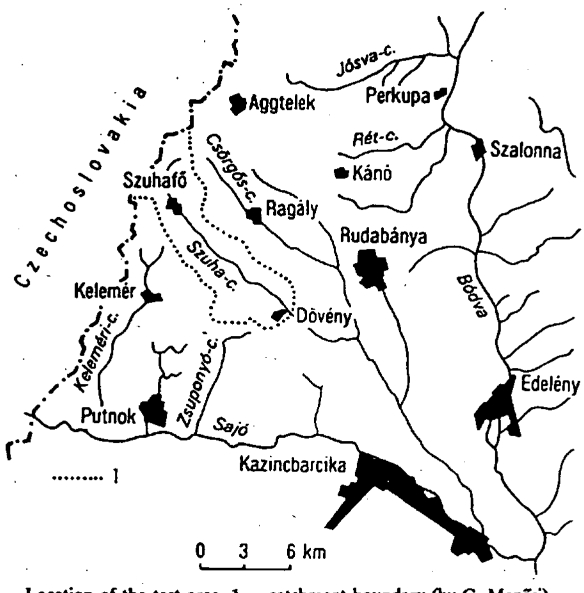
ASSESSMENT OF POTENTIAL PRIMARY PRODUCTIVITY OF DIFFERENT LANDSCAPE TYPES BASED ON MICROCOMPUTER INVESTIGATIONS

Á. Kertész – G. Mezősi

In our previous studies (*Mezősi* 1986, *Kertész–Mezősi* 1988) theoretical and methodological problems of a microcomputer assisted ecological feasibility study were examined in a hilly test area (Szuha valley, Borsod–Abaúj–Zemplén county, northern Hungary). In the present study a feasibility classification of the surface is given for the whole catchment area (*Figure 1*) from the point of view of maize production. Relationships between relief characteristics and land use types and between relief characteristics and crop rotation were evaluated as well. Maize was chosen since this is the most widespread crop in the area mostly because of economic, and not ecologic reasons. Our further objective was to investigate the interrelationships among landscape typological units,land use, the actual primary productivity of the typological landscape units were compared and the potential production corrected on the basis of soil characteristics was estimated. Suggestions for the best land use and crop rotation were elaborated based on the above mentioned calculations.

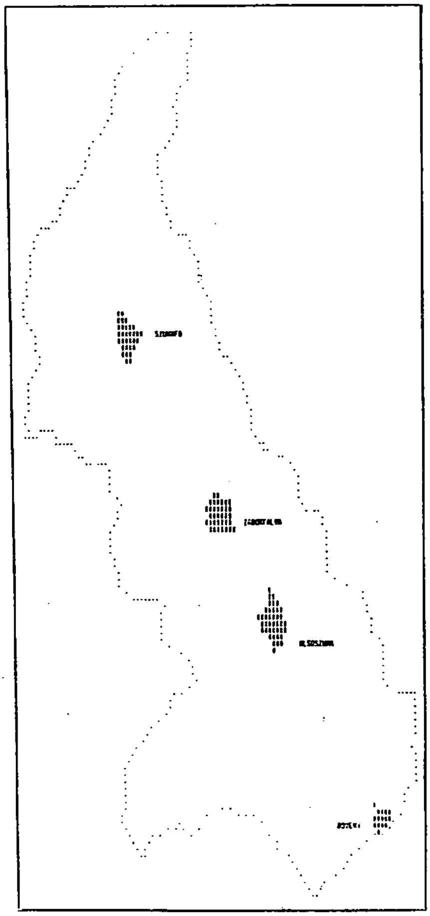
Fig. 1.



Location of the test area. 1 = catchment boundary (by G. Mezősi)

Test area, data base

Fig. 2



The test area with its settlements
(by G. Mezősi).
..... = boundary of the area;
# = settlements

The test area of the Szuha valley catchment (5814 ha) stretches from NW to SE (see *Figure 1*). Our investigations concern only 2054 ha situated mainly in the central and southern part of the Szuha valley catchment, since we were interested in the evaluation of large scale farming agricultural areas („agricultural land"). The most part of the remaining 3757 ha is forest.

Some private owned farmland belongs to the remaining 3757 ha as well („non-agricultural land" in *Figure 2*). The latter category could not be included in our study due to lack of some of the necessary data (e.g. data on crop rotation, average crop production, etc.). Lands belonging to this latter category are of much better quality than the agricultural lands of the catchment.

The study area is built up from Tertiary sediments. The valley of the Szuha-river is asymmetrical with several river terraces. The altitude varies between 380m and 125m a.s.l. (the higher values occur in N and SW of the catchment). SW and NE the divide runs on hilly plateaus. The valley side slopes in the NE parts are very steep with

Average slope angle and slope stability of agricultural lands (G. Mezősi) *Table 1.*

Land use	Area (ha)	Average slope angle (%)	Surfaces subjected to sliding	Surfaces with potential sliding hazard
			(in % of the given land use type)	
1. settlement	50	12,49	–	–
2. arable land	799	12,26	0,8	1,3
3. gardens and vineyards	45	15,73	–	2,2
4. pasture and meadow	810	17,19	0,9	4,0
5. areas taken out from production	80	13,17	–	–
6. areas near water surfaces	197	12,12	–	0,5
7. pasture & meadow with forest spots	71	21,14	1,4	4,2

Slope categories of different agricultural land use types (%) (G. Mezősi) *Table 2.*

Slope gradient category	arable land	areas near water surfaces	gardens and vineyards	pasture and meadow	pasture & meadow with forest spots
0–2 %	22,7	25,4	24,4	11,2	2,8
2–4 %	27,8	23,9	11,1	16,3	7,0
5–12 %	1,4	–	4,4	2,5	4,2
13–17 %	1,8	7,1	2,2	4,6	4,2
18–22 %	24,0	25,4	26,7	32,2	33,8
23–30 %	21,3	15,7	17,8	26,3	40,8
31 % <	1,1	2,5	13,3	6,9	7,0

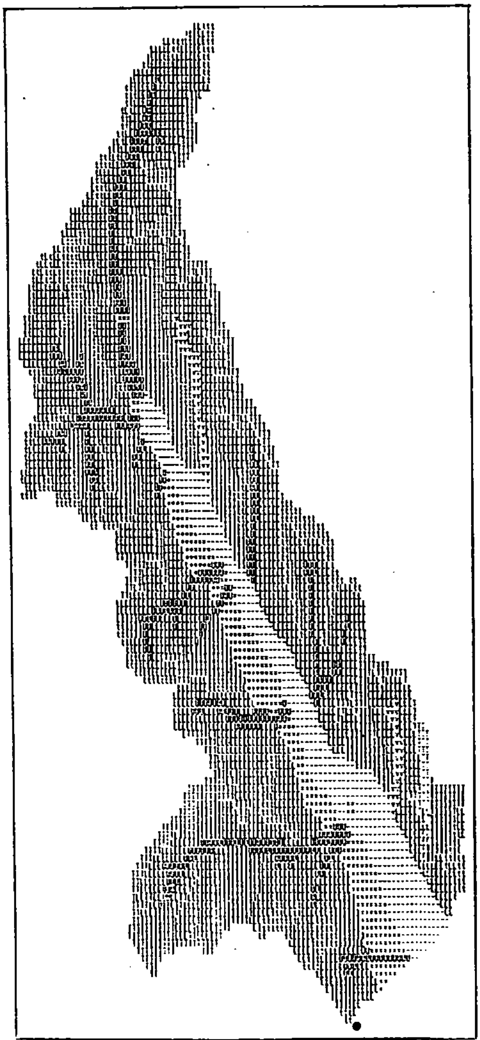
landslides or with the possibility of sliding. Slopes in SW are relatively long and gentle piedmont slopes with 2–3 cryoplanation terraces. The piedmont and terrace surfaces are dissected by erosional and derasional valleys and so they consist of several inter-valley ridges. More than 50% of the catchment slopes are steeper than 18% and about one third of the slopes have a gradient of only 0–4% (*Table 1, 2*). Most of the slopes (52%) are exposed to N, NE and E. According to *Figure 3* (Landscape types) slopes cover about 50% of the catchment area whereas one sixth of it are pediment surfaces, terraces and flood plains.

Figure 4 (Landuse map) was designed on the basis of 1986 data. Each grid cell of 1 ha was put into the category the precentage of which was the greatest in the grid cell. E.g. the real extention of outer zones of settlements comes to 73 ha, which is a bit more than the 70 ha taken into account in *Figure 4*. Infrastucture establishments (roads, railways, mines) are included in the category, „taken out from production". 35% of the special category, „areas near water surfaces" are arable lands and 60% of them are meadows and pasture. Half of the agricultural land is situated on floodplains, on terraces and on piedmont surfaces, whereas one third of them lies on hillslopes with a slope gradient of 12%. Half of the agricultural land is arable land, one quarter are meadow and pasture. The soils are or low quality (with a land score of only 17.5), with a thin fertile horizon, slightly acidic (40% of the soils have a pH value between 5,5–6,1), moderalely cohesive (40% of the soils have a saturation coefficient between 43–50). Brown forest soils are typical in the whole catchment, with a considerable loam end clay content.

Relief, climate and soil maps considered to be relevant and important were digitized and put in the database. Most of these data were directly available or could be taken from maps.In some cases, however, special programs must have been used. E.g. for the indentification of regional differences in the values of monthly precipitation the application of an interpolation procedure was necessary based on the data of meteorological stations, in the neighbourhood situated in different topographic positions, on the tendencies in horizontal precipitation changes and on short term microclimate measurements (*Figure 5*). The territorial distribution or monthly main temperatures was calculated in a similar way using the formula of *Péczely* (1979) elaborated for the Carpatian basin and slightly modified for the area in question.

The county council of Borsod–Abaúj–Zemplén county and the cooperatives owning farmland in the catchment gave us the 1:10 000 soil maps of the area. Land value scores (between 0–100) were calculated by the authors.

Some of the maps were generated by the applied programme itself, e.g. slope category, slope exposure maps, etc.. Land use, landscape typology and actual primary production maps, the latter based on the mean value calculated for the years (1983–86), complete the map series (*Figure 6*). Available data on fertilizers, amelioration and on income from agricultural production were also included in our investigations. Not all data were used for the above mentioned purposes, i.e. for the evaluation procedure. The rather broad data base enables us, however, to carry out quite number of feasibility or natural hazard studies. Among others soil erosion hazard, the analysis of anthropogenic influences and the investigation of recreation potential could easily be possible with the help of our data base.



MAP BASE: [illegible]
[illegible] : tajtipus terkep
SCALE : 100 —

SYMBOL	VALUE	LABEL	CELLS	COVERAGE +0	COVERAGE -0
	0	kulso terulet	7782	57.24	.00
----	1	ártér	553	4.07	9.51
••••	2	eróziós völgyek	69	.33	1.19
UUUU	3	er-der völgyek	503	3.70	8.65
••::	4	teraszfelszinek	234	1.72	4.02
llll	5	dombsági tetö,vhát	583	4.29	10.02
TTTT	6	u.s. degradált ABC,BD	609	4.43	10.47
IIII	7	12% alatti hátlejtök	718	5.28	12.35
LLLL	8	12% feletti lejtök	2446	17.99	42.07
••••	9	hegylábfelszin	99	.73	1.70

Landscape typology map of the test area (by G. Mezősi).

1 = floodplains with meadow soils;

2 = floodplain valleys with grove and swamp vegetation

3 = board derasional and erosional-derasional valleys with meadow- and slope deposite soils, meadow and pasture

4 = terraces with meadow and meadow chernozem soil type, oak and turkey oak forest;

5 = hilly plateaus and intervalley ridges on Tertiary sediments with lessivé brown forest soil and Ramann brown forest soil, originally covered with turkey-oak forest, today partly with agriculture;

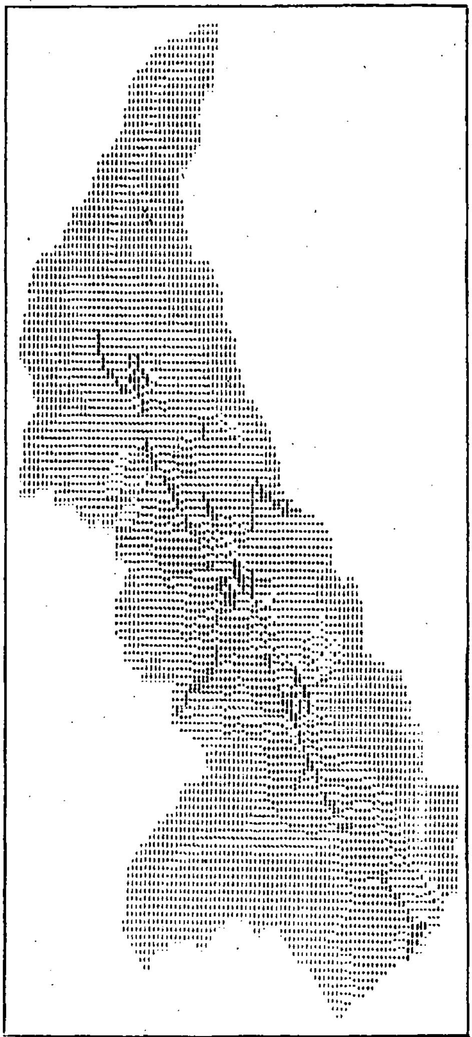
6 = same as 5, only degraded;

7 = hillslopes (<12%) with brown forest soil, turkey-oak vegetation;

8 = loose deposits of sliding hillslopes and mountain slopes, with degraded turkey-oak vegetation, with eroded brown forest soils, dissected by erosional-derasional valleys;

9 = slightly dissected piedmont surfaces with meadow and slope deposit soils.

Fig. 4.

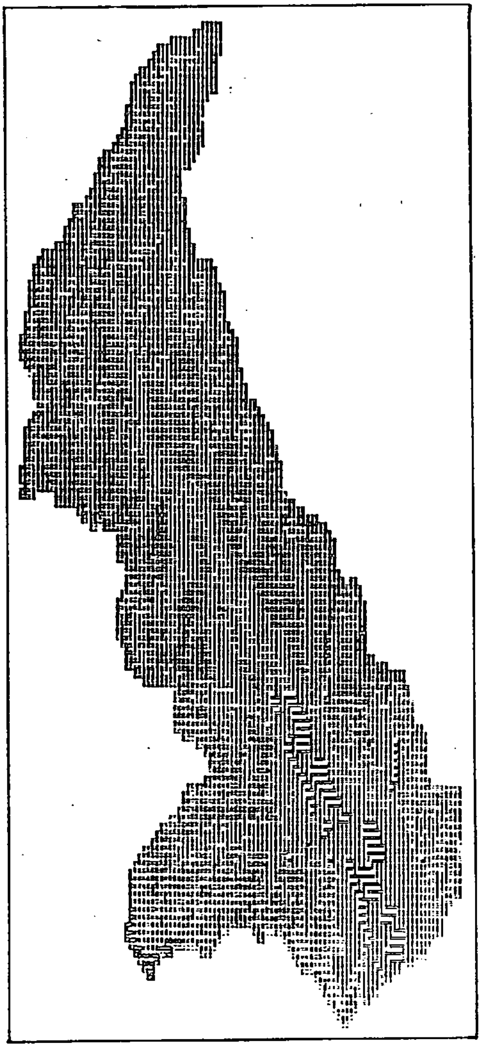


MAP BASE: LAND
HEADER : területhasznosítás
SCALE : 100

SYMBOL	VALUE	LABEL	CELLS	COVERAGE +0	COVERAGE -0
	0	külső terület	7782	57.24	.00
||||	1	belterület	70	.31	1.20
++++	2	szántó	832	6.12	14.31
....	3	kert,szőlő	121	.89	2.08
----	4	rét,legelő	1722	12.67	29.62
IIII	5	termelésből kivett	107	.79	1.84
----	6	vízközeli terület	347	2.55	5.97
----	7	erdősítéses rét,leg.	71	.52	1.22
!!!!	8	erdő	2544	18.71	43.76

Land use (by G. Mezősi).
1 = settlement;
2 = arable land;
3 = vineyard and orchard;
4 = meadow and pasture;
5 = area taken out from production;
6 = area near water surfaces;
7 = meadow and pasture with forest spots;
8 = forest

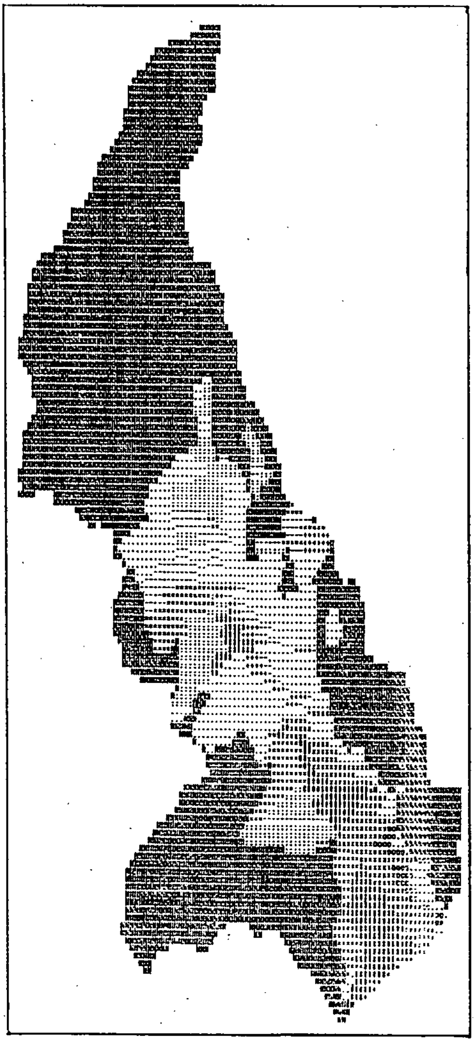
Fig. 5.



MAP NAME: JULCSAP
HEADER : A júliusi csapadékmennyiség mm-ben
SCALE : 100

SYMBOL	VALUE	LABEL	CELLS	COVERAGE +0	COVERAGE -0
	0	Külső terület	7782	57.24	.00
	67	mm	206	1.52	3.54
	68	mm	129	.94	2.20
	69	mm	726	5.34	12.49
	70	mm	635	4.67	10.92
	71	mm	760	5.59	13.07
	72	mm	1159	8.46	19.78
	73	mm	641	4.71	11.03
	74	mm	996	7.33	17.13
	75	mm	199	1.39	3.25
	76	mm	356	2.62	6.12
	77	mm	27	.20	.46

Mean precipitation in July (mm)
(by G. Mezősi)



MAP NAME: BIOM
HEADER : Biomassza produkció t/ha
SCALE : 100

SYMBOL	VALUE	LABEL	CELLS	COVERAGE +0	COVERAGE -0
	0	külső terület	7782	57.24	.00
NNNN	1	nem ag hasznositott	3757	27.63	64.62
....	2	1,77-2,63 t/ha	750	5.52	12.90
::::	3	2,63-3,48 t/ha	317	2.33	5.45
----	4	3,48-4,34 t/ha	178	1.31	3.06
xxxx	5	4,34-5,20 t/ha	251	1.55	4.32
++++	6	5,20-6,06 t/ha	73	.54	1.26
zzzz	7	6,06-6,92 t/ha	207	1.52	3.56
oooo	8	6,92-7,78 t/ha	37	.27	.64
!!!!	9	7,78-8,63 t/ha	171	1.26	2.94
####	10	8,63-9,49 t/ha	73	.54	1.26

Primary productivity (t/ha)
(by G. Mezősi)
-1 = areas not used for agriculture

Methods

For the purposes of the ecological feasibility study of the area from the point of view of maize production 3 ecological factors, i.e. relief, soils and climate, characterized by 14 parameters, were taken into account. In the course of our investigations ecological (site) requierments of maize were determined first followed by the elaboration of the weighted score system applied in the evaluation procedure. The evaluation procedure means the analysis of the ecological factors searching for an answer , why these factors and how well the optimum approach. That is why the results, i.e. the numbers on a scale between 1 – 100, do not only indicate the relative regional differences but they can be used as absolute values as well. Of course, this evaluation procedure contains a number of subjective elements as well, but it enables the digital analysis and management of data, it is relatively quick and the registration of the parameter changes, for one parameter or for all together, is also possible.

Ecological conditions of maize production

The conditions of maize production and the territorial distribution of the amount of yield are controlled first of all by the climate. In Hungary the temperature influences the ripening of the crop and the precipitation controls its quantity. On the basis of correlation coefficients calculated between climatic factors and crop yield the following climatic requirements of maize production can be determined. Arid weather in April is favourable, especially in regions with high precipitation. The temperature does not play an important role in April, whilst in May both temperature and precipitation are very important. In June even more precipitation is wanted with a peak in July which decides the yield in Hungary. As far as temperature is concerned it can be said that in the case of a dry period a very warm weather can do considerable harm while it does not do any harm with enough precipitation. In August less precipitation is wanted if temperature is about the 50 years' average whereas much precipitation is necessary if the August is hot. The optimum values area summarized below (after *Bacsó* 1963).

Temperature (°C)						Precipitation (mm)					
V	VI	VII	VIII	IX	Total	V	VI	VII	VIII	IX	Total
16,7	19,1	21,8	19,5	15,5	2880	80	75	86	96	54	391

To achieve a good yield the following series of weather conditions should be fulfilled:

1) a lot of precipitation in July,
2) high temperature in May,
3) enough precipitation in August,
4) enough precipitation in June preceeded by enough precipitation in May,
5) not too high temperatures with a considerable amount of precipitation.

Soil requierments for maize production are as follows:
pH: 5,5 – 7,0
saturation coefficent: 30 – 50
Soil type: loamy soil.

Evaluation procedure

In the course of the evaluation weighted scores (*Table 3*) and the land scores if fulfilled (*Table 4*) were multiplied and added for each grid cell of 1 ha. The MAP2 GIS software working with a grid system, was used, developed by the De Dorschkamp Institute (*Berg A. et. al. 1985*).

As we have already tried to use the MAP2 software package (*Kertész – Mezősi 1988*) we attemted to answer the question to select the best land use type for a given area.

Weighted scores from the point of wiew of maize production *Table 3.*
(Á. Kertész – G. Mezősi)

	Weigted scores
CLIMAT:	55 scores
Precipitation:	35 scores
1) July	13 scores
2) August	9 scores
3) June	7 scores
4) May	6 scores
Temperature:	20 scores
5) May	10 scores
6) August	5 scores
7) Total heat for the vegetation period	5 scores
SOILS:	30 scores
8) cohesion	5 scores
9) thickness of fertile layer	9 scores
10) pH	4 scores
11) soil texture	7 scores
12) soil type	5 scores
RELIEF:	15 scores
13) slope category	9 scores
14) geomorphological processes	6 scores

Scores for different factors (Á. Kertész – G. Mezősi) *Table 4.*

		scores
1) Precipitation in July (mm)		
optimum: 86 mm – 13 scores	94 – 97	11
	90 – 93	12
	86 – 89	13
	82 – 85	12
	78 – 81	11
	74 – 77	10
	70 – 73	9
	66 – 69	8
2) Precipitation in August (mm)		
optimum: 96 mm – 9 scores	94 – 97	9
	90 – 93	8
	86 – 89	7
	82 – 85	6
	78 – 81	5
	74 – 77	4
	70 – 73	3
	66 – 69	2
	62 – 65	1
3) Precipitation in June (mm)		
optimum: 75 mm – 7 scores	89 – 92	3
	85 – 88	4
	81 – 84	5

	77–80	6
	73–76	7
	69–72	6
	65–68	5
4) Precipitation in May (mm)		
optimum: 90 mm–6 points	78–81	6
	74–77	5
	70–73	4
	66–69	3
	62–65	2
5) Mean temperature in May (°C)		
optimum: 16,7 °C–10 points	19,0–19,9	5
	18,0–18,9	4
	17,0–17,9	3
	16,0–16,9	2
	15,0–15,9	1
6) Mean temperature in August (°C)		
optimum: 19,5 °C–5 points	19,0–19,9	5
	18,0–18,9	4
	17,0–17,9	3
	16,0–16,9	2
	15,0–15,9	1
7) Total heat for the vegetation period (°C)		
optimum: 2880–5 points	2870–2939	5
	2800–2869	4
	2730–2799	3

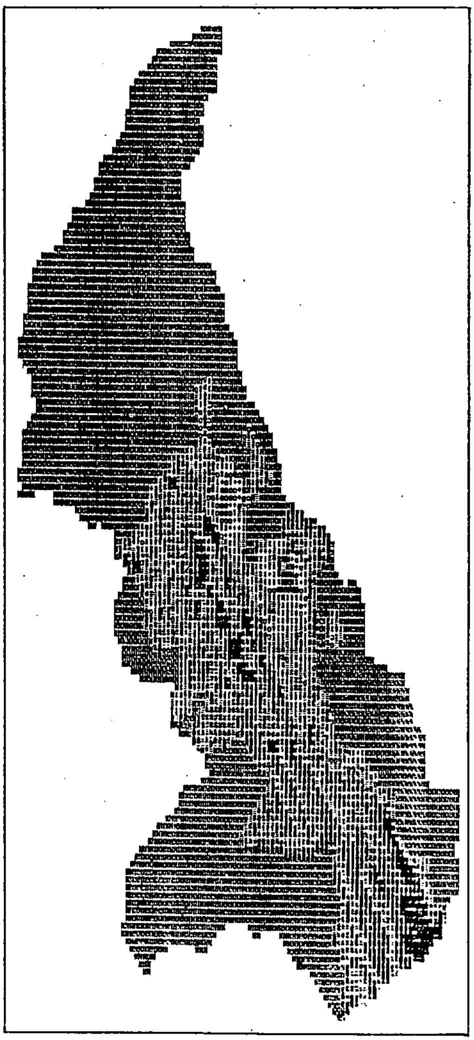
	2650–2729	2
	2580–2649	1
8) Saturation coefficient		
optimum: 30–50–5 points	38–42	4
	43–50	5
	51–58	3
	59–66	2
	67	1
9) Thickness of the fertile layer (cm) humus content (%)		
maximum: 9 points	50 cm, 3 %	7
	40–50 cm, 3 %	6
	40–50 cm, 1,5–3 %	5
	40–50 cm, 0,5–1,5 %	5
	30–40 cm, 1,5 %	4
	20–30 cm, 3 %	3
	20–30 cm, 1,5–3 %	2
	20–30 cm, 0,5–1,5 %	2
	10–20 cm, 1,5 %	1

Results

Site conditions of maize production in the Szuha valley catchment.

Figure 7 shows the areal distribution of the feasibility land value numbers for agricultural land. The mean value of the land scores ranging between 35–72 is 56,6. Values above the average (63–72) are to be found on piedmont surfaces, terraces and on floodplains. More than 50% these of these areas are used today as arable lands, 25% as meadow and pasture. Two thirds of the values near the average (51–62) can be detected on flood plains and on gentle slopes (with a gradient below 12%), one sixth in the valleys. As for current land use, most of them (75%) are arable land, meadow and pasture. Half of the slopes steeper than 12% and a quater of the slopes below 12 % have scores below the average (35–50). 75–80 % of the areas with low scores are meadow and pasture.

Fig. 7.



SYMBOL	VALUE	LABEL	CELLS	COVERAGE +B	COVERAGE -B
	B	Külső terület	7782	57.24	.00
XXXX	0	nem mg hasznositású	3757	27.63	64.62
++++	1	35-40 pont Score	33	.24	.57
OOOO	2	41-45 pont	93	.68	1.60
####	3	46-50 pont	306	2.25	5.26
	4	51-56 pont	637	4.69	10.96
	5	57-62 pont	409	3.01	7.03
	6	63-66 pont	458	3.37	7.88
	7	67-72 pont	121	.89	2.08

Feasibility scores
for maize production
(by G. Mezősi)
0 = areas not used for agriculture

Table 5 shows the areal distribution of primary production and of the feasibility scores for different landscape typological units. Values of primary production above the average yield (4,29 t/ha) are due to the fact that both primary and secondary production were included in the calculation (*Fazekas* et al. 1983). The development of the most favourable crop stucture and the most favourable agricultural utilization of an area do not absolutely mean a maximum primary production far above the potential productivity in spite of a preference system advantageous for crops with high primary productivity. It seems to be much more important, especially in regions with poor ecological conditions like the test area, to develop a crop structure better adjusted to the ecological conditions and based e.g. on industrial plants assuring the biggest net income. The results of our investigations can be considered authentic since they inform about the productivity of a landscape typological unit. The authenticity is guaranteed by relatively homogenous crop structure during the investigation period and by the significant correlation between plant production referred to fields and net income.

The question of the convertibility and confidence of the results should be asked as well. To answer this question and to test the method we started control investigations in the Bódva-valley (Szendrői basin) and in the Sajó-valley (in the vicinity of Putnok and Serényfalva). The following conclusions can be drawn from the first results of these investigations.

a) Landscape typological units controlling the functioning of the landscape should be exactly defined with leading parameters (*Mezősi* 1986).
b) Difference between actual and calculated primary productivity is less than 20 % in the control area except on floodplains and on slopes steeper than 12%
c) The production capacity of landscape typological units for different plants can be given considerably well in the case of bigger landscape units.

Table 6 gives a good evidence on the good correlation between calculated potential scores and primary productivity. The correlation is somewhat looser on piedmont surfaces and on floodplains. The high values of potential scores do not bring, high primary productivity with them.

Feasibility and primary productivity values of agricultural lands are shown in *Table 7* for each land use type. Areas near water surfaces are to be considered the best reserves offering a more intensive utilization of the areas after water regulation. Areas taken out from production have a relatively high production value. This can be explanied as follows. In the course of data input each grid cell was put into this category if one third of its area was occupied by roads, railways, etc.-

Primary productivity and potential scores of landscape ecological units (Á. Kertész – G. Mezősi)

Table 5.

Landscape ecological units*	Area (ha)	Contribution %	Actual primary productivity	Feasibility scores
1	507	24,7	5,31	59,2
2	25	1,2	2,65	52,3
3	192	9,3	3,45	57,5
4	227	11,0	6,30	60,9
5+6	162	7,9	3,15	55,7
7	175	8,5	3,59	51,7
8	670	32,6	3,28	53,6
9	99	4,8	5,03	61,6

* see *Figure 3*

Primary productivity of areas with different potential scores *Table 6.*
(G. Mezősi)

Potential score	Area (ha)	Primary productivity (± 0,43 t/ha)
35–40	33	2,54
41–45	93	2,92
46–50	306	3,02
51–56	636	4,02
57–62	407	4,42
63–66	458	5,10
67–72	121	5,22

Table 7.

Feasibility and primary productivity scores for different landuse types
(Á. Kertész – G. Mezősi)

	Area		Feasibility scores	Primary productivity (t/ha)
	(ha)	(%)		
settlements	55	2,7	58,4	4,38
arable land	799	38,8	59,1	4,98
gardens and vineyards	45	2,2	55,9	3,69
pasture and meadow	810	39,4	53,8	3,53
areas taken out from*	80	4,9	58,2	4,91
areas near water surfaces	197	8,6	58,2	3,81
pasture and meadow with forest spots	71	3,4	53,4	2,99
not used by large-scale farming (mainly forest)	3757	–	–	–

* e.g. public road, mining area

Defining areas with critical ecological conditions for maize production

In the course of the investigations the question was asked whether in the case of any ecological factor (relief, climate, soil) maize production would be impossible. *Figure 8* shows those agricultural lands where relief conditions exclude the possibility of maize production (see e.g. sliding slopes > 18 %). Half of the arable land is situated on slopes > 12 % (*Figure 9*) where approx on 12 ha no tillage would be possible due to unfavourable relief conditions. These areas are utilized as arable lands in spite of the bad ecological conditions because the economic preference system. *Figure 10* shows areas not suitable for plant production on arable lands because of poor soil conditions.

Assessment of primary productivity

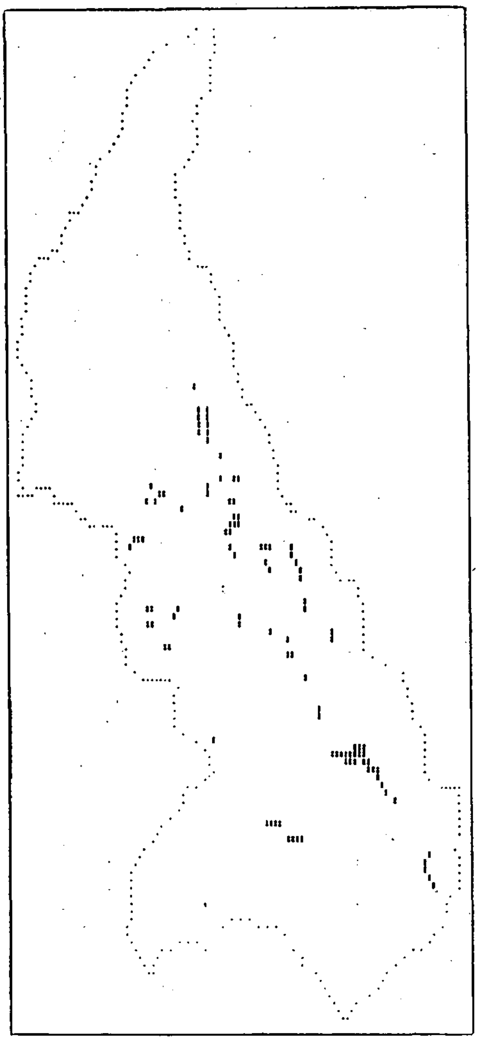
In the course of our investigations we attemted to assess the production capacity of different soil types as well. It is a rather delicate problem since differences between ANPP and ANPP* are not only the consequences of the not perfect methodology but they indicate agrotechnical, technological, agrochemical differences as well. The rather unimportant agrotechnical differences enabled the application of the *Moss–Davis* method (1982).

The investigation of the net primary production (NPP) is one of the most important tasks of ecology since the material and the energy potentially available for heterotrophs are concerned here. It is much easier to assess NPP than GPP as the latter requieres data on the intensity of photosynthesis and on active radiation. Assessments of NPP go on since over 2 decades. Most of them are empirical formulae using the measurable relationship between climate parameters and ANPP. The „Miami model" (*Lieth–Box 1972*–'Thornthwaite Memorial Model') is applied for regional investigations:

$$p = 3000\ /1\text{-}e^{-0{,}0009695\,(E-20)}/,$$

where p = NPP [g/m2/year, or t/100 ha/year],
E = actual evapotranspiration.
It must be emphasized that the model is suitable for only bigger regions with an actual evapotranspiration ranging between 200 and 700 mm. The exact determination of actual evapotranspiration depending on the moisture content of the air, on temperature, soil moisture, vegetation cover etc. requiers a network of measurement stations. For quite a number of localities in Hungary these data are available (*Varga–Haszonits* 1977). Actual evapotranspiration in the test area is 346 mm/year and the average value of NPP is 8,13 t/ha.

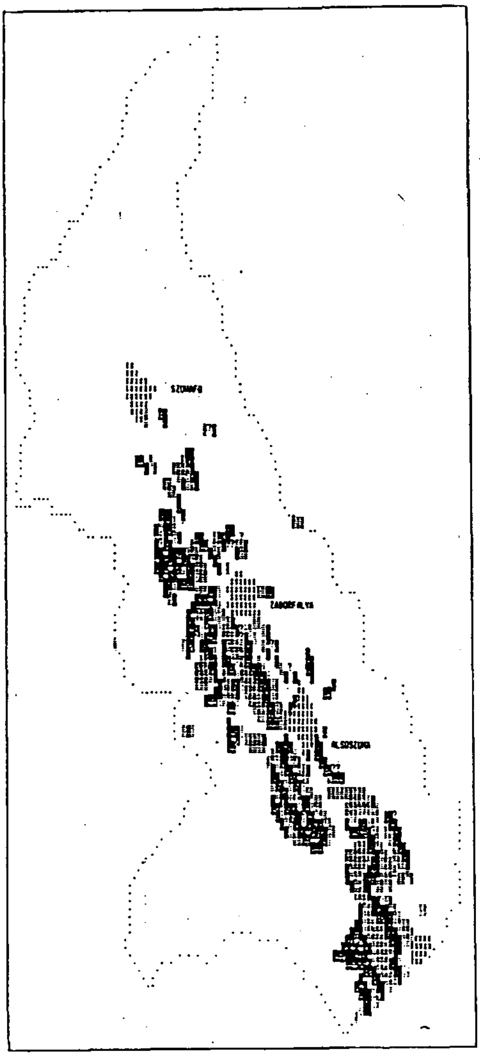
Fig. 8.



SYMBOL	VALUE	LABEL	CELLS	COVERAGE +8	COVERAGE -8
	8	Külső terület	12220	89.88	.00
	0	....	949	6.98	68.97
::::	1	kizárt felszinek	105	.77	7.63
....	2	határ	322	2.37	23.40

Agricultural areas where relief characteristics exclude maize production (by G. Mezősi)
1 = excluded areas;
2 = boundary of the area

Fig. 9.

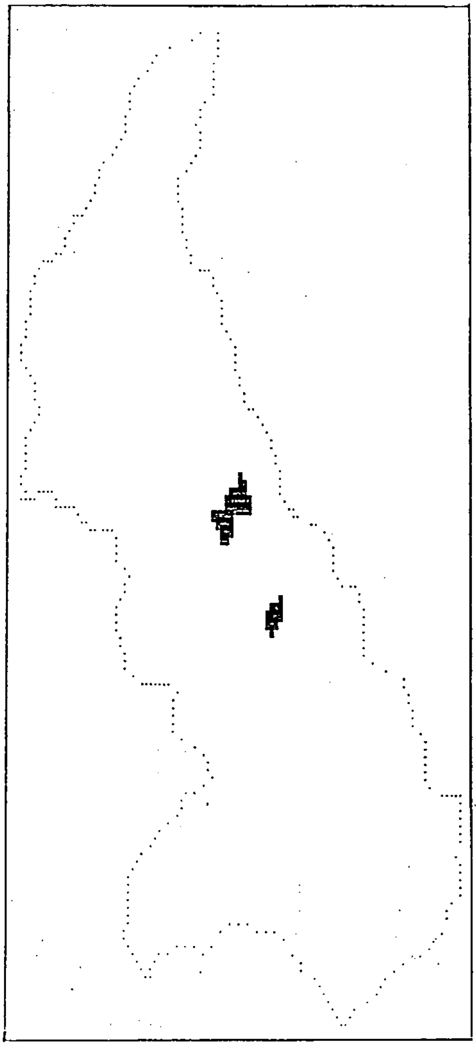


SYMBOL	VALUE	LABEL	CELLS	COVERAGE +0	COVERAGE -0
	0	....	12318	90.60	.00
....	1	határvonal	305	2.24	23.87
	2	12 % feletti szántók	399	2.86	30.44
	3	12 % alatti szántók	422	3.10	33.02
????	4	DOMBORZATILAG KIZÁRÓ	13	.10	1.02
IIII	5	belterület	123	.90	9.62

Arable lands with slopes
>12% and <12%
and such arable lands
where ecologic conditions
exclude the possibility of
maize production
(by G. Mezősi)

1 = boundary of the area;
2 = arable land on slopes >12%;
3 = arable land with slopes <12%;
4 = relief characteristics exclude maize production;
5 = settlement

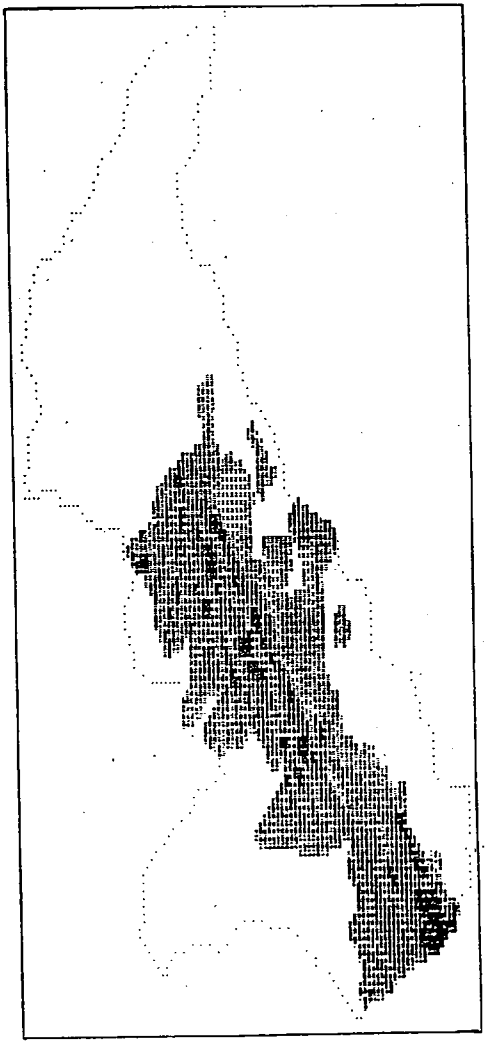
Fig. 10.



SYMBOL	VALUE	LABEL	CELLS	COVERAGE +B	COVERAGE -B
	B	külső terület	12275	90.29	.00
	0	....	953	7.01	72.20
	1	kis term.képességü t	45	.33	3.41
....	2	határ	322	2.37	24.39

Very low quality soils
excluding crop production
(by G. Mezősi)
1 = areas in question;
2 = boundary of the area

Fig. 11.



SYMBOL	VALUE	LABEL		CELLS	COVERAGE +8	COVERAGE -8
	8	külső terület		11160	82.08	.00
	0	....		78	.57	3.20
....	1	....		301	2.21	12.36
xxxx	39	3,8 t/ha biom	k=0.48	203	1.49	8.33
	40	3,9 t/ha	k=0.48	490	3.60	20.11
	47	4,0 t/ha	k=0.49	681	5.01	27.96
	54	4,7 t/ha	k=0.59	551	4.05	22.62
	65	5,4 t/ha	k=0.66	132	.97	5.42

Primary productivity corrected by soil conditions (ANPP*)
* (by G. Mezősi)
1 = boundary of the area

Regional differences in NPP can be concluded from different fertility characteristics of the surface. For this reason soil were classified into 7 classes taking the degree of hindering the agricultural activity into account. It follows the canadian classification based on relief (slope angle) and on climatic factors. The system is very similar to the FAO site classification system (LQ_5). Category I includes areas with optimal ecologic conditions without any hindering factors whereas category VII includes areas not suitable for agricultural activity.

The categories were characterized by the constant of *Anderson–Hoffmann* (in: *Moss–Davis 1982*), the values of which for each category are as follows: I–1,00; II–O,80; III–0,66; IV–0,58; V–0,49; VI–0,48; VII–0,48. The cartogram shown in *Figure 11* (ANPP*) was constructed by multiplying these constants and the value of NPP for each grid cell. *Table 8* contains the comparison of the actual (ANPP) and the estimated (ANPP*) values of primary production. Applying the results for landscape typological units it can be concluded that the floodplains, terraces and piedmont planes have values above the verage (4,5 t/ha) whilst the values calculated for slopes and erosional valleys are below the average (3,8 t/ha).

Suggestions for the alternative utilization of the area

It is not enough to consider only ecological data and aspects when suggesting the best utilization of an area. Therefore we make suggestions only for those areas where instead of the actual utilization another kind of utilization could be advised but we do not analyse whether the best crop structure is applied.

Figure 12 shows the areal distribution of agricultural areas where forestry could be suggested instead of the recent land use type. These territories with steep slopes have low potential scores. In the case of arable lands with poor ecological conditions an alternative land use, i.e. pasture and meadow could be suggested. In a similar way, pasture and meadow with good conditions should be utilized as arable land (*Figure 13*). Performing the feasibility study on the moment some sites with very good conditions could be found (*Figure 14*).

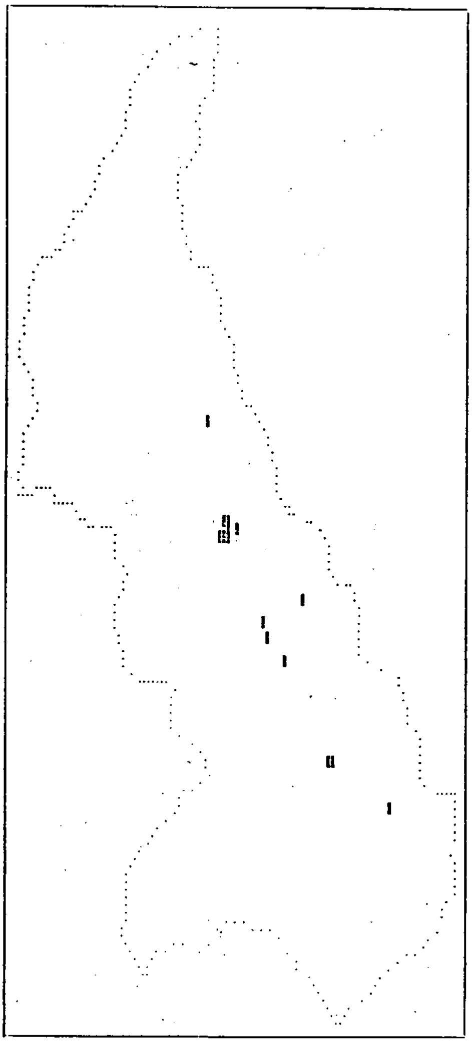
Potential scores, primary productivity (ANPP) and corrected primary productivity (ANPP*) for different soil types (G. Mezősi)

Table 8.

	Area (ha)	Potential scores	ANPP (t/ha)	ANPP* (t/ha)
acidic non podzolic brown forest soil	1085	54,84	4,91*	4,16
lessivé brown forest soil	202	57,89	3,42	4,30
Ramann's brown forest soil	168	61,62	4,36	4,49
slope deposit soil	602	57,71	4,56	4,28

* with high standard deviation

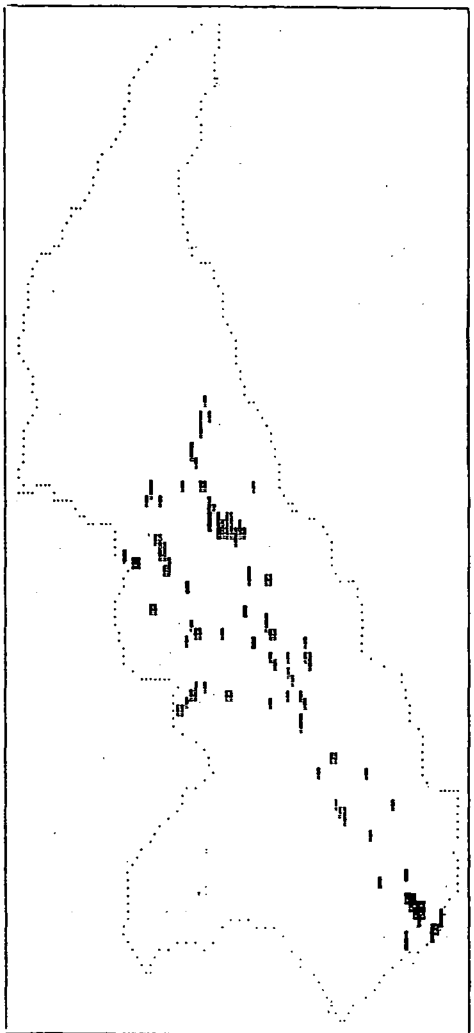
Fig. 12.



SYMBOL	VALUE	LABEL	CELLS	COVERAGE +B	COVERAGE -B
	B	....	12311	90.55	.00
	0	....	947	6.97	73.70
IIII	1	erdőnek javasolt	15	.11	1.17
....	2	határ	323	2.38	25.14

Agricultural lands suggested
for forestry
(by G. Mazősi)
1 = suggested areas;
2 = boundary of the area

Fig. 13.

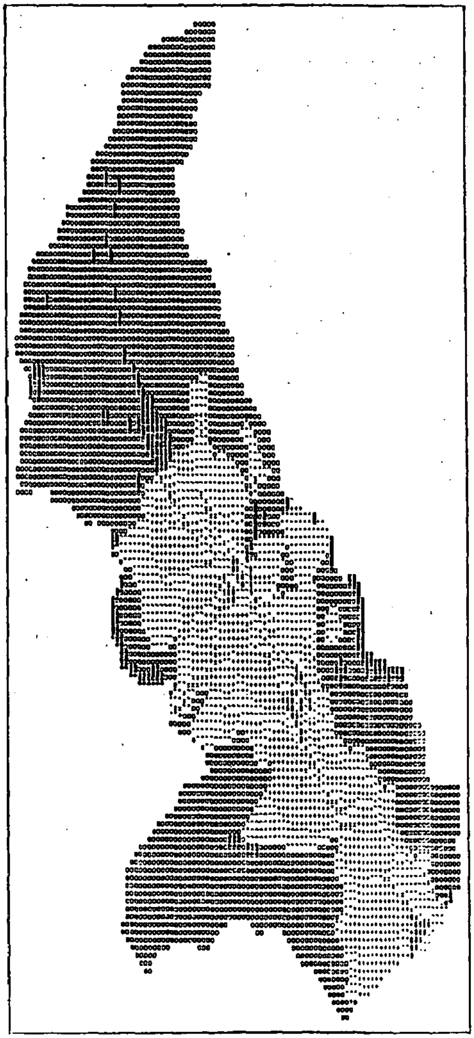


SYMBOL	VALUE	LABEL	CELLS	COVERAGE +B	COVERAGE -B
	B	külső terület	12231	90.11	.00
	0	....	903	6.64	67.14
	1	átminősítendő szántó	92	.68	6.84
	2	-"- rét,legel	29	.21	2.16
....	3	határ	321	2.36	23.87

Low quality arable lands
and good quality meadow
and pasture suggested for
alternative utilization
(by G. Mezősi)

1 = arable land suggested for alternative utilization
2 = meadow and pasture suggested for alternative utilization
3 = boundary of the area

Fig. 14.



SYMBOL	VALUE	LABEL	CELLS	COVERAGE +B	COVERAGE -B
	0	külső terület	7782	57.24	.00
IIII	1	belterület	55	.40	.95
++++	2	szántó	799	5.88	13.74
....	3	kert,szőlő	45	.33	.77
****	4	rét,legelő	810	5.96	13.93
xxxx	5	termelésből kivett	80	.59	1.38
~~	6	vízközeli terület	197	1.45	3.39
^^^^	7	erdőfoltos rét,leg.	71	.52	1.22
IIII	8	tartalékterület	157	1.15	2.70
0000	9	nem tsz ter,főként e	3600	26.49	61.92

Reserve areas suitable
from ecological aspect
for agricultural utilization
(by G. Mezősi)

1 = settlement;
2 = arable land;
3 = vineyard and orchard;
4 = meadow and pasture;
5 = area taken out from production;
6 = area near water surfaces;
7 = meadow and pasture with forest spots;
8 = reserve areas;
9 = area not belonging to state farms, mostly forest

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