification of agricultural production greatly increases the possibilities for polluting the environment.

It is not precisely clear at the moment just what proportion of the pollution agriculture contributes. In the first place, there is a lack of this type of research, and secondly, it is difficult to determine the source of harmful substances in the water, especially in densely populated regions where population, traffic, industry, and agriculture are tightly interwoven. The separate treatment of the effects is just as difficult because the three spheres—air, water, and soil—are inseparably linked and a threat to one actually poses a threat to them all.

5.1. Possible Effects of Agriculture on the Air

Agriculture pollutes the air with emission of exhaust gasses. However, the amount of oil derivatives used for agricultural production is considerably smaller than the amount of gasoline used for automobiles. Of course, it does add its contribution to air pollution and the occurrence of acid rain. Ammonia is released from animal excrement, causing acidity of the soil. In the areas with high cattle breeding density, large amounts of animal excretion occur and the possibility of pollution is larger. Research (Klavžar, 1994, after Potthast) in various regions of North Rhine-Westphalia showed that the contribution of ammonia to acid rain varies depending on the location. The proportion in Lower Rheinland (a region with intensive agriculture bordering on similar regions in The Netherlands), for example, ranges around 75%, while in very wooded regions it only reaches 25% to 30%. Even in an industrially developed country like Germany, 95% of the ammonia originates in agriculture, and half of this is produced by cattle.

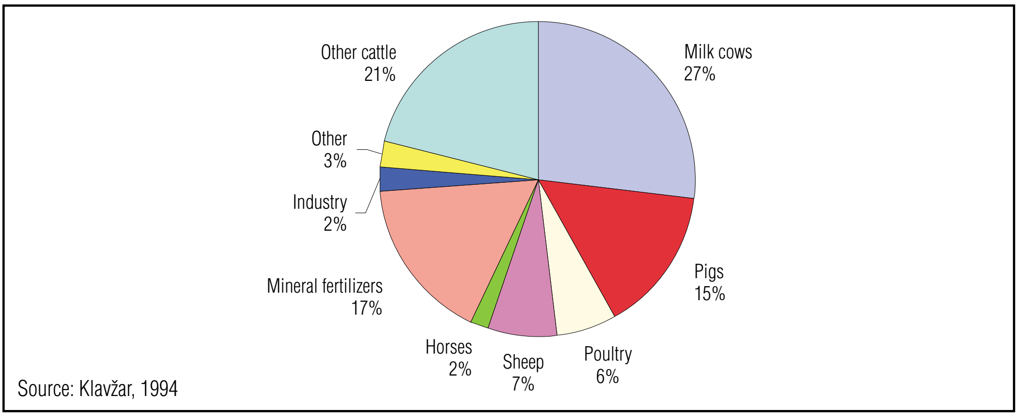


Figure 32: Sources of ammonia in Germany.
Slika 32: Vir amoniaka v Nemčiji.

Agriculture also pollutes the air with smells, which in most cases are not directly harmful to health. The most annoying is the stench of decaying liquid dung, although it is perceptible only when liquid dung is actually being sprayed on cultivable surface areas. Consequently, it is less objectionable since the spraying generally occurs during unpleasant weather conditions when few people are in the vicinity. Animal excretions cause a greater stench, depending upon the proportion of fodder in the feed (Lobnik, 1989). Because of great use of fodder additives on the farms studied and the large quantities of liquid dung, the stench is considerable but for the time being not a matter of controversy.

5.2. Possible Effects of Agriculture on the Pedological Blanket

Agriculture presents a potential danger on several levels:

1. The most important danger is the burdening of the soil due to various *energy inputs*, primarily in the form of organic and mineral fertilizers and pesticides. The effect of the latter was of no interest to us because of the extremely small quantities, but we were very interested in fertilization and particularly the use of mineral fertilizers. Their average specific use in the area studied is moderate, not even reaching the Slovene average. The method or rather scheduling of its use is also favourable, because the farmers add manure in the growing periods, that is, 4 or 5 times a year, meaning that individual concentrations are not excessive.
   There is a question, however, regarding unprofessional fertilization due to the poor choice of mineral fertilizers. Analyses should be made of the quantities of nitrogen that plants can accept. This particular fertilizer is the most dangerous relative to its possible negative consequences for the plants, the soil, the subsoil, and the environment. The amounts applied for individual cultures are determined more or less by guess and are far from what is actually needed. This not only means a smaller yield and irrational waste of energy but primarily the possibility of environmental pollution. The use of liquid dung is especially controversial, primarily because of the large quantities employed. The effect of liquid dung strongly depends on the type of soil on which it is used. At the Department of Agronomy of the Biotechnology Faculty, the suitability of soils for the use of liquid dung was determined on the basis of the physical and chemical properties and thickness of the soil and the relief, and the following groups were defined: (Monitoring, 1994):
   - use of liquid dung forbidden,
   - use of liquid dung with restrictions,
   - use of liquid dung allowed.

   The greater part of the area studied belongs in the second group where the use of liquid dung is possible with certain limitations, but part of the farm land is in the first group where its use is forbidden, specifically, gleyed soil or hypogley. A smaller part of this land has been drained, and here the use of liquid dung is permitted.

2. *The use of heavy machinery* effects changes in the structure of the soil, which over the years deteriorates. The use of heavy machinery in the rain is especially damaging and on surface areas that are wetter due to the high level of the ground water (Prus, 1991). The use of tractors and tank trailers to spread liquid dung causes the greatest damage to grass turf because it occurs in damp weather.

3. *Unbalanced use of monocultures* impoverishes the soil and presents a higher risk of pests developing (Prus, 1991). The farmers in the villages studied have generally abandoned crop rotation, which enriches the soil's organic material. This will probably become a serious problem in time, especially where silage corn has been grown on the same surface areas for years. In most cases, the farmers are aware of the need for crop rotation but have few possibilities for »moving« their fields because of the moist soil.
   Because of the extreme intensity of the farming, soil analyses were done. The first sampling encompassed three samples. The farmers used fertilizers last at the beginning of April when there was considerable rainfall, but the last week before the sampling was dry and hot. The samples were taken from grassy surface areas where the layer of soil is thick and all the soils are clayey. The samples were taken from heavily, moderately, and poorly fertilized meadows. The differences in the amount of nitrates in the soil were very small, contrary to expectations given the quantities of manure used. The upper limit for nitrates is 40 or 44 mg NO^3/l. The second sample with a value of 40 mg NO^3/l is on the border, while the first and the third with values of 50 and 48 mg NO^3/l respectively exceed the limit. The explanation for the surprisingly small differences may lie in the fact that almost two months had passed since the liquid dung was spread and the rain had already washed away the excess nitrates in the soil.
   The second sampling included six samples (three from the same areas as the first sampling), all taken from grassy surface areas a few days after liquid dung had been applied and an abundance of rain. Three samples were taken from heavily fertilized meadows, two from a moderately fertilized meadow, and

the last from an unfertilized meadow. This time, the quantities of the nitrates show a direct connection with the quantity of manure. Two samples exceed the upper limit, and one is borderline. The most nitrates, 60 mg/l, are in the soil from the very heavily fertilized meadow, followed by soil from the fields with heavy fertilization, 52 and 40 mg/l. The amounts of nitrates in the soil of the moderately fertilized meadows are 36 and 24 mg/l, while the soil of the poorly fertilized meadow registers 28 mg/l. If we compare the samples with those taken from the same surface areas during the first sampling, the first sample has more nitrates and the other two have less.
The amounts of nitrates in the soil are certainly increasing, but for the moment do not indicate more heavily burdened soil due to the use of mineral and natural fertilizers. In contrast to the first sampling, the second shows a direct relationship between the quantities of nitrates in the soil and the intensity of dunging.

5.3. Possible Effects of Agriculture on the Quality of Water

Agriculture pollutes water primarily through dunging (Lobnik, 1991) because of the increased quantities of nitrogen and phosphorus. The quantities of mineral fertilizers introduced are not excessive, particularly if the farmers dung several times a year and in suitable weather conditions, although individually there are major transgressions. We get a different picture, however, if we evaluate liquid dung in a similar way. The comparison with the optimal quantities indicates that the amount of nitrogen introduced is double the optimum, as is the amount of phosphorus. Only potassium remains within the limits, in which case the farmers introduce less than their crops consume.

A larger proportion of phosphorus is even reasonable relative to the increased moisture of the soil in some places. Phosphorus does not represent a larger potential danger due to its exceptional ability to bond into forms of insoluble compounds in the stated quantities. According to foreign research, phosphates contribute about 4% (in Slovenia perhaps a bit more) to the cumulative burdening of surface waters (Vajnberger, 1990). With regard to the possibility of agriculture burdening the environment, we should also take into consideration the considerable quantities of detergent used for cleaning the milking systems.

The soil is excessively saturated with nutrients, in particular nitrates. A proportion of these is lost as they leach into the ground or washed into the surface waters, and some is lost in the form of gasses in the air (Vajnberger, 1990). We cannot speak about the actual quantities of nitrates washed away. It is known that in the Ljubljana area about 30 kg/ha of nitrates leach from a sowed field to below the fifty-centimeter upper layer of soil if we fertilize correctly, disregarding the quantity of nitrogen (Lobnik, 1989). It is not yet determined how much nitrogen reaches the subsoil. The leaching of nitrates increases due to the large input of mineral and natural fertilizers and the quantity of precipitation and its distribution. In the growth period when the dunging is most intense, the climaxes of precipitation also occur. Poorer permeability of the soil and a thick layer of soil with plenty of humus inhibit the leaching action. Land use is also favourable since leaching is minimized on meadows with thick turf as it is on the level land where the majority of agricultural activity goes on.

The great majority of farmers use rinsing systems to clean their stables, which produces mostly liquid dung (12,077 m^3 in 1995). The quantities of nutrients depend on the manner of feeding the cattle and without a detailed analysis can only be estimated. Because of large quantities of corn silage, the liquid dung contains less nitrogen while the amount of phosphorus is increased due to the large proportion of fodder additives and silage. The heavy use of mineral fertilizers, fodder, and especially silage increases the potassium content of the liquid dung (Lobnik, 1989). The intensity of leaching depends on the relative use efficiency of nutrients. With proper use, the use efficiency of nitrates is up to 80%; otherwise, it may only reach 30% (Ciraj, 1991). In some European countries, the use or non-use of liquid dung is defined by law. It cannot be used outside the growth period because the leaching of nitrates and the evaporation of nitrogen is then much greater, the former even more so on frozen ground (Monitoring, 1994). Furthermore, plants cannot utilize the nutrients outside the growing period. More diluted liquid dung is more suitable because it is easier to utilize. On the other hand, it penetrates into the ground more quickly and more transportation

TABLE 16: RESULTS OF THE ANALYSES OF WATER SAMPLES.
PREGLEDNICA 16: REZULTATI ANALIZE VZORCEV VODE.

Sample No.	Date	pH[9]	Water Hardness				Cl^- mg/l[10]	SO_4^{2-} mg/l[11]	PO_4^{2-} [12]		NO_3^- [13]	SEP[14] μSim^{-1}	Site
			Carb.	Total[15]	Ca	Mg			Orto	Total			
1	4.4.96	8.09	8.40	9.50	7.50	2.0	7.34	221.8	0.051	0.086	10.0	314	Golnišnica, at contact between river deposits covered with clays and conglomerate
			149.5	169.1	75.0	8.7							
2	4.4.96	8.21	9.94	11.80	9.10	2.70	9.78	274.6	0.117	0.197	20.0	383	Periodic stream at contact between alluvial fan and Tertiary hilly world, alongside cultivated areas
			176.9	210	91	75.0							
	8.5.96	7.65	13.6	15.1	12.4	2.70	8.39	322.6	0.117	0.200	18.0	485	
			242.1	268.8	124.0	11.7							
	5.6.96	8.04	15.3	17.2	14.2	3.0	10.0	313.9	0.310	0.550	40.0	539	
			306.2	306.2	142.0	13.0							
	20.6.96	7.49	13.4	14.7	11.5	3.2	12.3	144	0.209	0.375	20	484	
			238.5	261.7	115.0	13.9							
7	4.4.96	8.46	10.90	11.65	7.90	3.75	3.21	194.9	0.010	0.017	9.0	363	As above, only higher and of torrential character
			194.0	207.4	79.0	16.3							
	5.6.96	8.08	9.38	10.1	6.70	3.40	2.51	229.4	0.0	0.0	16.1	319	
			166.9	179.8	67.0	14.8							
3	4.4.96	7.38	3.50	3.90	3.70	0.20	4.89	94.1	1.589	2.663	5.0	131	Open drainage ditch in middle of wet meadows
			62.3	69.4	37.0	0.87							
	8.5.96	6.99	7.28	7.90	6.40	1.50	3.55	178.6	0.145	0.273	1.0	271	
			129.6	140.6	64.0	6.52							
	5.6.96	7.45	9.1	9.50	7.60	1.90	2.82	192.0	0.250	0.475	0.0	446	
			162.0	169.1	76.0	8.26							
4	4.4.96	7.76	3.50	3.80	3.20	0.60	3.97	70.1	0.113	0.202	12.0	131	Groundwater from well in Letenice, in contact with clayey deposits 1 meter deep
			62.3	69.4	37.0	0.87							
	8.5.96	7.33	14.80	15.2	13.1	2.10	8.07	174.7	0.105	0.195	0.0	505	
			263.4	270.6	131.0	9.13							
	5.6.96	7.65	13.0	13.8	11.5	2.30	7.22	188.2	0.250	0.475	0.0	502	
			231.4	245.6	115.0	10.0							
	20.6.96	7.46	14.7	15.2	13.0	2.2	9.56	83.5	0.123	0.201	5.0	499	
			261.7	270.6	130.0	9.57							

Sample No.	Date	pH[9]	Water Hardness				Cl^- mg/l[10]	SO_4^{2-} mg/l[11]	PO_4^{2-} [12]		NO_3^- [13]	SEP[14] μSim^{-1}	Site
			Carb.	Total[15]	Ca	Mg			Orto	Total			
5	4.4.9	8.08	9.66	12.1	9.8	2.3	17.4	241.9	0.312	0.557	45.0	427	Open drainage channel on edge of alluvial dam, periodic
			62.3	67.6	32.0	2.61							
	8.5.96	7.00	11.6	13.7	11.0	2.7	18.1	246.7	0.025	0.048	24.0	463	
			206.5	243.9	110.0	11.7							
	5.6.96	7.83	11.9	14.8	11.3	3.5	25.4	250.6	0	0.0	40.0	319	
			211.8	263.4	113.0	15.2							
	20.6.96	7.82	12.2	13.9	11.2	2.7	29.3	145.9	0	0	22	502	
			217.2	247.4	112.0	11.7							
6	4.4.96	8.14	7.42	8.50	6.40	2.10	2.60	197.8	0.011	0.019	8.0	271	Sevnik stream above settlements and cultivated land
			132.1	151.3	64.0	9.13							
	8.5.96	7.95	10.2	10.9	7.4	3.5	2.58	205.4	0.0	0.0	10.0	341	
			181.6	194.0	74.0	15.2							
8	4.4.96	8.40	12.60	12.85	8.40	4.45	7.03	259.2	0.059	0.108	18.0	411	Sevnik stream below Goriče
			224.3	228.7	84.0	19.4							
	8.5.96	8.55	11.3	12.3	8.0	4.3	5.49	240.0	0.057	0.108	13.0	382	
			201.1	218.9	80.0	18.7							
	5.6.96	8.07	10.5	11.1	7.4	3.7	4.08	240.0	0	0	20.0	341	
			186.9	197.6	74.0	16.1							
	20.6.96	7.42	10.9	11	7.8	3.2	4.32	115.2	0.297	0.589	7	346	
			194	195.8	78.0	13.9							
9	4.4.96	8.27	10.10	12.10	8.00	4.10	7.64	243.8	0.042	0.076	16.0	386	Sevnik stream before mouth into Golnišnica, after flowing across cultivated areas
			179.8	215.4	80.0	17.8							
	8.5.96	7.06	10.6	11.7	8.50	3.2	4.84	226.6	0.0	0.0	12.0	375	
			188.7	208.3	85.0	13.9							
	8.5.96	7.29	10.1	10.7	7.7	3.0	4.39	220.8	0.2	0.3	20.0	341	
			179.8	190.5	77.0	13							
	20.6.96	7.13	9.1	10.25	7.50	2.75	5.24	114.2	0.0	0.1	10	327	
			162.0	182.4	75.0	12							
10	8.5.96	6.99	8.26	8.9	7.2	1.7	6.13	188.2	0.0	0.0	10	286	Drinking water
			147.0	158.4	72.0	7.39							

[9] Permitted values for drinking water (*Official Gazette RS* 46/1997): from 6.8 to 8.5.
[10] The upper limit for chlorides is 20 mg of Cl/l.
[11] The normal value for sulfates in water is 200 (250) mg SO_4/l.
[12] The permitted amount of polyphosphates is up to 1.5 mg/l.
[13] For nitrates there are two tolerance limits: 10 mg NO_3/l and 50 mg NO_3/l.
[14] Specific electroconductivity shows general level of pollution. The upper limit is 500 microsimens per liter of water.
[15] Hardness of water: <5 = soft water, 5 to 10 = moderately hard water, 10 to 15 = medium hard water, >15 = hard water

is required and therefore greater quantities of diesel fuel. (Monitoring, 1994). The use efficiency of nitrogen from liquid dung also depends on the weather situation as it evaporates faster in dry and sunny weather. A suitable time for dunging is in cloudy weather before or after precipitation; however, large amounts of precipitation wash too much of it away. The storage of liquid dung, that is, the impermeability and size of the pits, is also important. Regarding impermeability, the older pits are especially problematic. The pits should be large enough to hold six-month quantities of liquid dung, allowing its use at suitable times. Only a few pits meet this requirement, and the average size is only sufficient for four and a half months.

In time, the liquid dung (in large quantities) will probably become a burden for the farmer. In some Western European countries, a maximum allowed cattle breeding density (and with it the quantities produced of organic manure per hectare of cultivable surface area) has been set. The defined but not yet adopted limit for Slovenia is 3 LU/ha (Leskošek, 1993). This is the limit at which the organic manure produced can still be returned to the soil without causing damage. Five farms in the settlements studied exceed this limit, four of them being the largest farms.

5.3.1. Analyses of water

Due to the exceptional intensity of farming in the settlements studied, we decided to perform analyses of the water to demonstrate the potential possibilities for water pollution and show the actual pollution due to farming.

The first sampling was taken after several days of snow and thaw followed by more snow. The streams were above their average heights, and all the channels cut for the faster drainage of water during rains were full. Water pooled on the surface in some places on the wet meadows. In Letenice, the groundwater level in a well had risen to only one meter below the top. There had been no rain for several consecutive days before the second sampling, and the streams were at a medium height. The farmers had not dunged in the period between the first and the second samplings. During the third sampling, the waters were also medium high but lower than during the previous sampling, and the farmers had not dunged since early spring because they were waiting for rain after the first cut. The fourth and final sampling was taken after a long period of high temperatures without precipitation. The farmers had not dunged from March on, and the streams were medium low.

The interpretation of individual analyzed indicators was made relative to drinking water. In contrast to expectations given the level of intensity of farming, the results of the analyses did not indicate pollution. The values of some indicators are certainly elevated but for the time being are not alarming. There is no direct proof of higher pollution for the extremely intensive farming studied.

5.4. Effects of Agriculture on the Transformation of the Landscape

Agriculture is spatially demanding and therefore strongly influences the structure of the landscape. The degree of transformation of the landscape can be defined with the quantitative method of arable equivalents defined according to the work invested.[16] Through an index of arable equivalents, we can directly determine the impact on the environment since greater work invested signifies a higher potential danger to the environment. The values of the index of arable equivalents range from 10 to 250. In our situation, indexes over 100 indicate a very high level of transformation of the landscape: the lowest index would mean there are only pastures, the highest that there are only vineyards.

The index of the transformation of the area studied is 31, indicating a low level of transformation of the environment. This value is not surprising, given the high proportion of forest and meadow. However, the described method of arable equivalents is no longer a reflection of actual conditions in agriculture because the values of individual categories expressed in arable equivalents have not been adapted to modern meth-

[16] Arable equivalents: field = 1 AE, vineyard = 2.5 AE, meadow = 0.4 AE, forest = 0.15 AE

ods of farming. In today's modern farming, the work or input on meadow areas no longer lags behind the input on field areas and even exceeds it.

In closing, I would like to point out yet another element of agriculture's impact on the environment, one that is overshadowed by more urgent questions and is usually not mentioned at all: the packaging used for fodder additives and mineral fertilizers and the superfluous plastic sheeting used in storing round rolls of hay.

6. Conclusion

The natural assets of Goriško polje are advantageous for the development of cattle breeding:

- flatland world,
- sufficient precipitation and its advantageous distribution throughout the year,
- sunny location protected from cold north winds,
- riverside eutric soil that changes into brown eutric soil, marshy in places, as well as gleyed ground on a clayey base,
- sufficient amounts of drinking water.

In recent decades, the farmers have focused on dairy cattle breeding, which intensified after Slovenia gained independence due to the loss of income from forestry. Milk production is now their only activity and their sole source of income. Strict specialization has resulted in extremely large yields, but at the same time it demands constant adapting by the farmers to achieve quality norms. The agricultural methods employed depend to a large degree on the price policies of the dairies.

The intensive production of milk demands large quantities of input energy. Energy intensity in agriculture leads to increasingly greater pollution, and the question is what its threshold is in the alpine world or in the Gorenjske Dobrave area specifically.

To calculate the energy intensity of agriculture, the following direct energy inputs were taken into consideration:

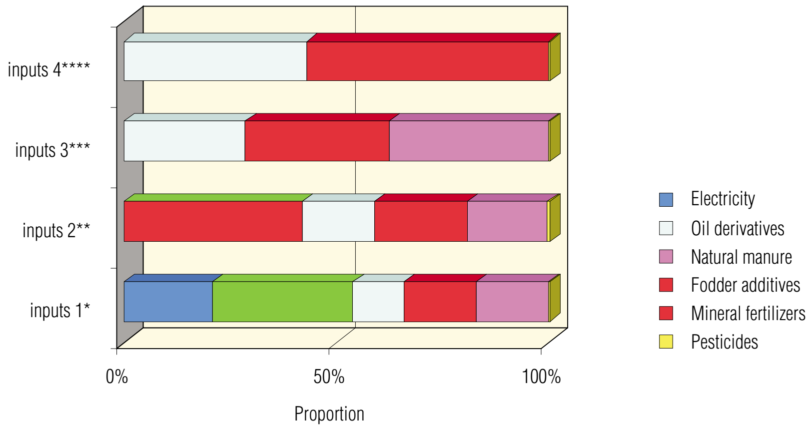
- organic and mineral fertilizers,
- pesticides,
- oil derivatives,
- electric energy,
- fodder additives.

The logic of taking all these types of input into consideration can be questioned as it is reasonable to consider them from the viewpoint of the level of energy intensity itself. However, when we view the energy equivalents of agricultural inputs as indicators of the energy burdening of the environment, it would be wise to consider that electric energy and fodder additives do not burden the particular environment directly.

TABLE 17: MEAN, MAXIMUM, AND MINIMUM SPECIFIC ENERGY INPUTS IN GJ/HA OF CULTIVATED SURFACE AREA.
PREGLEDNICA 17: SREDNJI, MAKSIMALNI IN MINIMALNI SPECIFIČNI ENERGETSKI VNOSI V GJ/HA OBDELOVALNE POVRŠINE.

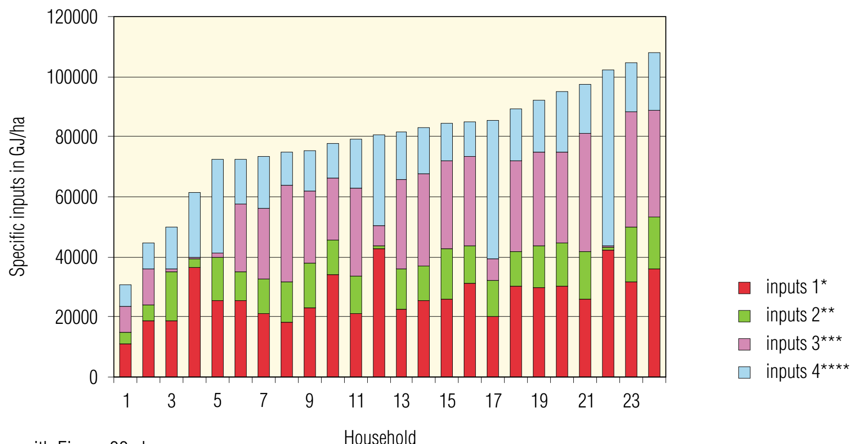
Input in GJ/household	Mean	Maximum	Minimum
Inputs 1*	79	108	30
Inputs 2**	60	89	24
Inputs 3***	38	53	15
Inputs 4****	27	43	11

* See notes with Figure 33 above.



* All direct inputs of energy considered
** Inputs without electric energy
*** Inputs of energy in the form of natural and mineral fertilizers, oil derivatives, and pesticides
**** Inputs in the form of mineral fertilizers, oil derivatives, and pesticides

Figure 33: Structure of direct absolute agricultural inputs in 1995 on the farms studied in Gorenjske Dobrave.
Slika 33: Struktura neposrednih absolutnih agrikulturnih vnosov na anketiranih kmetijah na Gorenjskih Dobravah v letu 1995.



*See notes with Figure 33 above.

Figure 34: Structure of specific energy inputs according to households.
Slika 34: Struktura specifičnih energetskih vnosov po gospodinjstvih.

If we consider all kinds of energy, almost all the farms (with one exception) can be considered industrial operations. The direct inputs are extremely high, amounting to 79 GJ/ha on average. Three households input more than 100 GJ/ha, and only three input less than 60 GJ/ha. Even without taking electric energy and fodder additives into consideration, only thirteen households remain under the 40 GJ/ha limit, and two even exceed the upper limit of 60 GJ/ha. On average, the inputs reach 38 GJ/ha.

Inputs of energy are also high due to the gleyed soil that demands twice the amount of input energy and work. The farms studied have approximately one half of their land subject to gleying.

A comparison on the basis of energy use with various methods of food production in intensive agricultural systems is most interesting (after Radinja, 1990):

TABLE 18: COMPARISON OF ENERGY REQUIREMENTS OF SOME OF THE MOST INTENSIVE AGRICULTURAL SYSTEMS IN THE WORLD WITH AGRICULTURE IN THE STUDIED AREA.
PREGLEDNICA 18: PRIMERJAVA ENERGETSKIH ZAHTEV NEKATERIH INTENZIVNEJŠIH KMETIJSKIH SISTEMOV PO SVETU S KMETIJSTVOM NA IZBRANEM OBMOČJU.

Agricultural system	Input in GJ/ha	Yield in kg/ha	
Intensive farming	15 to 20	2000	(20 LU)
Cattle breeding on farms	40	3000	(36 LU)
Production of algae (Japan)	1600	22000	(? LU)
Milk production*	79**	7500	(90 LU)
Milk production***	91**	10808	(129.7 LU)

* Milk production on studied farms.
** All direct inputs in the form of mineral and natural fertilizers, fodder additives, electric energy, oil derivatives, and pesticides.
***Only pure farms included.

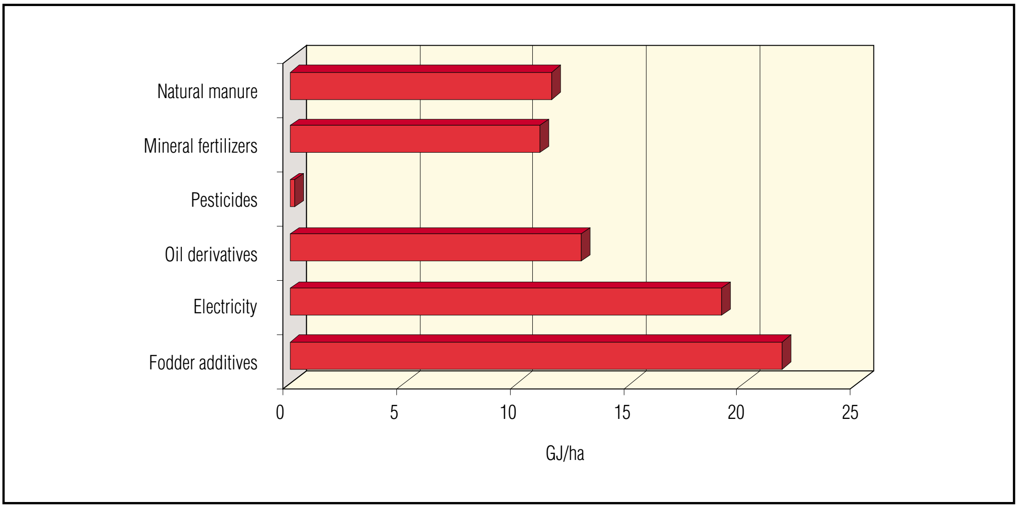


Figure 35: Mean specific value of agricultural inputs in GJ/ha.
Slika 35: Srednja specifična vrednost agrikulturnih vnosov v GJ/ha.

The characteristics of individual inputs are as follows:

Natural fertilizers: the proportion of natural fertilizers (17%) equals the proportion of mineral fertilizers, which is substantially more than on state-owned farms in Slovenia where natural fertilizers represents only 13% of all fertilizers. Part of this is due to large cattle breeding density, and the inputs total 11.5 GJ/ha. Natural fertilizer is problematic from the environmental protection point of view not only because of the large quantities but above all because of the form used.

Mineral fertilizers: the use of mineral fertilizers is moderate. On average, farmers invest 11 GJ/ha in the form of mineral fertilizers, which is the same as on state-owned farms (Radinja, 1993). Taking natural fertilizers into consideration, the burdening of cultivable surface areas due to fertilization is large (exceeding 20 GJ/ha of the cultivable surface area) and, according to Slesser, such agriculture is already intensive. Nitrates in various forms represent 68% of all the nutrients in the mineral fertilizers, on state-owned farms 82.8% (Radinja, 1993).

Fodder additives: considering all the inputs (including electric energy), the proportion of fodder additives is the largest, the consequence of intensive milk production. All together, they represent a good third of all energy inputs or 21.7 GJ/ha, on one farm even 39.5 GJ/ha. This structure of inputs is unique in Slovenia and is a reflection of the strict specialization in dairy cattle breeding. With fodder additives, farmers increase the number of cattle and achieve higher milk production.

Electric energy: in spite of the large consumption of this type of energy, 19 GJ/ha on average, its proportion in the overall energy structure decreases with the high inputs of natural and artificial fertilizers and fodder. Considering all the inputs, it takes second place with 20% after fodder additives; without them, its proportion increases to 30.4%.

Oil derivatives: diesel fuel comprises the largest proportion, gasoline is in second place, and the consumption of natural gas and heating oil is extremely small. Specific inputs totaled 11 GJ/ha on average, substantially less than on state-owned farms where the inputs total 18.9 GJ/ha (Radinja, 1993). The proportion of oil derivatives in the entire structure of inputs is small and totals 12.8%. If we disregard fodder additives, their proportion increases to 19.4%. This is less than on state-owned farms, where oil derivatives comprise one third of all inputs and on other types of private farms in Slovenia where they comprise as much as two thirds of all inputs (Radinja, 1993). Electric energy and oil derivatives are a constant in agriculture, but the inputs of fertilizers and fodder additives are a reflection of intensive specialized agriculture.

Pesticides: their proportion is extremely small, but we cannot overlook their toxicity. In the overall structure of energy inputs, they reach a good tenth of a percent. The specific consumption per hectare is 0.081 GJ, twelve times smaller than on state-owned farms (Radinja, 1993).

On the basis of direct energy inputs, we can see that the potential burdening of the environment due to agriculture is large, and we get a picture of the possibilities for actual pollution if we consider local natural conditions. It is primarily the pedological conditions with thick and moderately permeable soil and the flat relief that diminish the actual burdening of the environment.

The water analyses done during the period from the beginning of April to the end of June and the soil analyses did not indicate any major pollution in spite of the extreme intensity of farming. The samples of water and soil collected showed increased values of some indicators, but they were much lower than expected. The poorly permeable clayey soil makes the environment less sensitive. The area studied is suitable for dairy cattle breeding so intensive that the farms studied cannot be ranked into any of the typological groups according to direct energy inputs (Radinja, 1991). All of them belong with modern, intensive, specialized farms. The majority are oriented toward dairy cattle breeding, although some smaller ones are engaged in the beef production. We cannot say the supplementary farms are modern and intensive, in spite of the fact that they belong here according to their inputs. According to Slesser, this is agriculture with distinct industrial features. While this is quite true of the pure and mixed farms, whether it is also true of supplementary farms is debatable.

The described method of energy equivalents is quite appropriate for mixed farming-cattle breeding types of agriculture. However, in crop production operations, we should also take the input in the form of seeds into consideration. The method is only conditionally appropriate for narrowly specialized cattle breeding, particularly for intensive dairy cattle breeding. On the basis of the results, it is mainly the comparison with other agricultural systems that is questionable.

7. Bibliography

Atlas Slovenije, 1986: listi 83, 84, 105, 106, merilo 1:50000. Ljubljana.
Bernot, F., 1891: Klima Gorenjske, Zbornik 12. zborovanja slovenskih geografov Kranj – Bled, str. 107–119. Ljubljana.

Furlan, D., 1971: Klima Golnika, (tipkopis). Ljubljana.
Ciraj, M., 1991: Usmerjena raba gnojevke. Sodobno kmetijstvo, str. 35–38. Ljubljana.
Gams, I., 1981: Pokrajinsko-ekološka sestava Gorenjske, Zbornik 12. zborovanja slovenskih geografov Kranj – Bled, str. 18–30. Ljubljana.
Jeršič, M., Pleško, M., 1975: Zasnova uporabe prostora. Kmetijstvo. Ljubljana.
Jeršič, M., Pleško, M., 1976: Zasnova uporabe prostora. Vodno gospodarstvo. Ljubljana.
Jurkovič, J., 1994: Ekologija v službi živinoreje. Sodobno kmetijstvo, str. 147–148. Ljubljana.
Kajfež-Bogataj, L., 1989: Zgodnje jesenske slane na Gorenjskem. Zbornik Biotehniške fakultete Univerze v Ljubljani, zv. 53 – Kmetijstvo, str. 19–26. Ljubljana.
Kovačič, M., 1983: Tipi kmetij v Sloveniji in njihove značilnosti. Ljubljana.
Monografija krajevnih skupnosti Golnik, Goriče, Tenetiše in Trstenik, 1985: Pod Storžičem. Ljubljana.
Lampič, B., 1995: Kmetijsko obremenjevanje okolja v energijski luči na Kranjskem polju. Diplomska naloga. Ljubljana.
Leskošek, M., 1993, Gnojenje. Ljubljana.
Letni statistični pregled po občinah, 1991, 1993. Ljubljana.
Lobnik, F., 1989: Izbrana poglavja iz ekologije. Ljubljana.
Lovrenčak, F., 1981: Pedo in vegetacijsko-geografske značilnosti Gorenjske. Zbornik 12. zborovanja slovenskih geografov Kranj – Bled, str. 120–129. Ljubljana.
Monitoring onesnaženosti v kmetijstvu, 1994: Ekološke obremenitve v kmetijstvu. Ljubljana.
Osnovna geološka karta, 1976: Lista Kranj, Jesenice, merilo 1:100.000. Beograd.
Pavlovič, M., 1991: Onesnaževanje kmetijskih zemljišč skozi prizmo agrarne ekonomike. Sodobno kmetijstvo, str. 475–478. Ljubljana.
Pedološka karta, sekcija Tržič. Biotehniška fakulteta. Ljubljana.
Pimental, D., 1984: Energy Flows in Agricultural and Natural Ecosystems. Option mediterraneennes. C.I.H.E.A.M. Paris.
Podatki Kmetijske zadruge Naklo, Merkator Mlekarna Kranj in Geodetske uprave Kranj.
Popis prebivalstva, gospodinjstev in stanovanj 1991. Ljubljana.
Prus, T., 1991: Vrednotenje tal z vidika nekaterih kopenskih ekosistemov. Magistrska naloga. Ljubljana.
Radinja, D., 1990: Kmetijstvo v energijsko-ekološki osvetlitvi (tipkopis; ZI FF. Ljubljana.
Radinja, D., 1991: Kmetijsko obremenjevanje okolja na Slovenskem v energijski osvetlitvi (tipkopis). Ljubljana.
Radinja, D., 1992: Metodološka problematika proučevanja agrarnega obremenjevanja okolja na Slovenskem v energijski luči (tipkopis). Ljubljana.
Radinja, D., 1993: Obremenjevanje okolja v Sloveniji zaradi energijske intenzivnosti družbenega kmetijstva (tipkopis). Ljubljana.
Rejec Brancelj, I., 1993: Agrarnogeografska problematika Koprskega primorja z vidika varstva okolja. Magistrska naloga. Ljubljana.
Rejec Brancelj, I., 1989: Uporaba umetnih gnojil in zaščitnih sredstev z geografskega vidika varstva okolja. Geografski obzornik, letnik 36, št. 3 in 4, str. 47–50. Ljubljana.
Statistični letopis R Slovenije, 1995. Ljubljana.
Stritar, A., 1971: Izraba tal v spodnjem delu gorenjskih ravnin. Geografski vestnik, str. 53–64. Ljubljana.
Stritar, A., 1990: Krajina, krajinski sistemi, Raba in varstvo tal v Sloveniji. Ljubljana.
Šifrer, M., 1969: Kvartarni razvoj Dobrav na Gorenjskem, Geografski zbornik, let. 11, str. 101–219. Ljubljana.
Šifrer, M., 1981: Nova dognanja o razvoju reliefa na Gorenjskem. Zbornik 12. zborovanja slovenskih geografov Kranj – Bled, str. 64–76. Ljubljana.
Temeljni topografski načrt, 1976: List Tržič, merilo 1:25000. Ljubljana.
Topografska karta, 1981: List Jesenice, merilo 1:50000. Ljubljana.
Tivy, J., 1990, Agricultural Ecology. Harlow.

8. Summary in Slovene – Povzetek

Kmetijsko obremenjevanje okolja na Gorenjskih Dobravah v energetski luči na primeru naselij Goriče, Letenice in Srednja vas

Mimi Urbanc

1. Uvod

Obremenjevanje okolja je pereča problematika naše vsakdanjosti, pomembna za našo skupno prihodnost. Tako je, kot segment celostnega vpliva na okolje, pomembno tudi kmetijsko obremenjevanje, o učinkih katerega pa še ni zadostnih raziskav. Pozornost raziskovalcev je običajno veljala gosto naseljenim industrijskim in mestnim aglomeracijam, ki so dolgo veljale za edini vir onesnaževanja, katerega učinki so bili očitni. Na drugi strani pa je kmetijstvo veljalo za dejavnost, ki je v sozvočju z naravo, okolje ohranja in ga ne onesnažuje, torej z vidika njegovega varovanja ni problematično. To je držalo le za samooskrbno ekstenzivno kmetijstvo, ki je ohranjalo kulturno pokrajino. Današnje kmetijstvo pa se z modernimi agrotehničnimi procesi in kemizacijo vedno bolj približuje industrijskemu načinu pridelave in zaradi energetske intenzivnosti ter prostorske razširjenosti deluje obremenjujoče na okolje. Posamezni primeri onesnaženja podtalnice so pokazali, da tudi naše kmetijstvo, ki po hektarskih donosih večinoma zaostaja za zahodnoevropskim, obremenjuje okolje.

V ospredju preučevane problematike je kmetijstvo dela Gorenjskih Dobrav, točneje treh obravnavanih vasi pod Storžiškim pogorjem Kamniških Alp, kjer se je v zadnjem desetletju razvila izjemno intenzivna mlečna govedoreja. Predmet preučevanja ni bilo kmetijstvo samo po sebi, ampak njegov okoljevarstveni vidik. Poskušali smo prikazati energetsko podobo, jo ovrednotiti z vidika vpliva na pokrajino in nakazati možnosti onesnaženja okolja.

Cilji preučevanja so bili naslednji:

1. Kvantitativni prikaz intenzivnosti preučevanih kmetij na podlagi hektarskih donosov, energetske bilance in živinorejske obremenjenosti tal.
2. Prikaz, razlaga in vrednotenje strukture energetske intenzivnosti.
3. Prikaz značilnosti kmetijske dejavnosti izbranega območja.
4. Prikaz preobrazbe okolja zaradi kmetijske rabe tal in iz tega izhajajočega obremenjevanja pokrajine.
5. Seznanitev z možnimi posledicami onesnaževanja naravnega okolja zaradi energetske intenzivnosti kmetijstva.
6. Ugotavljanje dejanske onesnaženosti na osnovi analize voda in prsti.

2. Metode dela

Pri geografski osvetlitvi prostora smo uporabili splošno literaturo, ki med drugim zadeva tudi obravnavano pokrajino in jo dopolnjevali s kartografskim materialom ter tako v grobem orisali fizičnogeografske elemente okolja. Pri pregledu družbenogeografskih lastnosti smo se oprli na uradne popise prebivalstva in gospodinjstev oz. gospodarstev. Osnovni podatki o kmetijstvu so bili dobljeni z anketiranjem na terenu, pri njihovem kritičnem vrednotenju podatkov pa so bili v veliko pomoč podatki Geodetske uprave Kranj ter Merkator Mlekarne Kranj in Kmetijske zadruge Naklo. Na osnovi primerjav, vrednotenja podatkov, dopolnjevanja ter predstavitve v kvantitativni obliki na koncu, so bile pokazane osnovne značilnosti kmetijstva, iz katerih se da sklepati na obremenjevanje okolja. Posebna pozornost je veljala literaturi s področja kmetijstva, ekološkim pogojem za kmetijsko izrabo zemlje, vplivom kmetijstva na okolje, natančni seznanitvi s problematiko mlečne živinoreje ter gnojevke, ki pri tem nastaja v velikih količinah.

Zbrani podatki so bili analizirani s statističnimi kazalci, kot so indeks preobrazbe okolja zaradi kmetijstva, koeficient razparceliranosti in povprečna velikost parcel, ki nam posredno kažejo nekatere lastnosti kmetijstva in so z vidika varstva okolja zanimivi. Nadalje smo poskušali ovrednotiti kmetijstvo z vidika vpliva na pokrajino in nakazati možnosti onesnaževanja obravnavanega okolja prek različnih pokazateljev, to je hektarskih donosov, živinorejske obremenjenosti tal, rabe tal, energetske intenzivnosti. Analize možnih posledic onesnaževanja naravnega okolja so bile dopolnjene z ugotovitvami dejanske onesnaženosti na osnovi analize voda in prsti.

Opravila sem 26 anket v naseljih Goriče, Letenice in Srednja vas. Vzorec zajema 52 % gospodinjstev s kmečkim gospodarstvom po popisu iz leta 1991 in 89,6 % gospodinjstev, ki imajo živino ter vsa gospodinjstva ter še nekaj drugih, ki oddajajo mleko v mlekarno. Dve anketi sem zaradi pomanjkljivih odgovorov izločila iz nadaljnje obdelave. Analizirala sem torej 24 anket in z njimi zajela kmete, ki imajo 97 % vsega staleža goveje živine na tem območju.

3. Nekatere geografske značilnosti

Omenjene vasi ležijo v severnem delu Gorenjskih Dobrav na vršaju, obdanem z rahlo valovitim, gričevnatim svetom iz terciarnih kamenin, največ peščene in laporne gline, laporja in peščenjaka. V vršaju prevladuje slabo zaobljen prod, ki postaja z oddaljevanjem od visokogorskega sveta drobnejši in čedalje bolj sortiran (Šifrer, 1969). V njega so potoki vrezali svoje struge in najnižja dna prekrivajo holocenski nanosi v obliki ilovnatih in peščenih sedimentov, ki izvirajo iz bližnjih globoko preperelih in slabo odpornih kamenin. Zlasti na prehodu iz pobočnih sedimentov v široke poplavne ilovnate ravnice v dolinah so nastala mokrotna tla. Še bolj kot proti jugu, se površje spušča proti zahodu, kjer so dna dolin za okrog 15–20 m nižje in potoki imajo skoraj neznaten padec. Zato je samo del vode obdržal prvotno smer proti jugu, sicer pa je prišlo do odtoka proti zahodu. Erozijska sposobnost vode je bila majhna in to je tudi razlog, da je vzhodni del, t. i. Goriško polje suho in ugodnejše za kmetijsko izrabo, medtem ko je zahodni del močviren, o čemer nam pričajo tudi ledinska imena: Na mlakah, Trste, Ribjek, V bajerju …

Goriče, Srednja vas in Letenice predstavljajo večji del krajevne skupnosti Goriče in ležijo v skrajnem severnem oz. severozahodnem delu mestne občine Kranj. Od občinskega središča so oddaljene približno devet kilometrov. Ležijo na območju dveh katastrskih občin; k. o. Goriče, ki v celoti leži na ravnini, in Srednja vas, ki sega v strma prisojna pobočja Kamniških Alp, vse do grebena, ki povezuje Zaloško goro (Tolsti vrh, 1715 m n. v.) na zahodu s Storžičem (2132 m) na vzhodu.

Kmetijska izraba tal je odvisna od naslednjih naravnih pogojev (Jeršič, Pleško, 1975):

- pedološke lastnosti tal,
- klimatske razmere,
- naklon zemljišča in osončenje,
- nadmorska višina.

pedološke lastnosti tal: težišče kmetijske pridelave je na obrečnih evtričnih tleh na aluvialnih nanosih in fluvioglacialnem produ, ki so mestoma oglejena. Na sušnejših in globljih tleh so njive, sicer travniki. Delno so travniki tudi na evtričnem hipogleju na glini in melju in na evtričnih rjavih tleh na sivici. Približno polovica vseh obdelovalnih površin je mokrotnih, kar pogojuje samo rabo tal, predvsem pa predstavljajo določene omejitve pri načinu obdelave, predvsem pri gnojenju, uporabi mehanizacije in časovni razporeditvi del.

klimatske razmere: območje spada v tip zmerne inačice alpskega podnebja, v drobnem pa zaradi reliefne razgibanosti prihaja na majhnih razdaljah (horizontalnih in vertikalnih) do razlik kot posledica lege in nadmorske višine. Padavin je dovolj in so enakomerno razporejene prek celega leta, primarni višek je novembra, sekundarni poleti. Za vse navedene kraje velja, da imajo ugodnejše podnebje kot nižje na Kranjskem polju, kar nam kažejo spodnje preglednice. Imajo manj megle in več sonca, obenem pa jih visok gorski greben varuje pred hladnim severnim vetrom. Zadnji dan s slano je 11. april, na Brniku 1. maj. Prvi dan s slano je 14. oktober. Število dni brez slane je 186, na Brniku 170. Vsota efektivnih temperatur nad 5°C je 3300 ur, na Brniku 2630. Število dni s temperaturo nad 5°C je 245 dni, na Brniku 225 (Gams, 1981).

Padavine imajo velik vpliv, saj so večje količine lahko zaradi retencijske sposobnosti ilovnatih tal omejitveni faktor. Ob močnejšem deževju voda stoji na površju in takrat so dejansko neprimerna za obdelovanje. Mokrotnejša tla je treba obdelovati s premislekom, sicer lahko uporaba težke mehanizacije napravi veliko škode na travni ruši. Zaradi slabše propustnosti tal kmete suša kasneje prizadene. Večje količine padavin pomenijo tudi večjo možnost izpiranja gnojevke in mineralnih gnojil. Gnojenje zahteva določeno količino vlage, prevelike količine pa povzročijo izpiranje hranil, ki so tako izgubljene za rast, obenem pa obremenjujejo podtalnico in površinsko tekoče vode.

naklon zemljišča in osončenje: večji del kmetijske zemlje je v ravnini, nakloni so manjši od 6°. Goriško polje je ravno, medtem ko je mokrotnejši svet na zahodu v drobnem bolj razgiban, vendar omogoča uporabo kmetijske mehanizacije. Bolj strme so samo ježe nad potoki ter stik med terciarnim gričevjem in nasuto ravnico. V zadnjem času se nekatera izmed teh strmejših površin ponovno zaraščajo z gozdom. Celotno območje se rahlo vzpenja proti severu. Zlasti vzhodni del, to je Goriško polje je odprto proti jugu in zato na soncu. Zahodni del območja, kjer so posamezni travniški kompleksi obkroženi z gozdom, je delno na osojni strani.

nadmorska višina, omenjene vasi ležijo v nadmorski višini od 440 m do 500 m. Obdelovalna zemlja, ki jo uporabljajo kmetje omenjenih vasi, leži večinoma pod 480 m. Višje imajo zemljo le redki kmetje.

Višje temperature in osončenost ter manj megle in slane so izredno pomembni za kmetijstvo izbranih vasi. Težka ilovnata zemlja je hladnejša in se počasneje segreva kot lahka peščena tla. Kljub ugodnim temperaturnim razmeram, morajo kmetje zato saditi zgodnejše sorte silažne koruze, setev pa opraviti v suhem vremenu.

4. Kmetijstvo v luči obremenjevanja okolja

4.1. Glavne značilnosti kmetijstva

Razgiban teren s prevlado težkih ilovnatih in vlažnih tal je bil najprimernejši za živinorejo. Za razvoj kmetijstva in tudi sicer za socialnoekonomski razvoj je bila pomembna bližina Kranja z močno industrializacijo in urbanizacijo. Zagotovljen je bil stalni odkup pridelkov, zlasti mesa in mleka. Zaradi sprotnejšega načina plačevanja je mleko postajalo vse pomembnejše. Tako so se zadnjih deset let kmetje usmerili v intenzivno mlečno govedorejo. Stroga specializacija je pripeljala do izrednih donosov. Skupaj so leta 1995 pridelali 2.201.609 l mleka, posamezniki prek 200.000 l. To zahteva od kmetov stalno prilagajanje oz. doseganje kvalitetnih norm, obenem pa tudi velike količine krmil.

Na osnovi socioekonomske analize[1] dobimo naslednjo diferenciacijo gospodinjstev s kmečkim gospodarstvom; izmed 24 anketiranih imamo 9 čistih in 2 potencialno čisti gospodinjstvi. Mešanih je 5 in 8 je dopolnilnih. Ostarelega ni nobenega, v nekaj letih pa bosta v to kategorijo prešli 2 gospodinjstvi brez naslednikov, izmed katerih je danes eno čisto kmečko, drugo pa dopolnilno.

Čista kmetija: vsi družinski člani v aktivni življenjski dobi delajo samo na kmetiji ali so vzdrževani. *Potencialno čista kmetija*: zunaj kmetije so zaposleni samo tisti družinski člani, ki ne pripadajo jedru družine. *Mešana kmetija*: najmanj eden od proizvodno aktivnih članov jedra družine dela samo na kmetiji

[1] *Socio-ekonomski tipi kmetij;*

in hkrati je najmanj eden od teh redno zaposlen zunaj kmetije. *Dopolnilna kmetija*: vsi proizvodno aktivni člani družine so zaposleni zunaj kmetije in delajo na kmetiji izključno v prostem času. *Ostarela kmetija*: vsi člani družine so starejši od 64 let in se še ukvarjajo s kmetovanjem (Kovačič, 1983).

Anketirane kmetije imajo skupaj 466 ha lastne zemlje, povprečna velikost kmetije je torej okrog 19 ha, večji del odpade na račun gozda, kot nam kaže slika št. 4. Sicer travniki prevladujejo, redke njivske površine so namenjene koruzi. Kmetije so močno obremenjene z mehanizacijo, zlasti če jo primerjamo z velikostjo posesti. Pomanjkanje zemlje rešujejo z najemom zemlje gospodinjstev, ki kmetovanje opuščajo.

Koeficient razparceliranosti je obratno sorazmeren koeficientu povprečne velikosti parcele, ki za vso zemljo skupaj z gozdom znaša 1,28 ha. Povprečna velikost parcele uporabljane obdelovalne zemlje pa znaša 0,93 ha, kar pa je vseeno za slovenske razmere presenetljivo veliko. Vzroki so naslednji:

- Zaradi zgodnje industrializacije Gorenjske okolica Kranja agrarne prenaseljenosti ni poznala v tolikšni meri in pritisk na zemljo ni bil tako močan.
- Večina tukajšnjih kmetij je zaščitenih, kar pomeni, da se ne smejo deliti, ampak dediči dobijo deleže izplačane v denarni odškodnini.
- Kmetje ves čas težijo k zaokroževanju svoje posesti, tako pri nakupu, kot pri najemu. Pri tem ni nepomembno, da imajo tisti, ki mejijo na parcelo, ki je naprodaj, prednostno pravico pri nakupu.

4.2. Intenzivnost kmetijstva

Tudi v kmetijstvu edino specializacija in intenzifikacija pridelave zagotavljata preživetje in primeren življenjski standard. Velike donose omogočajo zadostne količine gnojil – domačih in kupljenih, zaščitnih sredstev in krmil ter krmnih dodatkov – večji donosi pa pomenijo nižjo ceno na enoto pridelka. Nekateri stroški so fiksni: nafta, amortizacija, človekovo delo in se pri večjih donosih porazdelijo na več enot.

Intenzivno gnojenje je osnovna značilnost modernega kmetijstva in izbrano območje ni izjema. Čeprav je sama poraba mineralnih gnojil (836 kg/ha) zmerna, zlasti če jo primerjamo s slovenskim povprečjem, ki je leta 1987 znašalo 975 kg/ha (Ministrstvo za kmetijstvo, povzeto po Lampič), in je tudi manjša od povprečja anketiranih kmetij, ki ga navaja Radinja in znaša 763 kg/ha (Radinja, 1991). Vzrok je v intenzivni živinoreji z veliko živinorejsko gostoto, kjer nastajajo velike količine naravnega gnoja (skupno letno 12.077 m^3 gnojevke). Naravni gnoj v energetskem oziru predstavlja več kot polovico vsega gnoja, kar nam kaže slika št. 7, kjer je zaradi različnih merskih enot ves gnoj glede na energetsko vrednost na osnovi hranil pretvorjen v GER.[2]. Torej naravni gnoj odgovarja 220 tonam mineralnih gnojil, iz česar ugotovimo, da je gnojenje na izbranem območju izredno intenzivno.

Zaradi specifične kmetijske usmeritve je poraba zaščitnih sredstev zelo majhna. Travnikov in njiv silažne koruze živalski škodljivci (še) ne ogrožajo, prav tako ne bolezni. Na travnih površinah uporabljajo herbicid deherban proti ščavju, na posevkih koruze herbicide za zatiranje plevela, vendar v majhnih količinah. Delež zaščitnih sredstev je tudi v energetskem smislu zelo majhen. Vpliv na živi svet pa močno presega količine in energetsko vrednost in bi jim zaradi toksičnosti morali posvetiti več pozornosti.

V kmetijstvu nafta pomeni osnovni pogonski vir za delovanje mehanizacije, saj le manjši del strojev deluje na elektriko. Med tekočimi derivati je najpomembnejša, le med gospodinjstvi, ki se ukvarjajo s kmetijstvom samo kot dopolnilno dejavnostjo, bencin tvori pomemben delež.

Specifična poraba nafte na hektar obdelovalne površine je glede na intenzivnost kmetijstva proti pričakovanju dokaj majhna. Minimalna znaša 43,4 in maksimalna 339,8 litra na hektar. Povprečna poraba gospodinjstev znaša 194,3 l/ha, kar je pod slovenskim povprečjem (Radinja, 1991).

[2] Bruto energetske zahteve

Vzroki za nizko specifično porabo nafte/ha obdelovalnega zemljišča so naslednji:

- majhna razdrobljenost zemlje oz. povprečna velikost parcele znaša skoraj 1 ha,
- bližina parcel,
- največji porabniki imajo pestro strukturo traktorjev po moči,
- silažna koruza zahteva malo delovnih ur,
- število ur pri sušenju sena je zmanjšano na minimum zaradi prisilnega sušenja sena z električnimi ventilatorji in sončno energijo,
- travna silaža v okroglih balah ne zahteva delovnih ur, razen prevoza s travnikov do doma,
- kmetje ne skrbijo sami za prevoz svojih pridelkov, razen nekaterih, ki še vozijo mleko v zbiralnico,
- krmila in mineralna gnojila jim trgovci dostavijo na dom.

Razgibani svet Gorenjskih Dobrav je najprimernejši za živinorejo, ki je v zadnjih letih povsem prevladala. Število ostalih živali se je zmanjšalo ob velikem povečanju staleža goveje živine. Za razliko od Slovenije, kjer je število živine v tem obdobju upadalo, se je v izbranih naseljih povečalo, še zlasti v zadnjih 5-ih letih in sicer na čistih kmetijah. V letu 1995 je bilo 830 glav goveje živine, ostale vrste pa so skromno zastopane, kar nam kaže slika št. 13.

Intenzivnost živinoreje nam med drugim pokaže živinorejska gostota[3] in nam obenem pove, kje prihaja do koncentracije pridelave, in s tem zaradi velikih vložkov energije ter velikih količin naravnega gnoja tudi do večje obremenitve okolja. Povprečna živinorejska gostota za anketirane kmetije znaša 2,53, kar je bistveno višje od slovenskega povprečja (Statistični letopis, 1986, 1993), ki znaša 0,9 GNŽ/ha obdelovalne površine. Med posameznimi gospodinjstvi pa so velike razlike, najmanjša gostota znaša 1,1 GNŽ/ha, največja 3,8, kar je 3,5-krat več.

Največja dopustna živinorejska gostota naj bi bila 3 GNŽ/ha površine. Pri taki gostoti lahko še brez negativnih učinkov porabimo organski gnoj na razpoložljivih površinah (Leskošek, 1993). Večja gostota pa pomeni že obremenjevanje okolja z organskimi ostanki. Dobro petino gospodinjstev presega to mejo, v povprečju za 0,5 GNŽ/ha, preobremenjenih pa je 26,5 % vseh obdelovalnih površin (55 ha). Deloma drugačno sliko dobimo, če upoštevamo poletno pašo mladega goveda, še vedno je preobremenjenih 48 ha obdelovalnih površin ali 19,6 % vseh.

Velika živinorejska gostota pomeni, da lastna pridelana krma ne pokrije vseh potreb, zato del krme kupujejo; krmila in krmne dodatke ter silažno koruzo, v manjši meri tudi seno. Strukturo krme glede na njihovo težo nam kaže slika št. 16, drugačno sliko pa dobimo, če posamezne vrste pretvorimo po ključu v žitne enote[4]. Koruzna silaža obdrži velik delež, zmanjša pa se delež sena in poveča delež krmil. Ta struktura je tipična za mlečnoživinorejske kmetije, kjer je za doseganje visoke mlečnosti potrebno zagotoviti velike količine silaže in krmil.

Intenzivna živinoreja zahteva ne samo velike količine krme za prehrano živali, ampak tudi uravnoteženo prehrano z določenimi kvalitativnimi lastnostmi. Stroga specializacija v mlečno govedorejo je pripeljala do velike porabe krmil, ki jih delimo na žita[5] in krmne mešanice[6].

[3] Število živali na hektar obdelovalne površine

[4]

Število ŽE	100 kg ali 100 l
8	telečje meso
1,2	mleko
0,9	koruza za siliranje …

[5] To so različne vrste žit in drugih poljščin; koruza, ječmen, soja, sončnične tropine, pesni rezanci, bombaž in melasa. Kmetje jih sami mešajo in meljejo. Žita so energetsko močna krma in z njimi krave dobijo zadostno količino ogljikovih hidratov in beljakovin.

[6] Druga vrsta krmil so različne krmne mešanice. Večinoma kmetje uporabljajo krmila K 19 (proizvajalec Mlinotest Ajdovščina) mešanico za krave mlekarice. Osnovo tvorijo različna žita v točno določenih razmerjih, ki so termično obdelana in zato lažje prebavljiva. Pomembni so dodatki v obliki vitaminov, beljakovin, rudnin in mineralov.

Natančne podatke o hektarskih donosih v ožjem pomenu besede težko dobimo, saj sta osnovni kulturi, trava in koruza namenjeni izključno prehrani živine. Edini pokazatelj donosov je pridelano mleko, ki je v letih po osamosvojitvi nadomestil izpad dohodka iz gozdarstva. Le-to je vsa leta dajalo pomemben del zaslužka. Zaradi velike ponudbe so kmetje, ki se zavedajo ekološke vrednosti gozdov, sečnjo večinoma opustili, ker niso hoteli prodajati pod ceno. Dela v gozdu so omejili na pripravo drv za domačo porabo in na vzdrževalna dela. Dodatni zaslužek predstavljajo teleta in meso kot stranski produkt pridelave mleka, žganjekuha pa je tako kot les izgubila svoj pomen. Vsi ostali pridelki so večinoma namenjeni samooskrbi. Mleko usmerja način kmetovanja in narekuje intenzivnost prireje. V letu 1995 so oddali 2.201.609 litrov mleka, od tega prek 90 % čista gospodinjstva.

Porast pridelave mleka je šla na račun:

- specializacije v mlečno govedorejo,
- povečanja živinskega staleža,
- povečanje deleža črno-bele živine,
- najemanja novih obdelovalnih površin,
- večjih hektarskih donosov na račun večje porabe mineralnih gnojil,
- načina krmljenja z večjo porabo krmnih dodatkov,
- nove tehnologije pri gradnji hlevov in načinu molže.

Mlečnost je eden izmed pomembnih kazalcev intenzivnosti kmetijstva. Srednja mlečnost za gospodinjstva znaša 5525 litrov na kravo, najvišja prek 8000 litrov. Glede na to, da je del staleža lisaste pasme, ki dosega nižjo povprečno mlečnost, lahko zaključimo naslednje: mlečnost nad 7000 l/kravo je zelo visoka in zahteva veliko vložene energije, znanja in tehnologije. Mlečnost nad 8000 l/kravo je izjemen dosežek za slovenske razmere. Povprečne količine pridelanega mleka so izredno velike, če jih primerjamo z obdelovalnimi površinami. Specifična prireja mleka na hektar znaša 8591 l, če dopolnilnih gospodinjstev ne upoštevam znaša 9993 l/ha. Donosi izraženi v žitnih enotah so povprečno skoraj dvakrat višji od donosov na Brniku (Lampič, 1994).

Mlečnost je v prvi vrsti povezana z velikimi vložki energije (znanje in tehnologijo bom zanemarila) v obliki gnojil, elektrike, tekočih derivatov, krme in krmnih dodatkov. Na osnovi izračunanih korelacijskih količnikov lahko povzamem, da je visoka mlečnost odvisna od uporabljene krme. Korelacijski količnik 0,71 kaže na dokaj močno povezanost, statistična povezanost med količino porabljenih krmnih dodatkov in mlečnostjo pa je nizka.

4.3. Energetski vnosi na izbranih kmetijah

Intenzivno kmetijstvo je pogojeno z velikimi vnosi energije, ki smo jih doslej obravnavala ločeno, med seboj primerjali in jih obravnavali kumulativno. Vsi vnosi v obliki mineralnih in organskih gnojil, električne energije, tekočih derivatov, krme in krmnih dodatkov bodo na osnovi njihove energetske vrednosti pretvorjeni v GER-e. Njihov vpliv bo vrednoten z ugotovitvami, ki veljajo za zahodno Evropo. Po Slesserju je meja, ko se vplivi začno širiti izven kmetije, 15 GJ/ha, pri vnosih nad 40 GJ/ha kmetijstvo dobi poteze industrijske pridelave. Zgornjo mejo postavlja pri 60 GJ/ha obdelovalne površine.

Ob upoštevanju vseh neposrednih vnosov* na kmetijo dobimo naslednje rezultate. Anketirana gospodinjstva dosegajo zelo visoke vsote vložene energije, kar nam kaže preglednica št. 10. Skupaj so vložili 20.424 GJ neposredne energije. Največji vnos na posamezno gospodinjstvo znaša 1729 GJ, najmanjši 122 GJ, v povprečju pa so gospodinjstva vložila 851 GJ.

Boljši pregled vnosov dobimo, če jih primerjamo z obdelovalnimi površinami. Mejo 15 GJ/ha obdelovalne površine presegajo vse izbrane kmetije, pod 40 GJ/ha ostaja samo ena kmetija. V povprečju kmetije dosegajo energetske vnose 79 GJ/ha obdelovalne površine z razmikom od 30 do 108 GJ/ha, razmerje je 1 : 3,6.

---

* Vsi neposredni vnosi zajemajo mineralna in organska gnojila, električno energijo, zaščitna sredstva, krmne dodatke in tekoče derivate.

Postavi se nam vprašanje upoštevanja električne energije, ki okolja, kjer se jo uporablja, ne onesnažuje, onesnažuje pa ga tam, kjer jo proizvajajo, če gre za elektriko, proizvedeno v termoelektrarnah. Brez upoštevanja električne energije dobimo v povprečju 30 % nižje vrednosti neposrednih energetskih vnosov na hektar obdelovalne površine. Srednja vrednost vnosov sedaj znaša 66 GJ/ha z razponom od 24 do 89 GJ/ha in večina še vedno presega kritično mejo 40 GJ/ha po Slesserju.

Z okoljevarstvenega vidika je najbolj pereča uporaba mineralnih gnojil, tekočih derivatov in zaščitnih sredstev. Ti okolje neposredno onesnažujejo. Krmni dodatki pomenijo sicer velik energetski vložek, ne predstavljajo pa neposredne nevarnosti za okolje.

Zgornja slika nam kaže bistveno drugačno strukturo od tiste, ki jo za anketirane slovenske kmetije navaja Radinja (1991). Radinja govori, da največji delež odpade na tekoča goriva in sicer povprečno skoraj dve tretjini, eno tretjino pa mineralna gnojila. Ena izmed posebnost izbranega območja so velike količine gnojevke, ki predstavljajo nevarnost onesnaženja. Ob smiselnem upoštevanju gnojevke dobimo strukturo energetskih vložkov, ki pomenijo dejansko nevarnost za okolje.

Povprečna specifična poraba v GJ/ha je znašala 38, maksimalna 53 minimalna 15, porabo po gospodinjstvih pa nam prikazuje preglednica št. 14.

Tudi, če ne upoštevamo vložene električne energije in krmnih dodatkov, dobimo še vedno izjemne visoke specifične vnose energije na hektar obdelovalne površine. Pod mejo 15 GJ/ha je eno samo gospodinjstvo (14,8 GJ/ha), manj kot 40 GJ/ha znašajo vnosi pri 11 gospodinjstvih obravnavanega območja, eno je na meji. 11 gospodinjstev presega mejo 40 GJ/ha in sicer v povprečju za 4,9 GJ/ha, pri enem vnosi znašajo več kot 50 GJ/ha.

Energetske vnose sem soočila z hektarskimi donosi in pri tem upoštevala samo čiste kmetije, kjer so dobljeni rezultati veliko realnejši kot pri mešanih in dopolnilnih, kjer prihaja do velikih odstopanj. Korelacijski količnik 0,77 kaže na dokaj veliko soodvisnost pojavov, vendar so tudi precejšnja odstopanja. Pridelava mleka ne zahteva samo velikih vložkov energije, ampak tudi veliko znanja. Velike vnose glede na vloženo energijo lahko delno pripišem nakupu sena in koruzne silaže, kar ni zajeto v energetski sliki, premajhne vnose pa imajo tisti kmetje, ki imajo večji delež mokrotnih tal.

Pri energetskih vnosih na hektar obdelovalne površine so si bila gospodinjstva dokaj enotna. Razmerje med največjim in najmanjšim vnosom na hektar obdelovalne površine je znašalo največ 1 : 3,6. Razlike med donosi pa so veliko večje, razmerje je 1 : 41,4 oz. 1 : 21,6**** Na osnovi tega lahko zaključim, da se gospodinjstvom z več zemlje in intenzivnejšim kmetovanjem enota vložene energije povrne v veliko večjem obsegu hektarskega donosa kot dopolnilnim gospodinjstvom z malo zemlje. Za kilogram mleka je potrebno 3,5 MJ energije (povzeto po Radinji, 1990). Za vse izbrane kmetije sem izračunala, da porabijo za liter mleka 8,7 MJ vse energije. To pa je druga plat velikih količin pridelanega mleka.

5. Vpliv kmetijstva na okolje

Intenzifikacija kmetijske pridelave je imela poleg pomembnih pozitivnih učinkov tudi negativne učinke na okolje. Kmetijstvo obremenjuje okolje, to je zrak, tla in vodo predvsem z uporabo mehanizacije, velikimi vnosi energije in z različnimi melioracijami. Okolje je obremenjevalo tudi samooskrbno kmetijstvo, spomnimo se primerov različnih bolezni, katerih vzrok so bili nitrati v vodi, z intenzifikacijo kmetijske pridelave pa se seveda obremenjevanje oz. možnost onesnaževanja okolja stopnjuje.

Kolikšen delež onesnaževanja prinaša kmetijstvo, zaenkrat ni jasno. Prvič manjka tovrstnih raziskav, drugič pa je težko določiti izvor škodljivih snovi v okolju, še zlasti v gosto naseljenih pokrajinah, kjer se poselitev, promet, industrija in kmetijstvo tesno prepletajo. Prav tako je ločeno obravnavanje učinkov težavno, ker so vse tri sfere, zrak, voda in tla, neločljivo povezane in ogroženost ene dejansko pomeni tudi ogroženost ostalih.

5.1. Možni učinki kmetijstva na zrak

Kmetijstvo onesnažuje zrak z emisijami izpušnih plinov. Vendar, je količina porabljenih tekočih derivatov za kmetijsko pridelavo precej manjša od količine bencina, porabljenega za osebne avtomobile. Seveda doprinese svoj delež k onesnaževanju zraka, predvsem k nastajanju kislega dežja. Iz živalskih iztrebkov se sprošča amoniak, ki povzroča zakisanje tal. Na območjih z visoko živinorejsko gostoto nastaja velika količina živalskih iztrebkov in s tem je možnost onesnaženja večja. Raziskave (Klavžar, 1994, povzeto po Potthast), v različnih pokrajinah Severnega Porenja-Vestfalije kažejo, da je prispevek amoniaka h kislemu dežju zelo različen, odvisno od lokacije. Ta delež se npr. ob Nižjem Porenju (pokrajina z visoko stopnjo pridelave, ki meji na prav takšna območja na Nizozemskem) giblje okrog 75 %, nasprotno pa v zelo gozdnatih območjih znaša samo 25–30 %. Amoniak pa celo v industrijsko razviti deželi kot je Nemčija, izvira 95 % iz kmetijstva, pri čemer ga polovico proizvede govedo.

Kmetijstvo onesnažuje zrak tudi s smradom, ki neposredno zdravju večinoma ni škodljiv. Najbolj moteč je smrad razkrajanja gnojevke, ki pa je zaznaven samo ob polivanju gnojevke po obdelovalnih površinah. Neprijetno je, ker to poteka ob neugodni vremenski situaciji za človekovo počutje. Iztrebki živali povzročajo tem večji smrad, čim večji je delež krmil v obroku (Lobnik, 1989). Zaradi velike porabe krmnih dodatkov na anketiranih kmetijah in zaradi velikih količin gnojevke je smrad precejšen, vendar zaenkrat ni sporen.

5.2. Možni učinki kmetijstva na pedološko odejo

Težišče kmetijske pridelave v obravnavani regiji je na obrečnih evtričnih tleh na aluvialnih nanosih in fluvioglacialnem produ, ki so mestoma oglejena. Na sušnejših in globokih tleh so njive, sicer travniki. Delno so travniki tudi na evtričnem hipogleju na glini in melju in na evtričnih rjavih tleh na sivici.

Kmetijstvo predstavlja potencialno nevarnost na več nivojih:

1. Najpomembnejše je obremenjevanje tal zaradi različnih *energetskih vnosov*, predvsem v obliki organskega in tudi mineralnega gnoja, vpliv fitofarmacevtskih sredstev je zaradi izredno majhne količine skoraj zanemarljiv. Nevarnejše pa je gnojenje. Uporaba mineralnih gnojil je dolgo časa veljala za najbolj sporno. Na osnovi povprečne specifične porabe v izbranem območju lahko rečem, da je poraba mineralnih gnojil zmerna, saj ne dosega slovenskega povprečja. Prav tako je tudi način oz. čas uporabe ugoden, saj kmetje gnojijo v rasni dobi, večkrat letno, od 4- do 5-krat, kar pomeni, da enkratne koncentracije niso prevelike.
   Vprašljivo pa je nestrokovno gnojenje zaradi neprimerne izbire mineralnih gnojili. Nujne bi bile analize o količinah dušika, ki ga rastline lahko sprejmejo. Prav to gnojilo je glede možnosti negativnih posledic na rastline, tla, podtalnico in okolje med vsemi najbolj nevarno. Odmerki za posamezne kulture se določajo bolj ali manj na pamet, kar je lahko daleč od dejanskih potreb. To pomeni ne samo manjši pridelek in neracionalno razsipanje energije, ampak predvsem možnost onesnaževanja okolja.
   Na obravnavanem območju je sporna raba gnojevke, predvsem zaradi velikih količin. Vpliv gnojevke pa je močno odvisen od vrste tal, na katerih se uporablja. Na Oddelku za agronomijo Biotehnične fakultete so opredelili tla, primerna za nanašanje gnojevke, na osnovi fizikalno kemičnih lastnosti in debeline tal ter reliefa in določili naslednje skupine (Monitoring, 1994):
   - prepovedana raba gnojevke
   - uporaba gnojevke z omejitvami
   - tla z dovoljeno rabo gnojevke

   Večji del kmetijskih tal omenjene regije spada v drugo skupino, torej uporabe gnojevke z določenimi omejitvami, del kmetijskih tal pa je v prvi skupini, kjer je uporaba prepovedana, in sicer oglejena tla, hipoglej. Manjši del teh tal je bil hidromelioriran in tam je uporaba dovoljena.

2. *Uporaba težke mehanizacije* vpliva na spremembo strukture prsti, ki se z leti poslabša. Škodljiva je predvsem uporaba težke mehanizacije ob dežju in na tistih površinah, ki so zaradi visoke talne vode vlažnejše (Prus, 1991). Polivanje gnojevke povzroči največ škode travni ruši, ker poteka v vlažnem vremenu.

3. *Enostranska raba z monokulturo* tla enostransko siromaši in predstavlja večjo možnost razvoja škodljivcev (Prus, 1991). Kmetje v izbranih vaseh so dosledno opustili kolobar, ki tla bogati z organsko snovjo. To bo sčasoma verjetno postalo resen problem zlasti pri silažni koruzi, ki jo že leta gojijo na istih površinah. Kmetje se večinoma zavedajo potrebe po kolobarjenju, vendar zaradi vlažnosti tal nimajo veliko možnosti, da bi njive preselili.
   Zaradi izjemne intenzivnosti kmetovanja sem napravila analizo vzorcev prsti. Pri prvem vzorčenju sem vzela tri vzorce. Kmetje so zadnjič gnojili v začetku aprila, nakar je padlo veliko padavin, zadnji teden pred vzorčenjem pa je bilo suho in vroče. Vzorci so vzeti s travnatih površin, plast prsti je debela in vse prsti so ilovnato-glinaste. Vzorci so vzeti z močno, srednje in malo gnojenega travnika. Razlike v količini nitratov v prsti pa so si zelo blizu, kar je proti pričakovanju glede na količine uporabljenega gnoja. Zgornja meja nitratov je 40 oz. 44 mg NO^3/l. Drugi vzorec je z vrednostjo 40 mg NO^3/l na meji, prvi in tretji pa s 50 in 48 mg/l NO^3 to vrednost presegata. Presenetljivo majhne so razlike v količini nitratov glede ne količine uporabljenih gnojil. Razlog je lahko v tem, da je od gnojenja preteklo že skoraj dva meseca in so padavine sprale odvečne nitrate v tleh.
   Drugič sem zbrala 6 vzorcev, vse s travnatih površin in sicer nekaj dni po gnojenju in obilnejših padavinah. Prvi vzorec je z zelo močno gnojenega travnika, dva z močno, dva s srednje in zadnji z negnojenega travnika. Tokratne količine nitratov kažejo neposredno povezanost s količinami gnoja. Dva vzorca presegata zgornjo vrednost, en je na meji. Največ nitratov in sicer 60 mg/l je v prsti s travnika, ki je najmočneje gnojen, nato v prsti z močno gnojenih travnikov, 52 in 40 mg/l. Količine nitratov v prsti srednje gnojenih travnikih so 36 in 24 mg/l, v tleh malo gnojenega travnika pa 28 mg/l. Glede na prvo vzorčenje ima prvi vzorec več nitratov, ostala dva pa manj.
   Količine nitratov v prsti so povečane, vendar zaenkrat še ne kažejo na večjo obremenjenost tal zaradi uporabe mineralnega in naravnega gnoja. Drugo vzorčenje kaže na neposredno odvisnost količin nitratov v prsti od intenzivnosti gnojenja.

5.3. Možni učinki kmetijstva na kakovost vode

Kmetijstvo onesnažuje vodo v prvi vrsti z gnojenjem (Lobnik, 1991) zaradi povečanih količin dušika in fosforja. Vnesene količine mineralnih gnojil same po sebi niso pretirane, zlasti če kmetje gnojijo večkrat letno in ob primerni vremenski situaciji. Individualno prihaja do velikih prekoračitev. Drugačno sliko dobimo, če na podoben način ovrednotimo gnojevko. Primerjava z optimalnimi količinami nam pove, da je količina vnesenega dušika dvakratno prekoračena, prav tako količina fosforja. V mejah ostaja edino kalij, ki ga kmetje vnašajo celo manj, kot ga odnašajo s pridelki.

Večji delež fosforja je glede na povečano vlažnost tal na nekaterih mestih še upravičen. Fosfor tudi zaradi izredne sposobnosti vezave v oblike netopnih spojin v navedenih količinah ne pomeni večje potencialne nevarnosti. Po tujih raziskavah prinašajo fosfati okrog 4 % (pri nas morda nekaj odstotkov več) k skupni obremenitvi površinskih voda (Vajnberger, 1990). Pri možnosti obremenjevanja okolja skozi prizmo kmetijstva bi morali upoštevati tudi pralne praške, katerih poraba je precejšnja, ker jih uporabljajo tudi za pomivanje molznih sistemov.

Tla so prekomerno založena s hranili, zlasti z nitrati. Del njih se iz zemlje izgublja z izpiranjem v talne in površinske vode, del pa v obliki plinov v ozračje (Vajnberger, 1990). O dejanskih količinah izpranih nitratov ne moremo govoriti. Znano je, da se v okolici Ljubljane pod 50-centimetrsko zgornjo plast iz posejane njive izpere povprečno na leto 30 kg/ha, če pravilno gnojimo, neodvisno od količine dušika (Lobnik, 1989). Koliko tega dušika pride v podtalnico, še ni znano.

Količina nitratov, ki jih bodo padavine izprale, je odvisna od naslednjih dejavnikov (Vajnberger, 1990):

- količin vnesenega dušika,
- količin in razporeda padavin,
- mehaničnih lastnosti zemlje oz. propustnosti tal za vodo,
- vsebnosti organskih snovi v zemlji,
- vrste kulture,
- reliefnih oblik.

Na osnovi zgornjih kriterijev lahko zaključimo, da je izpiranje nitratov v obravnavani regiji povečano zaradi velikega vnosa z mineralnim in naravnim gnojem. Dodatno spodbuja izpiranje količina padavin in njihova razporeditev. Tudi v rasni dobi, ko je gnojenje najintenzivnejše, prihaja do viška padavin. Zaviralno na izpiranje vpliva slabša propustnost tal in debela plast prsti z veliko humusa. Ugodna je tudi raba tal, na travnikih z gosto rušo je izpiranje zmanjšano na minimum, prav tako na ravnih tleh, kjer poteka večino kmetijske dejavnosti.

Velika večina kmetov ima hleve na izplakovanje in zato nastaja pretežno gnojevka, vsega skupaj v letu 1995 kar 12.077 m^3. Količine hranil so odvisne od načina prehrane živine. Brez natančne analize količine hranil lahko samo predvidevamo. Glede na krmo anketiranih kmetij lahko ugotovimo, da ima zaradi velikih količin koruzne silaže manj dušika. Delež fosforja je povečan zaradi velikega deleža krmnih dodatkov in silaže. Močno gnojenje z mineralnimi gnojili, krmila in zlasti silaža povečujejo vsebnost kalija v gnojevki (Lobnik, 1989). Gnojevko anketiranih kmetij lahko primerjamo z gnojevko, ki nastaja na naših družbenih farmah.

Pri gnojevki je še mnogo bolj kot pri mineralnih gnojilih pomemben čas polivanja. V nekaterih evropskih državah imajo zakonsko določeno obdobje uporabe oz. neuporabe gnojevke. Gnojevka se ne sme uporabljati izven rasne dobe, ker je takrat izpiranje nitratov in izhlapevanje dušika mnogo večje, prvo še posebej na zmrznjeni zemlji (Monitoring, 1994). Pri nas zaenkrat vse ostaja samo pri načrtih.

Relativni izkoristek ali gnojilna vrednost dušika iz organskih gnojil je vprašljiva, saj je odvisna od naslednjih dejavnikov (Lobnik, 1989):

- od časa uporabe, meseca polivanja,
- od količine vode v gnojevki, dušik se mnogo bolj izkorišča iz razredčene gnojevke kot iz goste,
- od temperature in vlažnosti tal, od vremena in od vrste poljščin.

Čim večji izkoristek dušika dosežemo, tem manjša je nevarnost izpiranja nitratov v podtalnico. Pri pravilni uporabi je izkoristek nitratov do 80-odstoten, sicer lahko samo 30-odstoten (Ciraj, 1991).

Gnojevke ne bi smeli polivati v zimskem času, še posebno ne od novembra do februarja, ker rastline takrat ne morejo porabljati nitratov. Primernejša je tudi bolj razredčena gnojevka, ki je lažje izkoristljiva. Po drugi strani pa hitreje pronica v tla in zahteva veliko dela pri razvažanju, s pa tem večjo količino porabljene nafte (Monitoring, 1994). Izkoristek dušika iz gnojevke je odvisen tudi od vremenske situacije. Ob suhem in sončnem vremenu hitreje izhlapeva. Primeren čas gnojenja je ob oblačnem vremenu, pred ali med padavinami, vendar prevelika količina padavin pomeni tudi večje izpiranje.

Pomembno je tudi skladiščenje gnojevke oziroma nepropustnost in velikost jam. Glede prvega so problematične zlasti starejše jame. Velikost gnojnične jame naj bi zadostovala za šest-mesečne količine, kar bi omogočilo uporabo v najugodnejšem času. Temu kriteriju zadošča le malo kmetij, sicer povprečna velikost jame zadošča za 4 mesece in pol.

Sčasoma bo gnojevka (v velikih količinah) verjetno postala breme za kmeta. V nekaterih zahodnoevropskih državah so postavili maksimalno dovoljeno živinorejsko gostoto (in s tem tudi količine proizvedenega organskega gnoja na hektar obdelovalne površine). Definirana, vendar še ne sprejeta meja za Slovenijo, je 3 GNŽ goveda na hektar (Leskošek, 1993). To je meja, pri kateri lahko nastali organski gnoj brez škode vračamo v tla. V omenjenih naseljih 5 kmetij presega to mejno vrednost, štiri med njimi so največje kmetije.

Na koncu bi opozorila še na en dejavnik kmetijskega obremenjevanja okolja, ki ostaja v senci bolj perečih vprašanj in se ga navadno ne omenja. V mislih imam embalažo krmnih dodatkov, mineralnih gnojil ter odvečno plastično folijo okroglih bal.

5.3.1. Analize vode

Zaradi izjemno močne intenzivnosti kmetijstva v izbranih naseljih smo se odločili za analize vode, s katerimi lahko prej prikazane potencialne možnosti onesnaženja vode potrdimo in pokažemo dejansko onesnaževanje voda zaradi kmetijstva.

Prvo vzorčenje je bilo opravljeno po večdnevnih snežnih padavinah in odjugi, ki je sledila sneženju. Vode so bile nadpovprečno visoke in vsi kanali za hitrejše odtekanje v času padavin so bili polni. Na mokrotnih travnikih je voda mestoma stala na površju. V vodnjaku v naselju Letenice je bila samo 1 meter pod površjem. Pred drugim vzorčenjem nekaj dni ni deževalo in vode izbranega območja so imele srednje visok vodostaj. V času med prvim in drugim vzorčenjem kmetje niso gnojili. Ob tretjem vzorčenju so imele vode srednje visok vodostaj, vendar nižji kot pri prejšnjem vzorčenju, gnojili pa niso od zgodnje spomladi dalje, ker so po končani košnji čakali na dež. Zadnje, četrto vzorčenje sem opravila po daljšem obdobju brez padavin in visokih temperatur. Kmetje niso gnojili vse od marca dalje. Vode so imele srednje nizek vodostaj.

Interpretacija posameznih analiziranih kazalcev je narejena z vidika pitne vode (UL SFRJ 1987/3). Glede na stopnjo intenzivnosti kmetijstva bi pričakovali onesnaženost. Rezultati pa so pokazali drugače. Vrednosti nekaterih kazalcev so sicer povišane, vendar zaenkrat še niso zaskrbljujoče. Kljub izredni intenzivnosti kmetijstva, le-to ne onesnažuje vode v večji meri.

5.4. Učinki kmetijstva na preobrazbo pokrajine

Kmetijstva je prostorsko zahtevna panoga in zato močno vpliva na pokrajino. Stopnjo preobrazbe pokrajine lahko opredelimo tudi s kvantitativno metodo ornih ekvivalentov[7], ki so določene na osnovi vloženega dela. Prek njih lahko posredno sklepamo na obremenjevanje okolja, kajti več vloženega dela pomeni večjo potencialno nevarnost za okolje. Vrednosti indeksa ornih ekvivalentov se gibljejo od 10 do 250. Indeks prek 100 pomeni v naših razmerah zelo visoko stopnjo preobrazbe okolja, najnižji bi bil, če bi bili samo pašniki, najvišji samo vinogradi.

Indeks preobrazbe izbranega okolja je 31, kar pomeni nizko stopnjo preobrazbe okolja. Vrednost ni presenetljiva glede na visok delež gozda in travnikov. Opisana metoda ornih ekvivalentov se mi ne zdi več odraz dejanskih razmer v kmetijstvu. Vrednost posameznih kategorij, izraženih v ornih ekvivalentih, namreč ni prilagojena sodobnemu načinu kmetovanja. Delo oz. vnosi na travniške površine v modernem kmetijstvu danes ne zaostajajo za vnosi na njivskih površinah ali pa jih celo presegajo.

6. Sklep

Naravne osnove Goriškega polja nudijo optimalne pogoje za razvoj živinoreje:

- obrečna evtrična tla, ki prehajajo v rjava evtrična tla mestoma mokrotna ter oglejena tla na ilovnato-glinasti podlagi,
- ravnina,
- dovolj padavin in ugodna razporeditev le-teh prek leta,
- prisojna lega zaščitena pred hladnimi vetrovi s severa,
- zadostne količine pitne vode.

Zadnjih deset let so se kmetje usmerili v mlečno govedorejo, ki so jo v zadnjih letih zaradi izpada dohodka iz gozdov intenzivirali. Pridelava mleka pomeni edino dejavnost in tudi edini vir dohodka. Stroga specializacija je pripeljala do izrednih donosov, obenem pa zahteva od kmetov stalno prilagajanje oz. doseganje kvalitetnih norm. Način gospodarjenja je v veliki meri odvisen od cenovne politike na področju mleka.

[7] Orni ekvivalenti: njiva = 1 OE, vinograd = 2,5 OE, travnik = 0,4 OE, pašnik = 0,1 OE, gozd = 0,15 OE

Intenzivna pridelava mleka zahteva velike količine vložene energije. Energetska intenzivnost v kmetijstvu vodi k vedno večjemu onesnaževanju, vprašanje pa je, kolikšen je prag v alpskem svetu, kamor pripadajo Gorenjske Dobrave.

Za izračunavanje energetske intenzivnosti kmetijstva sem upoštevala naslednje neposredne energetske vnose:

- organska in mineralna gnojila
- zaščitna sredstva
- tekoči derivati
- električna energija
- krmni dodatki

Pojavlja se vprašanje smiselnosti upoštevanja vseh vrst vnosov. Smiselno jih je upoštevati z vidika stopnje energetske intenzivnosti. Kadar pa energetske ekvivalente agrikulturnih vnosov razumemo kot kazalec energetskega obremenjevanja okolja, bi veljalo upoštevati, da električna energija in krmni dodatki neposredno ne obremenjujejo prostora uporabe.

Če upoštevamo vse vrste energije, vse kmetije (z eno izjemo) kmetujejo na industrijski način. Neposredni vnosi so izjemno veliki. V povprečju znašajo 79 GJ/ha. Kar tri gospodinjstva vlagajo prek 100 GJ/ha in samo tri manj kot 60 GJ/ha. Brez električne energije in krmnih dodatkov dobimo naslednje rezultate: Še vedno samo trinajst gospodinjstev ostaja pod mejo 40 GJ/ha, dve presegata celo zgornjo mejo 60 GJ/ha. V povprečju pa gospodinjstva dosegajo vnose 38 GJ/ha.

Vložki energije so visoki tudi zaradi kvalitete tal, saj oglejena tla zahtevajo dvakrat več vložene energije in dela. Anketirani kmetje imajo po grobi oceni približno polovico tal, ki so podvržena oglejevanju.

Lahko pa naredim še drugo primerjavo na osnovi porabe energije pri različnih načinih pridelovanja hrane. Upoštevala bom samo intenzivnejše kmetijske sisteme (povzeto po Radinji, 1990):

Značilnosti posameznih vnosov so naslednje**:**

Naravni gnoj: delež naravnega gnoja je enak deležu mineralnih gnojil, kar je bistveno več kot v družbenem kmetijstvu, kjer naravni gnoj predstavlja le 13 % vsega gnoja. Del tega gre na račun velike živinorejske gostote in vnosi znašajo 11,5 GJ/ha. Naravni gnoj je z okoljevarstvenega vidika sporen, ne samo zaradi velikih količin, ampak predvsem zaradi oblike.

Mineralna gnojila: gnojenje z mineralnimi gnojili je zmerno. V povprečju kmetje vlagajo 11 GJ/ha v obliki mineralnih gnojil, kar je prav toliko kot znašajo vnosi v družbenem kmetijstvu (Radinja, 1993). Ob upoštevanju naravnega gnoja je obremenitev obdelovalnih površin zaradi gnojenja velika (presega 20 GJ/ha obdelovalne površine) in tako kmetijstvo je po Slesserju že intenzivno. Nitrati v različnih oblikah predstavljajo 68 % vseh hranil v mineralnih gnojilih, pri družbenem kmetijstvu 82,8 % (Radinja, 1993). Skoraj dvakrat večja pa sta deleža fosfatov in kalija.

Krmni dodatki: največji delež ob upoštevanju vseh vložkov (tudi električne energije) predstavljajo krmni dodatki, ki so posledica intenzivne pridelave mleka. V celoti predstavljajo dobro tretjino vseh energetskih vnosov ali 21,7 GJ/ha, pri enem kmetu kar 39,5 GJ/ha. Taka struktura vnosov je edinstvena v Sloveniji in je odraz stroge specializacije za mlečno govedorejo. S krmnimi dodatki kmetje povečujejo število živine, ker imajo na razpolago premalo obdelovalnih površin na razpolago in ker s tem dosegajo višjo mlečnost.

Električna energija: kljub veliki porabi električne energije, ki v povprečju znaša 19 GJ/ha se njen delež v celotni energetski strukturi zmanjša ob visokih vložkih naravnega in umetnega gnoja ter krmil. Ob upoštevanju vseh vnosov je s 20 % na drugem mestu za krmnimi dodatki, brez njih se njen delež poveča na 30,4 %.

Tekoči derivati: največji delež med tekočimi derivati predstavlja nafta, na drugem mestu je bencin, poraba zemeljskega plina in kurilnega olja pa je izredno majhna. Specifični vnosi so znašali povprečno 11 GJ/ha, kar je bistveno manj kot na družbenih posestvih, kjer znašajo vnosi 18,9 GJ/ha (Radinja, 1993). Delež tekočih goriv v celotni strukturi vnosov je majhen in znaša 12,8 %. Če zaradi lažje primerjave krmne dodatke zanemarim, njihov delež naraste na 19,4 %, To je manj kot pri družbenem kmetijstvu, kjer tekoči derivati dosegajo tretjino vseh vnosov, v zasebnem kmetijstvu v Sloveniji pa kar dve tretjini vseh vnosov (Radinja, 1991, 1993). Električna energija in tekoči derivati so v kmetijski prireji konstanta, vložki gnojil in krmnih dodatkov pa kažejo veliko intenzivnost usmerjenega kmetijstva.

Fitofarmacevtska sredstva: delež fitofarmacevtskih sredstev je izredno majhen, vendar ne smemo zanemariti toksičnosti. V celotni strukturi energetskih vnosov dosegajo dobro desetinko %, specifična poraba na hektar pa znaša 0,081 GJ, kar je 12-krat manj kot v družbenem kmetijstvu (Radinja, 1993).

Na osnovi neposrednih energetskih vnosov lahko sklepamo, da je potencialno obremenjevanje okolja zaradi kmetijstva veliko, sliko o tem, kakšne so možnosti dejanskega obremenjevanja, pa dobimo ob upoštevanju lokalnih naravnih razmer. Predvsem pedološke razmere z globokimi in zmerno propustnimi tlemi in raven relief zmanjšujejo dejansko obremenjevanje okolja.

Analize vode, ki so zajele obdobje od začetka aprila do konca junija, in prsti kljub izredni intenzivnosti kmetijstva niso pokazale dejanske onesnaženosti. Zbrani vzorci vode in prsti kažejo povečane vrednosti nekaterih kazalcev, vendar so le-te precej manjše od pričakovanih. Slabše propustna ilovnato glinasta tla pogojujejo manjšo občutljivost okolja. Izbrana regija je primerna za intenzivno mlečno govedorejo.

Pri izdelavi sem se v celoti držala Slesserjeve metode energetskih ekvivalentov in upoštevala vrednosti agrikulturnih vnosov v GER-ih, edino za gnojevko sem energetski ekvivalent izračunala sama. V danem primeru je bila metoda dobro izvedljiva, rezultati pa so prinesli nekaj presenetljivih ugotovitev:

Anketiranih kmetij po neposrednih energetskih vnosih ne morem uvrstiti v nobeno od tipoloških skupin (Radinja, 1991). Prav vse spadajo med sodobne, intenzivne, usmerjene kmetije. Kmetije so usmerjene večinoma v mlečno govedorejo, nekatere manjše v prirejo govejega mesa. Za dopolnilne kmetije izbranih vasi ne moremo reči, da so sodobne in intenzivne, kljub temu, da po vnosih nedvomno sodijo tja. Po Slesserju gre za kmetijstvo, ki ima že izrazito industrijske poteze. To popolnoma velja za čiste in mešane kmetije, vprašanje pa je, če velja tudi za dopolnilne.

Opisana metoda je primernejša za mešani poljedelsko-živinorejski tip kmetijstva. Vendar bi pri poljedelski pridelavi morali upoštevati tudi vnose v obliki semen. Za ozko usmerjeno živinorejo in še posebej za intenzivno mlečno govedorejo se mi zdi metoda le pogojno primerna. Na osnovi rezultatov je vprašljiva predvsem primerjava z ostalimi kmetijskimi sistemi.