ЕКОЛОГІЧНІ ДОСЛІДЖЕННЯ ГЕОСИСТЕМ

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BIOENERGY PRODUCTION ON AGRICULTURAL LAND IN SLOVAKIA

The potential of bioenergy accumulation and production of Slovakian agricultural soils was derived. Energetically most productive are the soil types like Chernozems (88.6 GJ.ha^{-1}) and Mollic Fluvisols (76.14 GJ.ha^{-1}). The least energy amount generate Gleys, Organosols, Solonetzes and Lithosols (31.63 GJ.ha^{-1}). Energy accumulated in farmland exploitability by plants cropped is variable depending from soil representative and its properties. The lowest exploitability was found at Cambisol (0.7–1.8 %), the highest at Regosols (3.1–7.0 %).

Key words: soil energy parameters, energy production, agricultural land

Вилчек Дж., Лисняк А. А. БИОЭНЕРГЕТИЧЕСКОЕ ПРОДУЦИРОВАНИЕ НА СЕЛЬСКОХОЗЯЙСТВЕННЫХ ЗЕМЛЯХ СЛОВАКИИ

Рассчитан биоэнергетический потенциал накопления и продуктивности словацких сельскохозяйственных почв. Энергетически наиболее продуктивными являются такие типы почв, как Черноземы (88,6 ГДж/га$^{-1}$) и Моллик Флювисоли (76,14 ГДж/га$^{-1}$). Наименьшим энергетическим продуцированием обладают Глеесоли, Органосоли, Солонцы и Литосоли (31,63 ГДж/га$^{-1}$). Энергия, которая накапливается в сельхозугодиях растениями, варьируется в зависимости от представленной почвы и её свойств. Самая низкая накопительная способность была найдена в Камбисолях (0.7-1.8%), а самая высокая в Регосолях (3.1-7.0%).

Ключевые слова: энергетические параметры почвы, энергетическая продуктивность, сельскохозяйственные земли

Вілчек Дж., Лісняк А. БІОЕНЕРГЕТИЧНЕ ПРОДУКУВАННЯ НА СІЛЬСЬКОГОСПОДАРСЬКИХ ЗЕМЛЯХ СЛОВАЧЧИНИ

Розрахований біоенергетичний потенціал нагромадження і продуктивності словацьких сільськогосподарських ґрунтів. Енергетично найбільш продуктивними є такі типи ґрунтів, як Чорноземи (88,6 ГДж/га$^{-1}$) і Моллік Флювісолі (76,14 ГДж/га$^{-1}$). Найменшим енергетичним продукуванням володіють Глеєсолі, Органосолі, Солонці і Літосолі (31,63 ГДж/га$^{-1}$). Енергія, що накопичується в сільгоспугіддях рослинами варіюється в залежності від представленого ґрунту і його властивостей. Найнижча накопичувальна здатність була знайдена в Камбісолях (0.7-1.8%), а найвища в Регосолях (3.1-7.0%).

Ключові слова: енергетичні параметри ґрунту, енергетична продуктивність, сільськогосподарські землі

Introduction

Through plants microorganisms and humus considerable amount of transformed solar energy is accumulated in soil, this energy is being consumed for continuous development of soils and their productivity. Biogeocoenoses as selfregulated systems represent energetic unity of mutual reactions among the lowest atmosphere layer, plant, soil, microorganisms and animals. I.e. if we want to regulate useful biomass synthesis (food, fodder, etc.), we must know basic rules of energy flow and transformation in particular natural biocoenoses and agrocoenoses. Bioenergetics significant advantage is the possibility to express various changes and actions by energetic units (J, kJ, GJ and similar).

Material And Methods

When assessing potentially possible crop bioenergy production, depending from soil representatives and characteristics, our starting point was natural phytomass production (overhead part and roots) of plant associations recalculated to energetic units. Database was primary background, it included real assumptions of ten main crops grown in Slovakia on arable land and yields of grassland determined for the soil quality indexes – Bonited Pedo-Ecological Units BPEU [6]. Based on typical cropping structures by the BPEU [7] and mentioned real

biomass production assumptions recalculated for dry mass [3], for every of BPEU was calculated its bioenergy productivity potential for whole crop production. By the codes into the BPEU characterizing adequate soil properties, by help of software filters by use of arithmetic mean, productivity energetic parameters were calculated for the soil types, sloping categories, stoniness, texture and climatic regions, respectively.

Results And Discussion

Soil organic compounds energy is assessed by biological C cycle in the ecosystems of biosphere. From former empiric calculation is resulting, every organic C kg is corresponding to energy supply 41868 kJ in average, whereby there are considerable differences in the particular ecosystems. This energy is a result of many complicated photosynthesis processes and activities of organisms. This introduces only 2 to 5 % energy used by green plants at photosynthesis, i.e. approximately 0.01 to 0.02 % of solar energy coming to soil surface. With died organic remains enters soil energy in the form of chemical structures in organic compounds. At the humification coefficient value 0.4 this represents annual energy accumulation in soil humus approximately $8.37.10^6$ to $41.87.10^6$ kJ.ha^{-1}. Just this value of inner energy is annually supplemented into soil due to biological substance exchange between soil and organisms. Contemporary with humus formation part of the organic matter is mineralized, this is associated with energy release [4].

When assessing, 1 gram of soil humus contains 19.22 kJ energy [5], for the soil types can be determined their approximate energetic potential as follows:

Soil type	GJ.ha $^{-1}$
Regosol	770 -1730
Luvisol	1630 - 3650
Solonetz	1350 - 2880
Haplic Luvisol	2300 - 3460
Rendzina	1920 - 4230
Fluvisol	2880 - 6730
Cambisol	2880 - 7690
Chernozem	3460 - 5960
Mollic Fluvisol	3840 - 11500

These values are approximately presenting energy accumulated in soil through soil humus. So they are potential energy source fore plant ecosystem and soil edaphon. It is logical, in the process of soil organic matter formation is not consumed all the energy accumulated in soil. Energy amount transformed through soil into plants is in various soil and climatic conditions variable. According energy amount accumulated in crops, in this way it is possible to assess production and bioenergetic soil potential.

Real soil bioenergetic potential in Slovakia in association with implemented system of farming – primarily structure of cropping system structure and soil use in given types of land, expressed through crop biomass, is for every soil other. Principally can be stated, that with increasing soil fertility is increased bioenergetic potential, too.

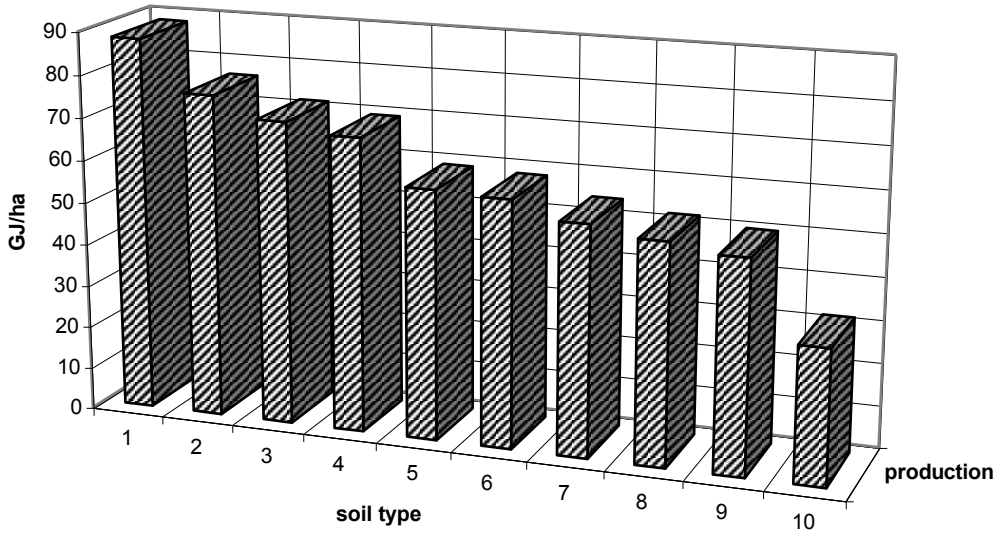
In particular expression, based on our recalculations on farmland, most bioenergy from the crops grown was produced on soils of chernozemic type (88.06 GJ.ha^{-1}) and Mollic Fluvisols (76.14 GJ.ha^{-1}). Least bioenergy was produced in Gleys, Organosols, Solonetzes and Lithosols (31.63 GJ.ha^{-1}).

Energetical potential of soils and plants can be positive influenced by man only with additional energy input (agro technics, fertilizers, etc.). With such progress can be reached the better results in biomass production also on the less productive soils.

An example is e.g. the map "Farmland Categorization by Plant Bioenergetics Production", where farmland is divided into following groups:

- bioenergy very low production (under l4l GJ.ha^{-1}) – 29 % farmland
- bioenergy low production (141-176 GJ.ha^{-1}) – 24 % farmland
- bioenergy medium production (176-212 GJ.ha^{-1}) – 20 % farmland
- bioenergy high production (212-247 GJ.ha^{-1}) – 20 % farmland, and
- bioenergy very high production (above 247 GJ.ha^{-1}).

Soil Science and Conservation Research Institute Bratislava ows and utilizes also completed databank, in which to every of BPEU is associated potentially possible supplemental energy deposit from the biomass produced.



Legend: 1 – Chernozem, 2 – Phaeozem, 3 – Fluvisol, 4 – Orthic Luvisol, 5 – Albic Luvisol, 6 – Pseudogley, 7 – Regosol, 8 – Cambisol, 9 – Rendzina, 10 – Gley, Organosol, Solonetz, Lithosol, Podzol

Fig. 1 Real bioenergy production of plants by soil types

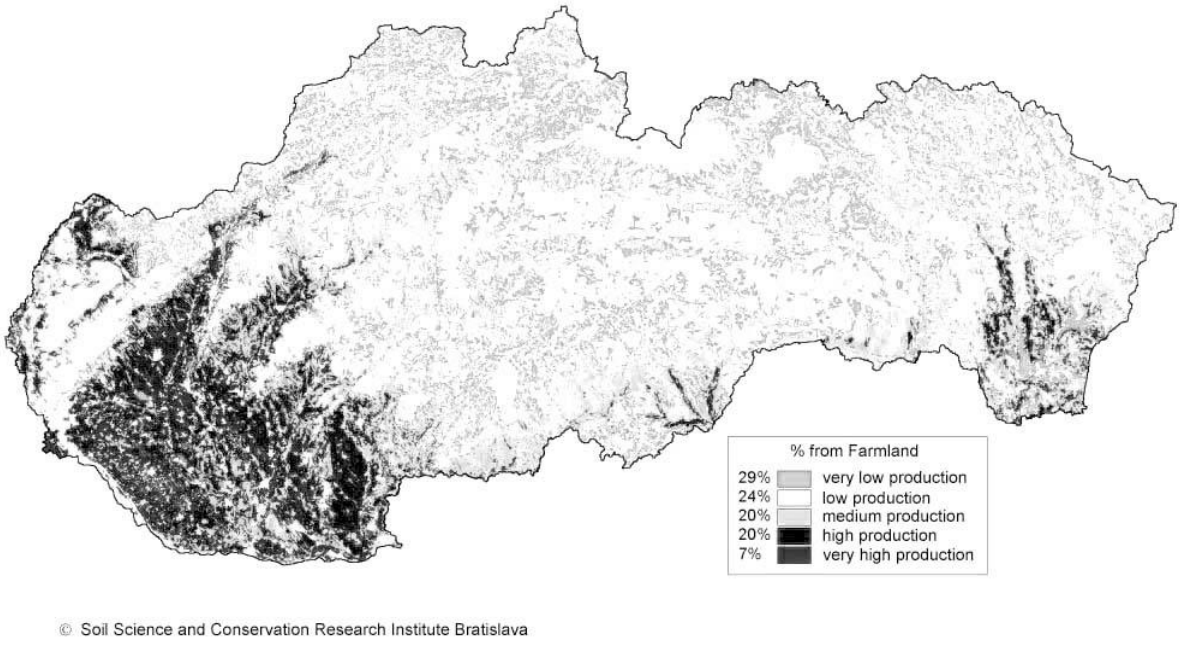


Fig. 2 Farmland categorization according to plant bioenergy production

It seems, that exploitability of energy accumulated by crops in farmland is variable, depending from soil representatives and soil characteristics. The lowest exploitability was observed at Cambisols (0.7-1.8 %), the highest one at Regosols (3.1-7.0 %), this is corresponding with the recently published works (2-5 %).

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