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ECONOMIC LAND EVALUATION FOR SUSTAINABLE LAND MANAGEMENT[1]

OCENA EKONOMICZNA ZIEMI NA POTRZEBY ZRÓWNOWAŻONEGO ZARZĄDZANIA GRUNTAMI

Key words: D-*e*-Meter land quality index, Land evaluation, Sustainable land use, Economic evaluation, Optimization of land use system

Slowa kluczowe: wskaźnik jakości gruntów D-e-Meter, ocena ziemi, zrównoważone uzytkowanie gruntów, ocena ekonomiczna, system optymalizacji uzytkowania gruntów

Abstract. In this paper the authors describe the steps of building of a new automated complex land evaluation system based on the D-*e*-Meter land quality index. Complex evaluation means an organic systematization of ecological and economical factors. Necessary of development of a new land evaluation system based on the undeveloped land market in Hungary, which causes difference between the level of actual land price and economic value of agricultural land. The land evaluation has – among others – an important task: that is to convey the value towards the land market actors, which can be the starting point in negotiation about market price and in decision-making about the land use. The estimated land value indicates the total values of land estates on the basis of their rent-production ability. These values can differ from land-estate prices formed on land market, nevertheless they are decidedly adequate to replace the Hungarian current land evaluation system, so called Gold-crown System and to solve whole series of objectives connected with land evaluation. The new land evaluation system is useful for estimating the realistic land value, but also helps to manage the land use on sustainable way.

Introduction

The formation of agricultural land market in Hungary like in other transitional-economy countries is not finished. There are not reliable databases of market land prices. Most of Central and Eastern Countries of Europe are characterized by big difference between the land acquisition prices and the real economic value of land [Sadowski 2009, Takácsné-Bandlerova-Sadowski 2007]. But the land value is needed for more economical purposes.

The market imperfection and information asymmetry is very danger when the poor farmers may forced to sell their land due to shocks or economic hardships as it is for example in Hungary. The liberalization of the Hungarian land market to be done by 2014, will bring some changes which cannot be followed by the currently applied land evaluation methods based on the outdated Gold Crown (GC) land quality assessment system.

The long-term development of socio-economic systems also requires the sustainable use of natural resources. In order to fulfill the important tasks related to the optimization of land use system − which is necessary due to the responsible management of land, the observance of environmental protection aspects and the more fierce competition – it is inevitable to determine the economic value of land, as production factor.

The importance of the topic was also justified by the EU Sustainable Development Strategy (EU SDS): the environmental load has drastically increased owing to the expansion and extension of the production activities, which evokes the need for maintaining the environment. The EU SDS added a third, environmental dimension to the Lisbon Strategy of economic and social renewal. The necessary financial sources can be ensured by imposing taxes on arable land. The differentiation of land according to its quality is not enough for the fair taxation, it is also inevitable to make value estimation in economic terms.

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Material and methods

An automated integrated evaluation system for arable lands is based on the D-e-Meter land quality index. Integrated approach to the land evaluation means an assessment of ecological (soil, climatic and land relief conditions) and economic (transport conditions, composition of the market environment, etc.) factors in a unified and closed system. The economic evaluation systematizes the effects of economic factors in conformity with structure of the D-e-Meter physical land evaluation (land quality assessment) system.

Based on the existing GIS system for the on-line calculation of D-e-Meter land quality index of agricultural plots, we developed the framework for the digital database creating further opportunities to improve the sustainability of land use such as optimizing fuel utilization, crop rotation etc.

The physical land valuation is based on the computerized statistical processing of available soil and plant cultivation information about the sample area. Soil and yield data obtained from the Hungarian Soil Fertility Monitoring System. These data were collected between 1985 and 1989 from 60 thousand fields, covering 4 million hectares yearly. For the information system of the sample areas it was necessary to digitalize the 1:10000-scale operating genetic soil maps. This could be followed by the harmonization of the soil and plot maps also by computer and based on the 1:10000-scale maps. As sample areas were chosen 5 areas under agricultural cultivation each had an area of about 4-8 thousand hectares [Gaál et al. 2007].

The initial phases of the land quality assessment are followed by the definition of the fertilizer responses of the soils. This is meant to explore the causes of changes in the production potential resulting from fertilizer application of various intensities and to express the extent of such changes.

The concept of D-e-Meter land quality index has being extended for croplands [Tóth et al. 2006, Tóth 2009, Gaál et al. 2007, Makó et al. 2007] for other land uses, such as grasslands [Dér et al. 2003] and forests [Bidló et al. 2003]. For purposes of economic analysis and help of economic decisions of stakeholders a physical land evaluation system was extended.

The basis of the integrated land evaluation system is establishing the equivalence between the index of land quality (in the D-e-Meter point) and the Gross Margin (GM) as a measure of profitability of production. The logic of the system can be interpreted as shown on the following figure (Fig. 1).

The precondition of the elaborated application of the land evaluation method in practice is to assign to each D-e-Meter category a weighted – so called standard – Basic Gross Margin value. The computation of Gross Margin is carried out by sampling. The responding units are the enterprises dealing with production of arable-land crops in the given region.

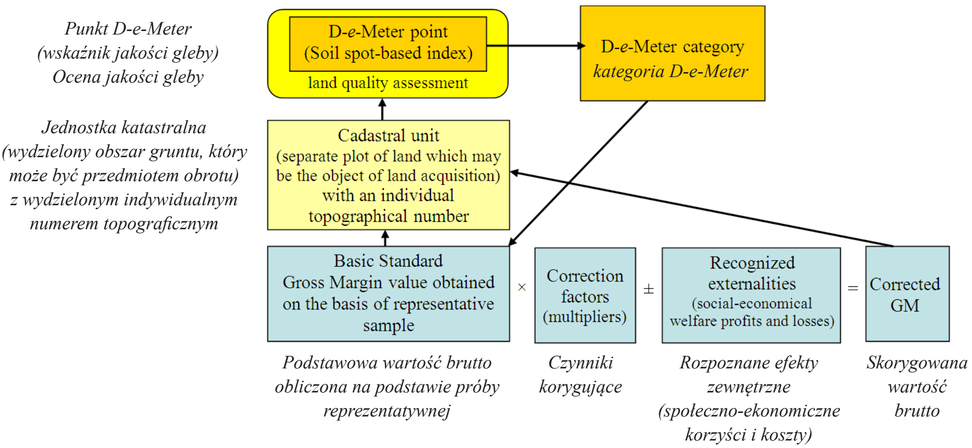

Figure 1. Computation of Corrected Gross Margin value of cadastral unit
Rysunek 1. Obliczanie skorygowanej wartości brutto katastralnej jednostki ewidencyjnej
Source/*Źródło*: Szűcs et al. 2008

Starting from the return land value, we tried to estimate the market price of arable land as a capitalized value of ground rent. However, we had to face the problem that in practice, the income share attributable to land was hardly to be separated from other production factors, so we were forced to find such an indicator, by means of which the profit-yielding capacity of different land-qualities can be estimated.

We found that the gross margin (GM), defined as the difference between production value and variable production costs could be suitable for this purpose. The application of gross margin (GM) can be recommended also because of that special reason that it is a generally accepted category in the European Union for the determination of production (branch) dimensions and of farm sizes.

The approach of the extent of the land-revenue of a given plot will be carried out as follows:

1. The D-*e*-Meter points will be determined in ecological block of the system on soil-plot level.
2. The basic returns of lands (basic standard gross margin, BSGM) will be incorporated into the input data of the system in an exogenous way after separated representative sampling, interconnected as point category. The basic returns of land will be determined separately to each regional level, because there are large differences in the infrastructural environment influencing economic values, which are to be taken into consideration in the construction of the system. The basic GM actually can be correlated with the differential land rent.
3. The correction factors, after having red off the maps by means of mathematical formulae, rectify the basic returns value.
4. The externalities are treated as corrections of basic gross margin by means of mathematical formulae.

To each examined land plot a special D-*e*-Meter point will be obtained after having identified it on the cadastre, orthophotographic, topographic and soil-plot maps. In the knowledge of the given region of the D-*e*-Meter point category, the standardized basic GM value will automatically be determined.

At the computation of land values the following correction factors have been taken into consideration: 1) the fragmentation of the area, 2) the possibility to irrigate, 3) obstructive objects in the field (elements of infrastructure), 4) accessibility of the area, 5) infrastructure, and 6) distance from waste storage facility [Tóth et al. 2006].

The GM corrections belonging to the bad-medium-good states of correction factors were determined on the basis of expert estimation and were expressed in per cent.

There is a need to change the paradigm in measuring and assessing land returns or yields, in the sense that when interpreting farm output, one should consider performance elements not measured or not measurable through the basic yields (and by-products); these elements are the effects called external and the positive-effect returns derivable from the latter ones and even the negative-effect costs.

Agricultural externalities occur in two forms:

– the so-called linked products when the external element is created unintentionally via the production of traditional farm food products or non-food articles (fodder, energy plant) – (soil-related effects, or effect on soil and river water, oxygen production and carbon sequestration).
– independent products, mostly in the form of public goods, when the activity is directly aimed at maintaining bio-diversity, landscape and soil protection, etc.

When determining the value of farmland by the application of the return principle, the discounted value of the private or social services expected from the land now or in the future is to be modified with the negative social effects of land usage, i.e. with the so-called external costs.

The complex land revenue computation algorithm, considering also the external effects, can be stated as follows (1. equation):

$$CGM = \left[BSGM^{DM} \cdot \left(1 + \sum_{i=1}^{6} (k_i - 1)\right) + E \right] \tag{1}$$

where:

CGM = Corrected Gross Margin, the return value of the land plot registered under the given topographical number in EUR/ha,

$BSGM^{DM}$ = the basic Standard Gross Margin value belonging to the given D-e-Meter category, EUR/ha,
k_i = change in BSGM caused by i-th correction factor in %,
E = quantified joint effect of external factors.

From economic point of view, a certain difficulty arises, because the returns of land as of production factor are not separated from the gross margin, so the capitalization in classical sense (land value = capitalized land rent) cannot be carried out.

In connection with present research work, we have applied such an estimation method which deduces the share (γ-value) of land rent within total income from the conditions of real land market.

In knowledge of the land prices and real interest rate, the extent of land rent can be determined (2. equation).

$$\textit{Estimated Land rent} = \textit{Land market price} \times \textit{real interest rate} \quad (2)$$

By means of the below formula (3. equation), the proportion of land revenue within the corrected gross margin can be determined.

$$\gamma = \frac{\textit{Land rent}}{\textit{Corrected GM}} \quad (3)$$

From this:

$$\textit{Return-based land value} = \frac{\gamma \textit{ x Corrected GM}}{\textit{interest rate}} \quad (4)$$

It is this indicator number that appears as the output of automated land evaluation system expressed in EURO.

Automatism in the estimation of land value means that after having entered the orthographic number, the land value belonging to the given number, appears automatically.

The quantitative control of obtained results forms part of research task, it is a proof, if the created automated evaluation system gives a true picture of the real value of examined land plot, or if the new evaluation system is better than the actually valid gold-crown system.

By means of the new method, elaborated by us, we have practically combined the land evaluation calculated on return basis with the comparison of prices established in land market, and in such a way we have created a modern economic land evaluation algorithm, which takes into consideration the ecological differences between land qualities, but also reflects the demand--supply relations for land.

By employing this method we have practically combined the land prices calculated on return (income) basis with those current on the land market, whereby an up-to-date economic land value is obtained that not only respects the ecological quality of arable lands but also reflects the demand/supply conditions for land price.

The outputs of complex land evaluation system based on the D-e-Meter land quality index are as follow: Cadastral unit, site number, D-e-Meter point, Basic GM (EUR/ha), Corrected GM (EUR/ha), Estimated land rent, (EUR/ha), Estimated land value(EUR/ha).

Results and Discussion

Advantages of complex land evaluation system based on the D-e-Meter land quality index

The advantages of the integrated land evaluation system based on the D-e-Meter land quality index can be summarized as follows. In contrast to many currently applied systems the D-e-Meter system is an automated complex land evaluation system which could be reached by the user (land owner, agricultural producer, bank, etc.) through Internet on his own computer.

The fundamental structure of D-e-Meter land quality assessment system is different: here the qualification of crop production conditions is made on yield basis. Those land qualities and their combinations are selected with the classification process which affect the fluctuation of yield to the greatest extent. The determination of productivity of each field crop is made in the size of potential yield expressed on a scale from 0 to 100 [Tóth et al. 2007].

The economic evaluation of land units for example in ALES – which was elaborated by a research group of Cornell University, Department of Soil, Crop and Atmospheric Sciences − is made on the basis of farming data. The land quality is built in the model involving yields. The economic evaluation does not use the results of physical evaluation. The economic evaluation gives the economic suitability of the land unit concerning the realization of the given type of land use, separately on the basis of the four economic indices (gross margin, net present value, benefit/cost ratio, internal rate of return) [Rossiter-Van Wambeke 1997].

The economic evaluation in D-e-Meter system fully utilizes the outcomes of land quality assessment, thus meeting the requirements towards complex land evaluation methods. The basis of economic evaluation is given by the estimation of returns on land but the method also presumes the analysis of land market data. By combining the two approaches – land evaluation based on returns and the market – a totally new method has been developed which enables the elimination of specific errors of the two above mentioned evaluation processes. This method may be able to be used for the assessment of land value devoid of speculation.

The excluding of effect of speculation in land economic evaluation is especially important in Central and Eastern EU countries where the land market is also undeveloped with lot of imperfection and potential possibilities of moral hazards.

We regard D-e-Meter automated complex land evaluation system − even in international terms concerning its methodology − a modern and interesting solution of economic land evaluation based on land quality assessment.

Conclusions

In this paper a theoretical framework of integrated land evaluation system was presented. The investigations of this research topic were motivated by internationally recognized demand of decision makers for uniformed land evaluation system. The starting point of our research was the critical assessment currently applied land evaluation models. During the literature overview it was considered that although the FAO Framework for Land Evaluation [FAO 1976] – the initial for number of land evaluation worldwide – provides guidelines for "purpose oriented" evaluation, but the currently applied systems are insufficient for comply the needs of Central and Eastern EU countries where the land market is also undeveloped [Ciaian-Swinnen 2006].

Based on the D-e-Meter land quality index of agricultural plots, we developed the framework of land evaluation based on an online GIS. The new complex evaluation system is useful for getting the realistic land value and land price. The economic value of land based on the calculation of potential Gross Margin, which includes the total social-economic return of the plot. It can also be used to define the requirements for the alternative usage for land and to estimate the value of development rights.

Bibliography

Bidló A., Heil B., Illés G., Kovács G. 2003: *Forest habitat classification in Hungary and its problems*, [In:] Z. Gaál, F. Máté, G. Tóth (eds.), Proceedings of the Conference *Land Valuation and Land Use Information*, Keszthely, Hungary, November 2003, Veszprém University, Keszthely, Hungary, p. 115-124.

Ciaian P., Swinnen J.F.M. 2006: *Land Market Imperfections and Agricultural Policy Impacts in the New EU Member States: A Partial Equilibrium Analysis,* Am. J. Agric. Econ., No. 4, p. 799-815.

Dér F., Marton I., Németh T., Pásztor L., Szabó J. 2003: *Habitat evaluation of grasslands*, [In:] Z. Gaál, F. Máté, G. Tóth (eds.), Proceedings of the Conference *Land Valuation and Land Use Information*, Keszthely, Hungary, November 2003, Veszprém University, Keszthely, Hungary, p. 125-130.

FAO. 1976: *A framework for land evaluation*, FAO Soils Bulletin, p. 32, 72.

Gaál Z., Tóth G., Debreczeni B., Hermann T., Kuti L., Makó A., Máté F., Németh T., Nikl I., Speiser F., Szabó B., Kele-Szabó G., Szakadát I., Tóth Z., Vass J., Várallyay G. 2007: *What is D-e-Meter? – Land evaluation in the XXI century*, [In:] T. Tóth, G. Tóth, T. Németh, Z. Gaál (eds.), Proceedings of the Conference *Land Quality Assessment, Land Economic Evaluation and Land Use Information*, Budapest--Keszthely, Hungary, November 2007, MTA TAKI: Budapest, Hungary, p. 3-8.

Makó A., Tóth G., Máté F., Hermann T. 2007: *Soil productivity assessment based on the genetic soil subtypes,* [In:] T. Tóth, G. Tóth, T. Németh, Z. Gaál (eds.), Proceedings of the Conference *Land Quality Assessment, Land Economic Evaluation and Land Use Information*, Budapest-Keszthely, Hungary, November 2007, MTA TAKI: Budapest, Hungary, p. 39-44.

Rossiter D.G., Van Wambeke A.R. 1997: ALES Version 4.65 User's Manual. SCAS Teaching Series No. T93-2 Revision 6. Ithaca; Cornell University, Department of Soil, Crop and Atmospheric Sciences: NY, USA, p. 7-16.

Sadowski A. 2009: *Własność a użytkowanie gruntów rolnych. Zarys tendencji rozwojowych,* Wydawnictwo Universytetu w Białymstoku. Białystok, p. 366

Szűcs I., Fekete Farkas M., Vinogradov S., Tóth-Naár Z. 2008: *Evaluating the production factors.* [In:] I. Szűcs, Fekete, M. Farkas (eds.), *Efficiency in Agriculture*, *Agroinform,* Budapest, Hungary, 64-94.

Takács-György K., Bandlerova A., Sadowski A. 2007: *Land use and land reform in former Central and East European countries. Agricultural economics and transition: „What was expected, what we observed, the lessons learned,"* A Joint IAAE – 104th EAAE Seminar. Corvinus University of Budapest. CD proceeding.

Tóth G. 2009: *Land evaluation with the D-e-Meter system* , Agrochemistry Soil Sci., No. 2, p. 227-242.

Tóth T., Németh T., Bidló A., Dér F., Fekete-Farkas M., Fábián T., Gaál Z., Heil B., Hermann T., Horváth E., Kovács G., Makó A., Máté F., Mészáros K., Patocskai Z., Speiser F., Szűcs I., Tóth G., Várallyay G., Vass J., Vinogradov S. 2006: *The Optimal Strategy to Improve Food Chain Element Cycles-Development of An Internet Based Soil Bonitation System Powered by a GIS of 1:10000 Soil Type Maps*, Cereal Res. Commun., No. 1, p. 841-844.

Tóth T., Vinogradov S., Hermann T., Speiser F., Németh T. 2007: *Soil bonitation and land valuation with D-e-Meter system as a tool of sustainable land use*, Cereal Res. Commun., No. 2, p. 1221-1224.

Streszczenie

W artykule opisano etapy budowania nowego zautomatyzowanego systemu kompleksowej oceny gruntów na podstawie wskaźnika jakości gruntów De-Meter. Kompleksowa ocena oznacza organiczne usystematyzowanie czynników ekologicznych i ekonomicznych, wpływających na cenę ziemi. Metodyka powstała na potrzeby rozwoju nowego systemu oceny rynku gruntów na Węgrzech, związanego z różnicami rzeczywistych cen działek a wartością ekonomiczną gruntów rolnych.

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