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ASSESSMENT OF SOIL QUALITY LIMITATIVE FACTORS. A CASE STUDY: SECAŞ, TIMIŞ COUNTY, ROMANIA

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Abstract

The paper aims, as the main purpose, at assessing the limiting factors of the soil quality in the perimeter of the Commune of Secaş, Timiş County, Romania. To achieve the aim pursued, we identified the main limitative factors of agricultural productivity and soil degradation processes. These were introduced in the database using modern methods, namely the GIS technique, for each soil unit, with "space" representations thereof. The soil surfaces on which each factor and/or degradation process is manifested and which is of particular practical importance in assessing soil quality were calculated automatically. The method used allows one to highlight the soils identified by various maps and cartographic representations. Most of the results were obtained from field work and calculations in the office and laboratory, supplemented by those from O.S.P.A. Timisoara and from literature. The importance of this study materialized in a complex database comprising all soil units in the studied perimeter, limiting factors specific to this area and degradation processes, as well as the establishment of fertility classes, i.e., the quality of existing soils in the studied area. The study highlights that the soils of the Commune of Secaş falls into grade III and IV fertility (quality).

Key words**:** *cartographic representations, limitative factors, soil, quality, evaluation*

INTRODUCTION

Agriculture plays an important role in preserving natural resources and landscapes. During the centuries, agriculture has contributed to the creation and preservation of a variety of landscapes and habitats. However, agricultural practices may have adverse effects on the environment. Soil degradation, water, soil and air pollution, habitat fragmentation and wildlife destruction may be the result of inappropriate agricultural practices [1], [9].

Soil is a complex, dynamic, living resource that plays many vital functions: food production and other types of biomasses, storage, filtration and transformation of substances, including water, carbon, and nitrogen [12], [8].

Soil is subjected to a series of degradation processes. Some of these processes are closely related to agriculture: water erosion, wind erosion and agricultural soil preparation works; compaction; decrease of the amount of organic carbon in the soil and soil biodiversity; salinisation and nitration; and soil contamination (with heavy metals and pesticides or excessive amounts of nitrates and phosphates) [7], [13]. The damage caused by soil erosion materialises in: loss of organic matter, soil structure degradation, soil surface compacting, low water infiltration, low water supply for the ground water layer, surface soil loss, nutrient removal, increase in coarse materials in the soils, stringing and gutter formation, plant uprooting, and decrease of soil productivity [14], [22].

Soil degradation processes involve the need to protect, maintain, and improve soil quality. Soil properties, as well as soil genesis factors such as climate, land use, or soil management determine the degree of soil degradation [18], [24].Certain agricultural systems and practices target one or more soil degradation processes and can contribute to better protection and preservation of soil resources.

The Commune of Secaş is located in north-eastern Timiş County, about 60 km from Timisoara, and occupies a total area of 5.767 ha, of which 5,006 ha have an agricultural destination [8], [21]. The natural framework of the locality was highlighted on the basis of the information in literature, complemented by field observations and by drawing up working maps [6], [13]. All these maps help us faster, clearer and easier soil identification in the studied area, and especially, to easier identify on the map all factors and degradation processes, maps and information that will benefit both locals and stakeholders and also future generations [3], [23].

In this context, the purpose of the paper was to assess the limiting factors of the soil quality, agricultural productivity and degradation processes in the perimeter of the Commune of Secaş, Timiş County, Romania.

MATERIALS AND METHODS

In order to achieve a detailed analysis of the factors that have contributed to the identification and description of soils and the achievement, due to GIS, of a multitude of representative materials, pedological maps containing a series of data on the soils studied, the limiting factors and the processes of degradation that limits soil quality were realised [1], [4], [20].

Part of the pedological data was obtained from the O.S.P.A. Timisoara archive, from the Secaş City Hall and from the field trips [21], [17].

For each soil unit, a series of features were identified, such as: name, area (automatically calculated with a program), degradation processes (limitative factors grouped according to their intensity) and quality class for arable use [5].

In the cartographic representation of limitative factors and of soil degradation processes, those degradation factors and processes specific to soils in the analysed area are presented [11], [19]. Data were introduced into the database for each soil unit, the "space" representations of these characteristics being thus obtained [2], [15], [16].

Spatial representations of the soil units were achieved using GIS techniques because they have multiple advantages compared to classical representation and mapping methods, of which the most important are: the net quality of cartographic representations, the possibility of automatic measurement of parameters like the area and the possibility of using data and representations in spatial analyses along with other digital data [10], [25].

RESULTS AND DISCUSSIONS

Soil quality in the investigated area is influenced by a series of limitative factors and/or degradation processes represented by some soil and/or environmental factors, which, through their action, lead to reducing fertility potential and, implicitly, to soil yielding capacity on which they exercise their action.

The spatial distribution of these factors and/or processes is presented below on the basis of GIS techniques. In this respect, the analysed factors limiting the quality of soils in the area and processes observed on the ground are:

a) The unevenness of the land displayed as a limiting factor on a share of 96.2% of the total area, the intensity of this factor being represented in Fig. 1.

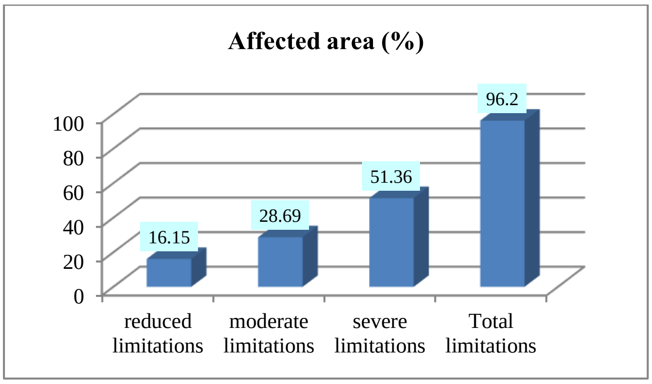

Fig. 1. Intensity of land unevenness
Source: Own calculation.

Therefore, the non-uniformity of the land affects the quality of soils in a very large proportion, the area analysed overlapping a hill region, with lands of different degrees of declivity.

The spatial distribution of the land affected by different intensities of unevenness is represented in Fig. 2.

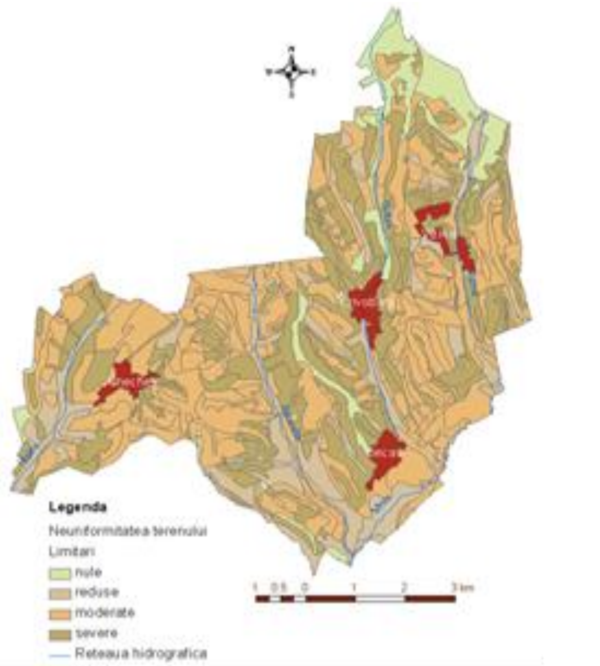

Fig. 2. Soil grouping according to land unevenness
Source: Own determination.
Legend, Land unevenness, *Limitations (top to bottom): null; reduced; moderate; severe; hydrographic network*

Limitations with severe intensities correspond to hill areas with higher altitudes, but as the altitude decreases, the intensity of unevenness decreases.

b) Acidic soil reaction limits the yielding capacity of 41.12% of soils, the largest share (38.83%) being that of reduced limitations (Fig.3).

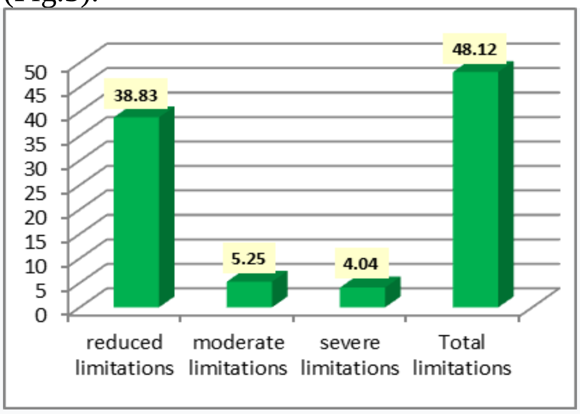

Fig. 3. Intensity of soil acidity
Source: Own calculation.

The space distribution of the soils whose quality is limited by acid reaction is shown in Fig. 4.

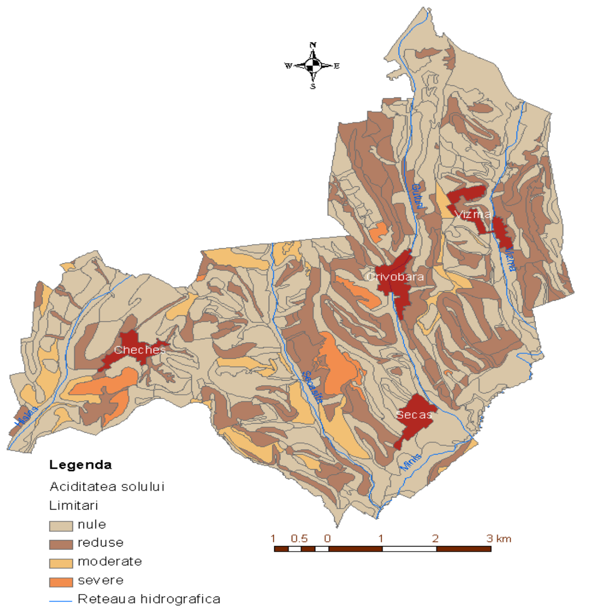

Fig. 4. Soil grouping according to acidic reaction
Source: Own determination.
Legend, Acidic soil reaction, *Limitation (top to bottom): null; reduced; moderate; severe; hydrographic network*

Unfortunately, at an area of 4.04% of the analyzed area, the limitations are severe in terms of soil acidity. In this context, it is important to carry out works to correct the acid reaction of the soils, such as the application of calcium carbonate amendments.

c) Humus reserve, a particularly important indicator in assessing soil quality, characterises 89.88% of the analysed soils. The intensity with which this factor acts is shown graphically in Fig. 5.

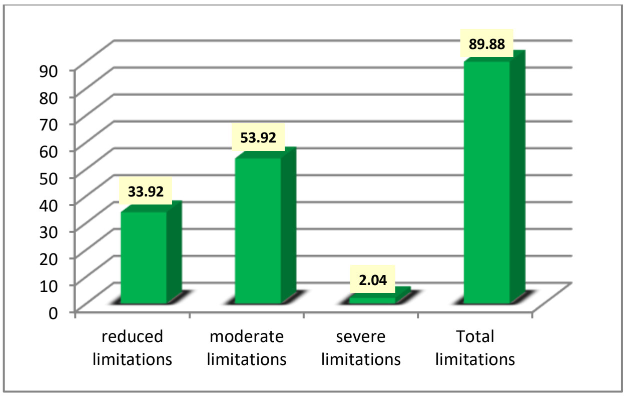

Fig. 5. Intensity of humus reserve
Source: Own calculation.

Soils, depending on humus reserve, are spatially "located" in Fig. 6.

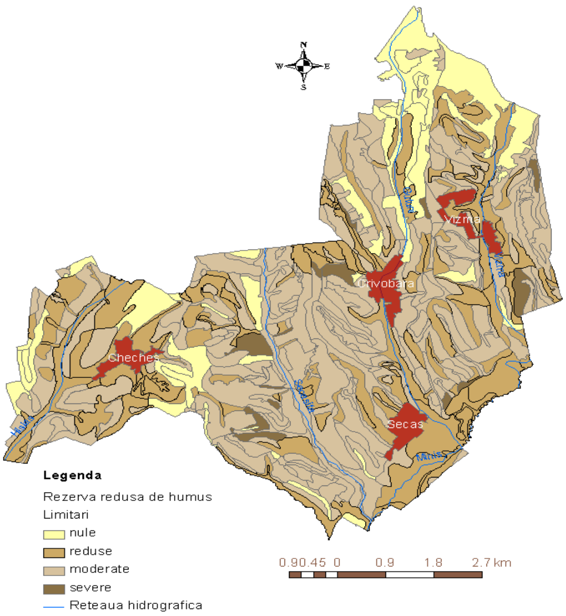

Fig. 6. Soil grouping according to humus reserve
Source: Own determination.
Legend, Low humus reserve, *Limitation (top to bottom): null; reduced; moderate; severe; hydrographic network*

d) Landslides limit the production capacity of soils in Secaș to 70.01% of the surface. (Fig.7).

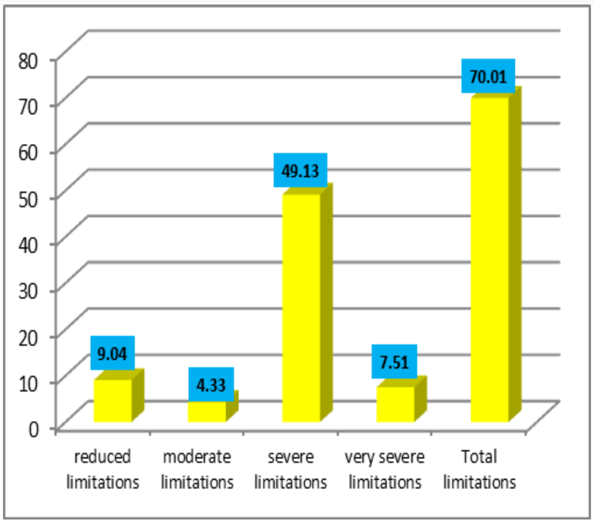

Fig. 7. Intensity of landslides
Source: Own calculation.

The lands most affected are by severe limitations, namely 49.13% of the surface. Out of the total of 70.01% of the lands affected by these landslides, on 7.51% there are very severe limitations. The territorial distribution of soils affected by landslides with different degrees of intensity is represented in Fig. 8.

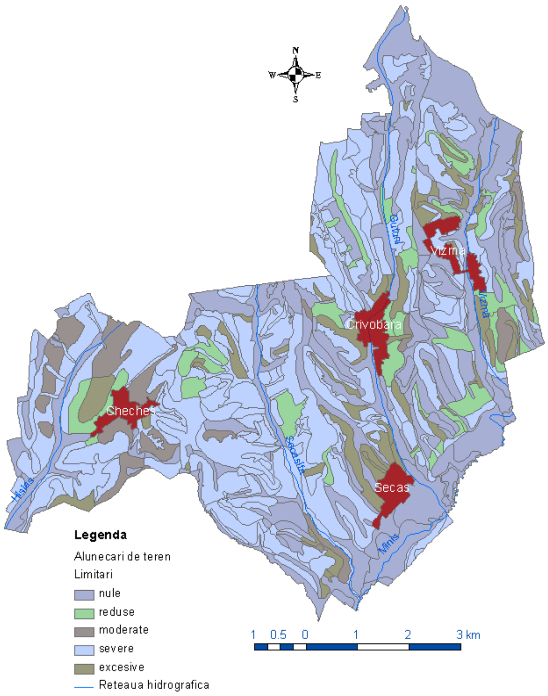

Fig. 8. Grouping of soils depending on landslides
Source: Own determination.
Legend, Landslides, *Limitation (top to bottom): null; reduced; moderate; severe; excessive; hydrographic network*

e) Land bearing capacity is manifest on 67.6% of the territory analysed with reduced limitations on 43.8% of the land limitations and with moderate limitations on 23.8% of the land (Fig. 9).

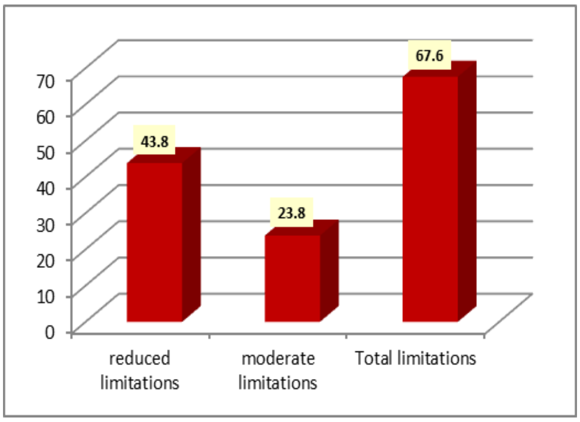

Fig. 9. Intensity of limitations depending on land bearing capacity
Source: Own calculation.

Regarding the Intensity of the limitations depending on the load-bearing capacity of the land, the Secaș locality has low and moderate limitations. does not have big problems, because the soils have low and moderate limitations.

Soil distribution according to land bearing capacity is represented in Fig.10.

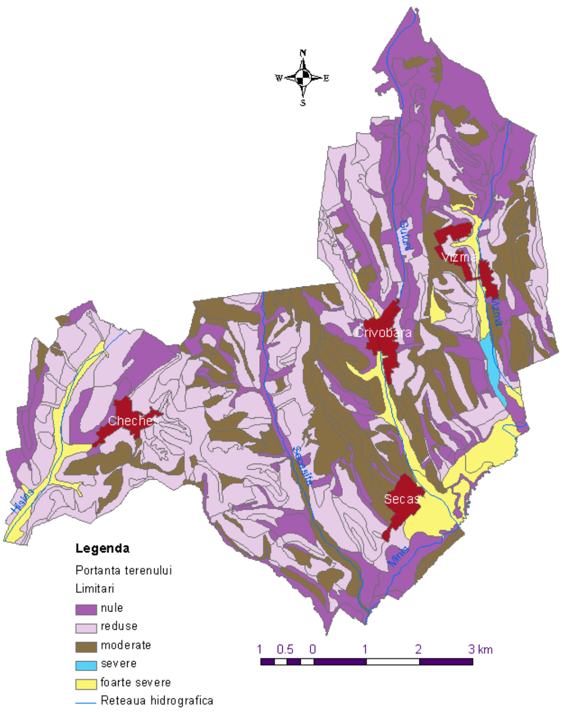

Fig. 10. Soil grouping depending on land bearing capacity
Source: Own determination.
Legend, Land bearing capacity landslides, *Limitation (top to bottom): null; reduced; moderate; severe; very severe hydrographic network*

f) Surface erosion, including erosion risk, affects 79.14% of the total area, the highest percentage being caused by severe limitations, i.e., 39.29%, followed by moderate limitations, by 28.53%.

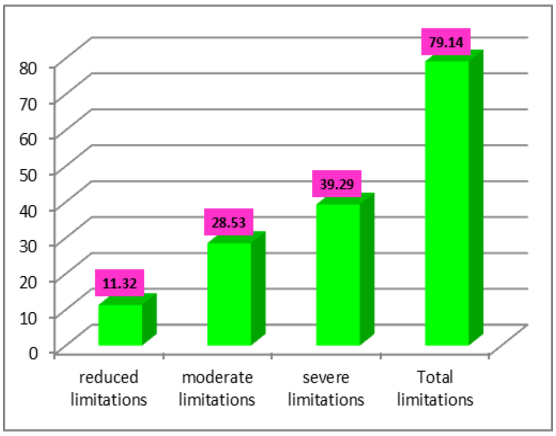

Fig. 11. Intensity of surface erosion
Source: Own calculation.

The territorial distribution of soils affected by erosion is represented in Fig. 12.

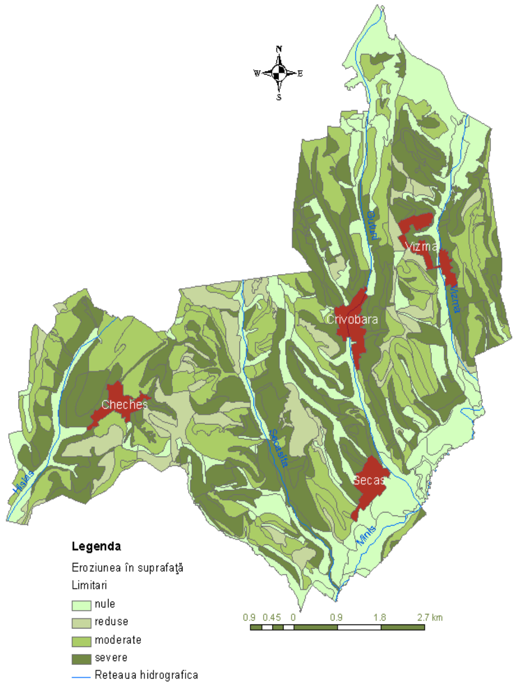

Fig. 12. Soil grouping depending on surface erosion
Source: Own determination.
Legend, Surface erosion, *Limitation (top to bottom): null; reduced; moderate; severe; hydrographic network*

Under the action of limiting factors and/or degradation processes in the research area, soils are classified in different quality classes as shown in Fig. 13.

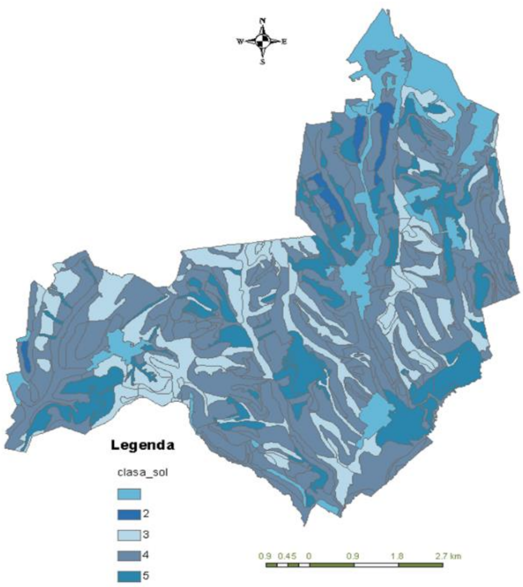

Fig. 13. Soil quality
Source: Own determination.
Legend, Soil_quality *(top to bottom):* 1, 2, 3, 4, 5.

As shown in the map presented above, grade III and IV quality soils predominate in the "arable" use category, a consequence of the physical-geographical conditions specific to the study area.

CONCLUSIONS

Considering the evaluated "limitations", we have found that soils in the study area are different both from a unit of relief to another and from one type of soil to another, their fertility potential being expressed by quality grades.

Soil erosion is a natural process, the main factors that determine this process are: intense rains, topography, low content of organic materials in the soil, percentage and type of vegetation cover. However, this process is intensified and accelerated by human activities, such as soil work techniques and improper harvesting practices, changes in hydrological conditions, deforestation and marginalization or abandonment of land. Improper land management is the main cause of soil compaction. A too large livestock number in a particular land area, improper use of heavy machinery in agriculture and soil work when it is too wet are factors that lead to soil compaction. Wet soils are not strong enough to withstand weight, and this leads to compaction.

The main limitations were conditioned by the existence of one or more limitative factors and degradation processes observed on the ground, namely:

1. *Land unevenness* on 96.2% of the studied area, with severe limitations on 28.69% of the area;

2. *Soil acidic reaction* on 41.12% of the area, with moderate limitations on 5.25% and severe limitations on 4.04% of the area, respectively;

3. *Humus reserve* on 89.23% of the area, with moderate limitations on 33.92% and severe limitations on 2% of the total area analysed;

4. *Landslides* on 70.01% of the analysed area, with severe limitations on 49.13% of the area, one of the factors that mostly limit soil quality in the area;

5. *Land bearing capacity* on 67.6% of the studied area;

6. *Soil surface erosion*, another major limiting factor, on 79.14% of the area, with severe limitations on 39.29% of the area, followed by moderate limitations on 28.53% on the area.

Following the assessment of the limitative factors and of the degradation processes, we have found that the analysed soils used as "arable" are *medium quality*, i.e., *grades III and IV fertility (quality)*.

In this situation, measures are required to increase soil fertility, namely its quality, depending on the specific needs of the field, so that they can classify in higher fertility categories. In this respect, we propose fertilization measures to increase the humus reserve by applying organic fertilizers (manure), given that over 89.88% of the land have a low content in humus. To correct the acidic reaction on acid pH land (41.12% of land) we propose amendments (calcium carbonate).

Soil structure can be improved with organic matter, thus reducing the predisposition of soil to compaction, erosion, landslides and desertification.

Also, practicing soil non-hazardous cultivation agricultural farming systems (*mixed cultures* – cultivation of two or more cultures in alternative rows, *subsoiling* – aerating compacted soil layers deeper than the ploughing, without overturning them, and *working the land along level curves* – to increase soil infiltration capacity and slows down water drainage, giving water the time to infiltrate the soil) can contribute to a better protection of soil resources.

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