*Agropedology, 2000, **10**, 88-100*

Use of land evaluation techniques to assess the market value of agricultural land

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Abstract

The value and sale price of land are determined by its production and income generation potential. Current valuation procedures use mainly an economic approach, but this cannot be applied when there is no or only a "thin" functional land market. In that case valuators are forced to adopt alternatives and/or to rely on their subjective personal experience, with a risk for objections and legal disputes. Numerical (parametric) land evaluation techniques based on natural physical parameters provide an excellent tool to define objectively the production potential of agricultural land, and obviously of its sale value. Examples are given from such procedures effectively implemented to determine (taxable) land values in the United States, Germany and Russia.

Additional keywords : Soil factor, land suitability, yield, price.

Introduction

Land is a major production factor. It provides food, water, shelter and space for leisure or urban and industrial development. The owner of a piece of land can derive a produce from it, and either use it for his proper benefit or commercialize it. Alternatively, he can lease the land against an agreed remuneration. Land as an income-generating commodity, either in money or in social esteem, is therefore desired by individuals and owner groups. It can be transferred in exchange of another commodity or against cash money. In both cases there is, however, a need for an agreed standard on its exchange (or market) value.

The objective of this paper is to discuss natural criteria for an objective assessment of the value and price of land, in particular of agricultural land. In this respect current parametric land evaluation methods are excellent tools which, for the moment, have not yet been fully explored.

Value of land : Value is an expression of the esteem by which something is held or can be exchanged. Value in *se* is the property of an object to satisfy a human desire. Scarcity increases this desire, and this explains why under certain conditions, an attribute once considered useless, has now acquired value (Carver 1978). In economic terms an attribute has value because it might give rise to a stream of future incomes. This means that the material value of that commodity depends upon the goods, services and/or cash which might emanate from it (Fibbens 1995).

Land has almost all the properties to meet the status of a desired attribute. It is finite in extent - especially in the light of the expansion of the world's population, India is a good example of this - and therefore holds an element of local (at a space scale) or future (at a time scale) scarcity. It is a vital natural resource, and it has a wide range of uses, either actual or anticipated, all of which can be a source for income generation and power.

Land like any other attribute of its kind has value only when there is a market for it. In a traditional tribal agricultural society, land is a common property that belongs to the people and, hence, there is no competition and no market for it. In a modern free-market economy, however, land is considered a production factor at the same level as labour and capital, and its market value is mainly determined by offer and demand. This value holds two major elements: its intrinsic production potential and a value-added premium, which is an expression of an expected (future) income from a change in use, speculation or other relevant socio-economic conditions. Obviously, in a predominantly rural area, where the challenges for alternative land uses do almost not exist, the land price will closely relate to its (agricultural) production potential. It is only in non-rural areas that the value-added premium may become important, and even overrule the intrinsic production value.

Current land valuation methods : Current land valuation procedures use mainly an economic approach. This is often based on either a comparative market sale (for land) or on the replacement cost for the good to be evaluated (Keith 1993). Obviously, for naked land with few or no buildings on it the latter method is hardly applicable. The most common approach is the comparative method, whereby representative sale prices in a functional market are used as a reference value, with subsequent individual appraisals made by relating and comparing the individual plots or properties with those of selected sales data.

Though this method seems logical from the viewpoint of both theory and practice and rests on the firm ground that market price is the only value that can be determined objectively, it has numerous limitations in practical applications, especially in areas where there is no or only a "thin" land market. Valuers may then be forced to adopt alternatives, as for example sales from a different locality or district, though with a proper adjustment. Where adjustments have to be made, arguments may however develop - especially if a valuation is objected and results in litigation - as to the nature and scope of the adjustment (Ewert 1979; Fibbens 1995).

The lack of a functional land market is more the rule than an exception. All land under customary tenure in Africa and in many countries emerging from a socialist-marxist political system (where private ownership was not allowed) come under this category. Moreover, the comparative sales method or any other approach associated to it, focuses mainly on buildings for which the replacement cost can be easily calculated than for arable land.

All the above aspects lead to the conclusion that currently applied valuation methods are not satisfactory, especially in areas where sales are not (yet) numerous, viz. in most of the world. Hence, there is an urgent need for an objective, transparent valuation approach with a wide application, based on a scientifically sound and repetitive method, and using parameters which are currently available. Numeric land assessment procedures as applied in agricultural suitability classifications provide a good basis for such new approach.

Land evaluation methods with a focus on land value assessment : Land evaluation is "the process of assessment of land performance in order to identify and make a comparison of promising kinds of land use in terms applicable to the objectives of the evaluation" (FAO, 1983). Land evaluation results in a rating of the land into suitability classes, which reflect potential yields and benefits. In this respect, land evaluation is a tool to assess income generation and value of land.

The first attempts to use land evaluation techniques on the basis of natural criteria were made for taxation purposes. Hence, they had to be objective, transparent and widely applicable so as to avoid arguments and legal disputes. Because they rely on easily measurable data, they can be checked and controlled by the taxpayers themselves.

The Storie index : This is an example of a broad-scale land rating for local use and based on a few simple parameters. It was originally developed in 1933 for taxation purposes in California, USA, but has repeatedly been revised (Storie 1933, 1954, 1976) and later been extended in an adapted form to many other parts of the world (McRae and Burnham 1981).

The Storie index reads as I = A x B x C x X, whereby the different components refer to parametric values allocated to soil profile characteristics (A), surface texture (B), slope (C) and a miscellaneous land factor (X). Each of those factors are scored as a percentage but multiplied as a decimal.

The ratings for the character of the soil profile (A) make a distinction between 9 different soil categories, which are further subdivided according to depth classes, gravel content and subsoil stratification. Hence, soils belonging to the category with undeveloped profiles can be given a value in the range 50-100%, with the lowest rating (50-60%) for soils less than 60 cm deep, whereas gravelly subsoils obtain 80-90%, and deep soils (more than 120 cm deep) are rated 100%. This is in clear contrast with the category of soils on older plains or terraces having strongly developed profiles or with soils having a hardpan for which the rating ranges are 40-80% and 5-80%, respectively.

The B factor refers to the texture of the surface soil. Ratings vary between 85 and 100% for medium-textured, 50-70% for heavy-textured and 30-90% for light-textured soils. A similar straight-forward numerical value is allocated for slope (C factor). The miscellaneous land factor (X) involves special properties such as drainage, alkalinity, nutrient status and acidity, type and degree of erosion, and micro-relief, all of which can be modified and/or improved by management. The nutrient/fertility rating for example includes 4 classes ranging from very high (rating 100%) to fair (95-100%), poor (80-95%) and very poor (60-80%). It should be noted that the ratings for soil properties which can be reclaimed through proper management are less severe than for conditions which can not be corrected (texture for example).

Application of the Storie index allowed to define 6 soil grades for the California region. Grade 1 (index 80-100%) refers to very suitable land allowing to grow a wide range of crops; grade 4 land (index 20-39) defines land with a narrow range in agricultural possibilities; and grade 6 land (index 0-10%) stands for land unsuitable for agriculture (McRae and Burnham 1981). As each of these classes defines a potential production and income level, they represent a potential value on which a land tax can be levied.

The method can be extended to other parts of the world under condition that the factors involved are adapted to the specific local conditions that have a direct impact on crop growth and production. This means for example that for application within a uniform agro-climatic area no (differentiating) climatic factor is needed, but that for application over larger areas also climatic differences have to be taken into account.

The German Bodenschätzung system : The German Bodenschätzung system was introduced by law as the official land valuation system for the country in 1934. It is still in use in some parts of Germany (NN 1934, Schachtschabel *et al.* 1982). Its purpose is, *inter alia*, (1) to create balanced taxes for land users independently from subjective assessments, (2) to improve the basis for the allocation of loans for land acquisitions and management, and (3) to simplify any future land valuation processes.

The method uses a step-by-step approach for a Soil Quality Assessment (SQA) in terms of points allocation. In a first phase the value and potential carrying capacity of land in so-called master areas (pilot zones) are carefully assessed. This should cover a wide range of soil qualities, and the exercise should be carried out by a specially appointed expert group. In a second phase individual land is then valued by comparing and matching plots of land with those from the master areas, using parametric values which are subtracted from a basic point rating of 100. The result of the SQA is an unambiguous land rating with legal value. It can only be changed or modified in a post-assessment procedure due to changing land use or management conditions, or as a result of changing agricultural techniques or cropping patterns. The valuation is done separately for agricultural land and pasture for the evident reason that income generation from both uses is substantially different.

The valuation for agricultural use starts with the establishment of an optimal assessment frame, which is allocated a basic rating or 100. Deviations from these optimal conditions modify the final rating. In this respect, consideration is given to three soil criteria : (a) texture, (b) parent material characteristics and (c) weathering stage of the profile.

For the textural rating for example (average textural class in the root zone) 8 mineral and 1 organic classes are differentiated, each of them being allocated a range of points. Sandy soils can obtain a maximum of 44 and a minimum of 9 points; for clay loam soils the range is 91 to 17, for humiferous soils it ranges from 10 to 54 (Table 1).

Table 1. Land ratings for a selected number of textures and parent materials as applied for agricultural use in the German Bodenschätzung system

Texture	Parent material	Weathering stage*						
		1	2	3	4	5	6	7
Sand	Alluvial soils	–	44–37	36–30	29–24	23–19	18–14	13–9
Clay loam soils	Alluvial soils	91–83	82–74	73–65	64–57	56–49	48–40	39–29
	Recently weathered soils without stones	87–79	78–70	69–61	60–52	51–43	42–34	33–24
	Idem with stones	–	–	67–58	57–48	47–38	37–28	27–17
Humiferous soils	–	–	54–46	45–37	36–29	28–22	21–16	15–10

* Weathering stages : 1 = Well drained soils with good crumb topsoil structure, gradual transition to the (often) calcareous subsoils, and no signs of acidification. 3 = Soils with less organic material in the topsoil, somewhat grayer subsurface colour, deeper decalcification zone, initial signs of tonguing and acidifcation. 5 = Soils with a sharply delineated organic topsoil, covering a moderately well defined eluviation and clay accumulation zone, with oxido-reduction features and signs of acidification. 7 = Soils with a well defined organic topsoil, covering a bleached subsurface and a clear clay accumulation layer, with obvious oxido-reduction mottling and/or possible pedogenetic crust formation in sandy materials.

Parent material characteristics allow to make a further second-level differentiation within the textural ratings. Four main groups are hereby distinguished including, *inter alia,* alluvial, loess soils and recently weathered stony or non-stony soils.

A third subdivision is made on the basis of the weathering stage of the profile. Seven stages are hereby distinguished, being an expression of the nutrient status in the root zone. Stage 1, the best soils, refers to well drained soils with good crumb structure and no signs of acidification. Stages 6 and 7, considered low-potential units, refer to soils with a bleached subsurface, marked clay accumulation and oxido-reduction mottling. Within the clay loam alluvial soils for example stage 1 soils are rated 83-91 points and for stage 7 soils, the ratings are dropped to 29-39 points. Table 1 displays in more detail the point ratings for a selected range of soils.

The ratings obtained through the procedure above are relative figures given for specific soils under ideal climatic, topographic and economic conditions. A slight additional adjustment for those conditions might therefore be needed. The final rating obtained after correction for other than soil factors leads to an overall agricultural value *(Ackerzahl)* as a norm for the carrying capacity and natural crop growth potential of the land concerned.

The land rating for pastoral use (Grünlandzahl) is calculated on the same principles, except that in this case more attention is paid to water/drainage and temperature conditions, and that only 4 textural classes and 3 weathering stages are taken into consideration.

These land values can easily be compared with actual market prices, and, hence, this numerical scale can easily be converted into a land price scale.

The Russian Bonitet system : This system uses a somewhat similar approach though mainly focused on soil fertility-related qualities and in view of technical inputs and crop production at different intensities (Karmanov 1980). Soil quality differences are expressed in relative numerical (indicator) values, which reflect both actual and potential yield expectations for various crops and cropping patterns. The system allows to define anticipated production levels as a function of natural land conditions.

The valuation procedure is mainly focused on humus content, texture and chemical characteristics (in particular cation exchange capacity) of the topsoil. Yield data for the most important crops are taken into consideration as well. Because these soil indicators vary, however, substantially from one geographical area (agro-ecological zone) to another, a preliminary differentiation is made between areas with sufficiently available soil moisture and areas where this is not the case. In the zones with good moisture availability the following soil parameters are considered : (a) humus content of the topsoil, (b) soil texture, (c) pH, (d) base saturation, (e) sum of bases and (f) exchangeable acidity. In areas with a soil moisture deficiency the collected soil information refers to : (a) humus content of the topsoil (Ah) and in the following depth ranges : 0–20 cm, 0–50 cm and 0–100 cm, (b) soil texture, (c) cation exchange capacity, (d) sum of bases and degree of base saturation, (f) exchangeable acidity (for Gray Forest and Chernozem Soils) and (g) exchangeable sodium percentage (for Solonetz soils).

Soil Bonitet uses a numerical scale of 100 points. This means that the best widespread cultivated soil in the area, providing the highest yields, gets 100 points and that all other soils are comparably rated in a downgrading scale. In general, a soil can not have more than 100 points, though a few exceptions may occur. Directly derived from statistically average yields a point is allocated a yield value in the system. Multiplying that point-related yield value with the number of points in *Soil Bonitet* will give concrete average yields. For the 1990 period the low, medium and very high wheat yield were allocated 25–30 kg/point, 45–50 kg/point and 65–75 kg/point, respectively (Stolbovoi 1997).

The system can be implemented at both local and national scales. In the former case, climate is considered homogeneous and is therefore ignored in the assessment. At national scale climate diversity plays, however, a much more important role and must be included at the highest level in the analysis. The basic assumption is that zonal soils comprise favourable characteristics, which do not negatively affect yield. The approach is thus primarily based on the actual yield performed by the best soil, followed in a latter stage by soil-specific corrections.

Table 2 displays the computed soil quality indices for a selected number of cultivated soils of Russia. The highest rating is given to typical and weakly leached Chernozems and very deep Chernozems of Krasnodar Kraj, giving the best yield performance. It should be noted that none of the cultivated soils of Russia have a value 1 for sugar beet. This is because the best soils for the crop are found in Ukraine.

The soil quality indices of table 2 are defined for zonal soils, having by definition a loamy parent material and a normal, unlimited moisture regime. Those soils do thus not have any characteristics limiting the yield.

Table 2. Total soil quality indices for major cultivated soils of Russia (after Karmanov 1980, and Stolbovoi 1997)

Soils (Russian classification)	Correlation with FAO (1988)	Index			
		Cereals	Sugarbeet	Sunflower	Grassland
Sod-Podzolic	Eutric Podzoluvisol	0.73	0.48	0.73	0.87
Light Gray Forest	Eutric Podzoluvisol	0.78	0.53	0.78	0.89
Gray Forest	Haplic Greyzem	0.81	0.56	0.81	0.91
Brown Forest	Eutric Cambisol	0.81	0.56	0.81	0.91
Cinnamonic	Chromic Cambisol	0.85	0.60	0.85	0.93
Chernozem podzolized	Luvic Phaeozem	0.92	0.67	0.92	0.96
Chernoz. leached	Haplic Phaeozem	0.96	0.71	0.96	0.98
Chernoz. typical	Haplic Chernozem	1.00	0.75	1.00	1.00
Chernoz. weakly leached, very deep of Krasnodar Kraj	Haplic Chernozem	1.00	0.75	1.00	1.00

However, in reality many soils differ in their characteristics from zonal ones and, therefore, the total soil quality indices have to be adjusted for those limiting characteristics. Such correlation values for texture are shown in table 3. For example, Light Gray Forest Soils having a fine loamy texture will perform 100% of the cereal yield, but they will only achieve 45% of the productivity when having sandy textures. To correct the total soil quality index in Light Gray Forest Soils with sandy textures for cereals the original coefficient of 0.78 of table 2 should therefore be multiplied by the value of 0.45 of table 3 resulting in a final index of 0.35.

Discussion

The current economic approach to land value determination from comparative market sales can only be implemented in areas where there is an active functional land market. In areas where this is not the case - e.g. in most parts of the world - alternative methods have to be used, and those can give rise to arguments sometimes even ending up in court cases. In this context, physical land evaluation methods - by preference using a parametric procedure - may provide a useful tool, at least when it comes to the assessment of the *inherent production value* of land.

Table 3. Coefficients for Soil Bonitet correction by texture for cereals (after Karmanov 1980, and Stolbovoi 1997)

Soil type	Texture					
	Light clay	Fine loam	Med. loam	Light loam	Loamy sand	Sand
Light Gray Forest Soils	0.85	1.00	0.98	0.92	0.68	0.45
Gray+Dark Gray Forest Soils	0.95	1.00	0.97	0.90	0.65	0.40
Chernozem podzolized	0.97	1.00	0.95	0.88	0.60	--
Chernozem leached + typical	0.98	1.00	0.93	0.87	0.57	--

The examples above illustrate that the assessment can take quite a large range of forms and implementing procedures, such as :

(a) by using only few and simple parameters (Storie index) or by applying more detailed land information (Bodenschätzung and Bonitet).

(b) by only multiplying the parameters (Storie index, Bonitet) or by adding/ substracting points from a standard value (Bodenschätzung),

(c) by using only physical parameters (Storie index, Bodenschaitzung) or focusing more on the fertility status of the soil (Bonitet).

(d) by making the assessment for a general land use (Storie index), a broad land use type (Bodenschätzung) or a crop- or crop-pattern-specific land use (Bonitet). This is mainly a scale problem and, therefore, closely linked to the number and type of parameters used for the assessment as described under 'a'.

(e) by regrouping the final result into broad land categories which are then allocated a value per category as a whole (Storie index, Bodenschätzung) or by allocating each point a yield/price value (Bonitet).

The overall market value and sales price of the land is, however, not only determined by its inherent production potential, but also by its *value-added premium*, which is an expression of the expected higher income-generation. This situation can be compared with the stock market where the sales price of a bond, though basically determined by the company's economic performance, is also affected by an undefined surrounding speculative market atmosphere. In the case of land, this means that the price of a plot currently used for rainfed cereal cultivation will substantially increase when that same piece of land becomes integrated in an irrigation scheme (and thus will be able to grow other high-value crops). Its value and price will even further rise when it should become part of an urban development programme. The expected higher income generation is obviously linked to the change in land use.

The value-added premium is largely influenced by the global socio-economic context wherein the land is located. In this respect the market price value might fluctuate as a function of speculations - some of them being even dubious - on future, better income-generating uses, political decisions will respect to land allocation, zoning, environmental regulations and infrastructure development, or just financial speculations in times of inflation.

Though it will never be possible to monitor exactly the extreme speculative land acquisitions, the general trend in the evaluation of land prices is closely linked to regional socio-economic development. Hence, within the European Community, land prices in The Netherlands and Germany are much higher than in France or Ireland, with more obvious variations even in between the regions (Eurostat 1997). This is mainly due to the variable competition for land, and to the national or regional economic and taxation policies.

In line with the above the impact of the value-added premium as discussed above can be assessed by adjusting the inherent production value by a *regional socio-economic correction factor* which can be regularly updated. For the procedures to implement this adjustment reference can be made to the German Bodenschätzung system which also used master areas or pilot zones to test and adjust the value of its key parameters.

Attempts are currently undertaken in a number of Central and East European countries where the old point system, largely based on the principles of the German Bodenschätzung, has become inapplicable after the recent flow of land privatizations. In Hungary a new system was therefore proposed holding two major components (Sipos 1989). The first factor involves the physical land value and is based on the assumption that the impact of natural conditions like soil, climate, relief and hydrology can be summarized in a single land value. It ranges between 1 and 100, and corresponds more or less with the limits of quality classes established by the current suitability classification systems. This valuation is based on the principle of yields and returns. It uses net returns to land as a factor of production, i.e. how much is the net income from crop production on different lands and how much of it can be contributed to the land itself.

The second component is more economy-oriented. It uses geographical differences in rent of lands with the same ecological endowments - assuming thus that the deviation may be traced back to the modifying effect of economic (market) conditions - as a criterion to subdivide the country into 23 economic environments. Each of those is given a correction value playing the role of an adjustment factor to the inherent physical land value.

A similar dual evaluation system, based on a physical assessment and a regional economic adjustment per major administrative region, is under study in Slovenia (Prus, pers. comm).

The former procedures are particularly promising for agricultural land in rural areas, where the risk for land speculation is low and the value-added premium is negligible. In addition, it opens interesting perspectives for the application of physical land evaluation procedures in a domain where there is an urgent need for objective assessments.

References

Carver, T.N. (1978). 'Value'. Encyclopedia maericana (Grollier Inc. : Danburry, Connecticut, USA).

Ewert, W.A. (1979). 'The Saskatchewan Rural Land Assessment Manual. Vol. 2 : Value and Valuation Theory in Assessment'. (Ministry Municipal Affairs : Regina; Saskatch ewan, Canada.

Eurostat (1997). Agricultural land prices and rents in the EU 1974-1995. Statistical Doc. 5C-Agriculture, Forestry and Fisheries, ECSC-EC-EAEC, Brussels-Lux embourg.

FAO (1983). 'Guidelines : Land Evaluation for Rainfed Agriculture'. (FAO Soils Bull. 52 : Rome).

Fibbens, M. (1995). Australian rating and taxing : mass appraisal practice. *Journal Property Tax Assessment and Administration* **1,** 61-77.

Karmanon, I.I. (1980). 'Soil fertility in the USSR : Natural Regularities and Quantitative Assessment'. (Kolos : Moscos).

Keith, S. (1993). Property tax in anglophone Africa : A practical manual'. World Bank Techn. Paper 209, Washington DC., USA.

McRae, S.G. and Burnham, C.P. (1981). 'Land evaluation'. (Oxford Univ. Press : Oxford, UK).

NN (1934). Bodenschaitzung : Technische Anweisungen. (Ministerium der Finanzen der Deutschen Demokratischen Republik. VEB Deutsche Zentralverlag : Berlin).

Schachtschabel, P., Blume, H.P., Hartge, K.H. and Schwertmann, U. (1982). 'Lehrbuch der Bodenkunde'. (Enke Verlag : Stuttgart).

Sipos, A. (1989). New land valuation system for an economy without a land market. In : 'Government Intervention in Agriculture : Causes and Effects'. (Eds: B. Greenschields and M. Bellamy) pp 324-329. (Dartmouth Publ. Cy Ltd. : Aldershot, Hants, UK)

Stolbovoi, B. (1997). Soil Bonitet system of Russia : Introduction and implementation into the agro-ecological zoning methodology. IIASA Interim Report IR-97-80, October 1997, Laxenburg, Austria.

Storie, R.E. (1933). An index for rating the agricultural value of soils. Bull. Calif. Agric. Exp. Station no. 556.

Storie, R.E. (1954). Land classification as used in California for the appraisal of land for taxation purposes. *Trans 5th International Congress of Soil Science, Leopoldville* **3,** 407-412.

Storie, R.E. (1976). Storie index soil rating. Spec. Publ. Div. Agric. Sci., Univ. Calif. no. 3203.

(Received : April, 2000; Accepted : October, 2000)