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Integrating Soil Quality Indicators Into Agricultural Property Valuation: A Human-Centred Decision-Support Perspective

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ABSTRACT

Agricultural property valuation is a complex expert task shaped by measurable land characteristics as well as professional judgement. In the Bloemfontein region of South Africa, inconsistent valuation outcomes may arise when structured environmental indicators are not routinely integrated into practice. This paper examines the potential of the Soil Management Assessment Framework (SMAF) as a human-centred decision-support mechanism in agricultural valuation. An inductive mixed-methods design combined qualitative and quantitative evidence. Survey questionnaires completed by seven experienced agricultural property valuers were used to rank valuation factors and test awareness of SMAF, while Ordinary Least Squares regression was applied to 97 verified agricultural property sales to identify significant price determinants. The results show that production potential, natural capital, soil quality, water availability, location and rainfall are highly ranked in valuation practice. Although only two valuers were familiar with SMAF and only one had used it, all respondents indicated that SMAF could improve the accuracy and consistency of valuations. The paper argues that SMAF should be treated not merely as a soil metric, but as a structured support tool that can strengthen expert judgement, reduce subjectivity and improve transparency in valuation reports.

Keywords: Human-centred decision-making, Expert judgement, Agricultural valuation, Decision support, SMAF

INTRODUCTION

Valuation of agricultural property is inherently complex because price formation depends on both measurable land characteristics and the valuer's interpretation of how those characteristics affect market value (Cabrido, 1990; Wessels & Willemse, 2013). In South Africa, agricultural land is purchased not only for production purposes, but also for lifestyle, investment and alternative land-use motives, which increases the need for context-sensitive valuation practice (Reed & Kleynhans, 2009; RICS, 2019). Agricultural

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valuation, therefore, remains a professional judgement task in which market evidence, local knowledge and environmental conditions interact to produce an opinion of value (Middelberg, 2014; Ramafoko, 2022).

In the Bloemfontein region, a further problem is that area-specific determinants of value are not clearly documented. This may contribute to inconsistent estimates among valuers, particularly when farm-specific indicators such as soil quality, carrying capacity, and production potential are assessed differently (Pienaar, 2013; Ramafoko, 2022). At the same time, advances in soil science provide structured tools that can potentially support valuation practice. One such tool is the Soil Management Assessment Framework (SMAF), which translates soil test results into an interpretable soil quality index and may offer a more transparent basis for considering soil-related value drivers (Andrews et al., 2004; Jimenez et al., 2022). Although SMAF has already been applied in South Africa, its practical value in valuation work remains largely unexplored (Gura and Mnkeni, 2019; Swanepoel et al., 2015).

The central argument is that agricultural valuation should not be viewed only as a technical pricing exercise, but as a socio-technical process in which expert judgement is shaped by the quality, accessibility and structure of available evidence (IVSC, 2020; RICS, 2020) (IVSC is the abbreviation for International Valuation Standards Council). Against that background, the paper investigates two linked questions: which factors do professional valuers regard as most important when valuing agricultural properties in the Bloemfontein area, and how might SMAF contribute to more consistent and transparent valuation practice?

VALUATION, SOIL QUALITY AND DECISION SUPPORT

Market value requires a willing buyer and willing seller acting knowledgeably, prudently and without compulsion (IVSC, 2016; IVSC, 2020). In practice, however, reaching such an estimate for agricultural property is difficult because farms embody a mixture of market, environmental and operational attributes (Appraisal Institute, 2000; Perujo-Villanueva & Colombo, 2021). Previous work has shown that agricultural valuation draws on conventional approaches such as the income-capitalisation, sales-comparison and cost methods, but these methods must be adapted to account for agricultural realities such as carrying capacity, rainfall, water access, soil form and proximity to markets (Murray, 1969; Middelberg, 2014; RICS, 2020).

Pienaar's (2013) categorisation of value determinants is especially useful for structuring agricultural valuation. It distinguishes between general, area-specific, and farm-specific factors (Pienaar, 2013). General factors include broad governmental, economic, social and physical influences. Area-specific factors include rainfall, water supply, health and safety conditions, location and perceptions of the district. Farm-specific factors include soil quality, grazing capacity, percentage cultivatable land, infrastructure, topography, development level and production potential (Kleynhans & Opperman, 2005; Reed, 2009; Ramafoko, 2022). This layered structure already implies

a decision-support problem: the valuer must interpret a large number of heterogeneous variables and weigh them in a way that remains credible to market actors (Wessels & Willemse, 2013).

Soil quality is one of the most important, yet also one of the most difficult, agricultural attributes to assess consistently (Pienaar, 2013; Ramafoko, 2022). The study argues that valuers recognise the importance of soil quality but often rely on indirect judgement rather than a standardised assessment protocol. SMAF offers a potential bridge between soil science and valuation by selecting relevant indicators, converting them through scoring functions, and combining them into an overall soil quality index (Andrews et al., 2004; Jimenez et al., 2022). Its value for valuation lies not in replacing the valuer's judgement, but in providing a structured evidence layer that can make judgement more transparent and less subjective. Under South African conditions, published applications of SMAF suggest that the framework is sufficiently robust to warrant further exploration in valuation contexts, provided that local calibration and practical interpretation issues are addressed (Gura & Mnkeni, 2019; Swanepoel et al., 2015).

The relevance of SMAF lies in the interaction between human expertise and structured information. Decision quality in professional practice depends not only on the accuracy of raw data, but also on whether information is understandable, comparable and usable by practitioners. A framework such as SMAF therefore belongs within human-centred decision support: it simplifies interpretation, supports explanation to clients, and can improve confidence in how soil-related conditions are represented in valuation reports (Andrews et al., 2004; RICS, 2019; Van der Walt & Boshoff, 2017).

METHODOLOGY

The study adopted an inductive mixed-methods design in order to address both practitioner judgement and observed market behaviour (Creswell & Creswell, 2018). The qualitative component used a semi-structured questionnaire completed by seven professional valuers with substantial experience in agricultural valuation within the Bloemfontein region. Respondents were between 37 and 54 years old, had an average of 23 years of experience as property valuers, and had approximately 20 years of experience valuing agricultural properties in and around Bloemfontein. The questionnaire asked respondents to rank the factors identified in the literature on a scale from 1 to 10, with 10 indicating very high importance. It also investigated awareness and use of SMAF in current practice. The use of ranking scales was appropriate because the study sought to establish relative importance among heterogeneous valuation factors rather than simple categorical responses (Anjana, 2021).

The quantitative component drew on recorded agricultural sales from the Deeds Office over an 18-month period from March 2022 to September 2023. The initial sales pool contained 177 transactions, but observations with zero values, incomplete locational information, properties smaller than 0.5 ha, and three extreme outliers were removed to preserve arm's-length comparability. The final analytic sample comprised 97 verified agricultural property sales. Variables retained in the dataset included total sales price, price per hectare,

property size, months since sale, direction from Bloemfontein and distance from the city. Distance was grouped into close, medium and far categories, while direction was coded into the eight principal compass categories. These variables align with factors frequently identified in agricultural valuation literature, particularly size, market access and locational variation (Maddison, 2000; Reed & Kleynhans, 2009; Ramafoko, 2022).

Two Ordinary Least Squares (OLS) regressions were used to analyse these factors. The first model tested factors influencing the natural logarithm of price per hectare. The second tested factors influencing the natural logarithm of total sales price. The mixed-methods design was appropriate because it allowed the study to compare what valuers say matters in practice with what can be shown to matter in observed transactions (Creswell & Creswell, 2018). OLS was selected because it remains a transparent and widely used approach for modelling price determinants and estimating the marginal influence of explanatory variables in property and land valuation research (Gujarati & Porter, 2009; Uyanık & Güler, 2013). Ethical clearance for the study was obtained through the University of the Free State General/Human Research Ethics Committee.

RESULTS

The questionnaire findings indicate that valuers do not rely on a single determinant of value, but instead apply layered judgement across general, area-specific and farm-specific categories. Under the general factors category (see Table 1), the physical condition of the property received the highest mean ranking (9.40/10), followed by economic conditions (7.57). Social factors ranked lower (5.57), while governmental factors were lowest (4.71). For area-specific factors, water supply received the highest mean ranking (8.71), followed by location in terms of market access and safety (8.43), and rainfall (7.86). Restitution actions (5.71) and industrial progress (5.86) received the lowest mean rankings in this category.

Farm-specific factors were ranked most strongly overall. Agricultural production potential received the highest mean score (9.43), followed by natural capital such as grazing capacity and soil forms (9.29), and the soil quality index (9.14). Development level, percentage cultivatable land and infrastructure each also received relatively high scores (8.71). By contrast, labour and capital intensity (5.00) and the number of land portions (4.29) were ranked as least important. Taken together, these results show that valuers place greatest emphasis on productive capacity and biophysical quality rather than on administrative or abstract structural characteristics.

The SMAF-specific responses are especially important for the paper's human-centred framing. Only two of the seven valuers were familiar with SMAF, and only one respondent reported using it where data were available. Nevertheless, all respondents agreed that SMAF could enhance the quality of agricultural valuations and stated that they would incorporate it if it were available in a usable form. This suggests that the main barrier is not resistance to structured environmental evidence, but limited exposure, limited operationalisation and limited integration into normal valuation workflow.

The sales analysis complements these findings. The descriptive statistics show a mean total sales price of R2,543,815.00, a mean price per hectare of R250,449.00, and an average property size of 97.13 ha. The price-per-hectare regression produced a strong overall fit ($F = 13.10$; $p < 0.0001$; adjusted R-squared = 0.5809). Property size had a statistically significant negative relationship with price per hectare, indicating that larger farms tend to sell for lower prices per hectare. Properties in the southeast of Bloemfontein also sold at significantly lower prices per hectare, and both medium-distance and far-distance categories were associated with lower per-hectare values than properties close to Bloemfontein. Time since sale was not statistically significant.

The total-sales-price regression was also significant overall ($F = 2.72$; $p = 0.005$; adjusted R-squared = 0.164). In this model, property size showed a statistically significant positive relationship with total sales price. Directional effects remained important: properties located east, southeast and south of Bloemfontein had significantly lower total sales prices than the reference area. Distance categories were not significant in the total-price model. These findings confirm that a combination of scale and location shapes market evidence in the Bloemfontein area, while the qualitative findings show that valuers also attach high importance to production potential, water and soil-related conditions.

Table 1: Ranked valuation factors identified by agricultural valuers.

Category	Highest-Ranked Factors	Mean	Lowest-Ranked Factors	Mean
General	Physical condition	9.40	Governmental factors	4.71
Area-specific	Water supply; Location; Rainfall	8.71; 8.43; 7.86	Industrial progress; Restitution actions	5.86; 5.71
Farm-specific	Production potential; Natural capital; Soil quality index	9.43; 9.29; 9.14	Labour/capital intensity; Number of portions	5.00; 4.29

DISCUSSION

The results reveal an important distinction between what is easy to measure in transaction data and what is important in professional judgement. The regressions identified size and location as statistically significant determinants of observed prices (see Table 2). By contrast, valuers place particular emphasis on productive capacity, natural capital, water supply, and soil quality. This does not represent a contradiction; rather, it shows that agricultural valuation is a layered decision process. Some attributes can be observed directly in transaction records, while others must be inferred from on-site evidence, specialist knowledge or supporting technical information. The role of decision support is therefore to improve how less directly observable but highly important factors are interpreted and communicated.

SMAF is relevant precisely because it addresses one of the more difficult farm-specific inputs: soil quality. The findings suggest that valuers already regard soil quality as important but lack a consistent, widely understood mechanism for incorporating it. A framework such as SMAF can support three aspects of human-centred practice. First, it can improve consistency by standardising how soil test results are translated into an interpretable index. Second, it can reduce subjectivity by anchoring the discussion of soil-related value in explicit, comparable evidence. Third, it can improve transparency by giving valuers a clearer basis for explaining soil-related judgement to clients, lenders and other market actors.

The findings also illustrate that adoption cannot be assumed simply because a framework is technically sound. If only a minority of valuers know of SMAF, then implementation challenges lie in awareness, calibration, accessibility and workflow design. This is a classic human-systems issue: useful information has little practical effect when it is not embedded in end users' routines, language, and tools. The results therefore support the conference framing that agricultural valuation should be treated as a human-centred decision-support problem. Valuers remain the decision-makers, but their judgement can be strengthened when complex environmental information is presented in a form that is credible, interpretable, and usable in practice.

A further implication is that SMAF should complement, not replace, the broader valuation process. The regression models make clear that location and distance remain important market determinants, while the questionnaire findings highlight water access, rainfall and production potential. Soil indicators, therefore, need to be integrated alongside, not above, other forms of evidence. The most practical role for SMAF is as a structured supplementary layer within valuation reports, especially where soil productivity, carrying capacity or long-term agricultural potential are material to value.

Table 2: Summary of empirical results relevant to decision support.

Component	Key Result	Decision-Support Implication
SMAF awareness	2 of 7 valuers knew SMAF; 1 had used it	Adoption barrier is workflow and exposure rather than outright resistance
SMAF acceptance	All valuers agreed that SMAF could improve valuation quality	Structured soil evidence is acceptable when available in usable form
Price per hectare regression	Negative relationship with size, southeast location, medium distance and far distance	Locational market evidence remains essential and must be integrated with soil evidence.
Total sales price regression	Positive relationship with size; negative effects for east, southeast and south	SMAF should complement rather than replace broader valuation determinants
Overall contribution	58.09% of variation explained in the per-hectare model; 16.44% in the adjusted total-price model	Decision support is needed most where important factors are hard to observe directly in transaction data

CONCLUSION

This paper examines agricultural valuation in the Bloemfontein region as a human-centred decision-support challenge, with particular attention to the potential contribution of the Soil Management Assessment Framework. The study confirms that valuers rely on a broad, layered set of determinants, with physical condition, water supply, location, production potential, natural capital, and soil quality all regarded as important. At the same time, market evidence from 97 verified agricultural sales indicates that size and location significantly influence both the price per hectare and the total sales price.

The most important contribution of the paper is not the claim that SMAF is already widely adopted; the evidence does not support that. Instead, the contribution lies in demonstrating that valuers are receptive to a structured soil-quality tool, despite limited current awareness. This positions SMAF as an emerging support mechanism rather than an established standard. Its practical value lies in helping practitioners translate complex soil information into a clearer, more transparent and more consistent basis for judgement.

The study demonstrates that property valuation in agricultural contexts should be understood as an interaction between human expertise and structured evidence systems. Better decision quality will depend not only on more data, but on better integration of environmental information into professional workflow. Future work should therefore investigate local calibration of SMAF, broader regional testing, and practical reporting protocols that enable valuers to incorporate soil quality indicators in a manner that is understandable to both practitioners and clients.

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REFERENCES

Brewer, M.F. and Boxley, R.F. (1981). Agricultural land: Adequacy of acres, concepts, and information. American Journal of Agricultural Economics, 63(5), pp. 879–887.

Cabrido, C.A. Jr. (1990). An overview of the methods and technical considerations in the valuation of agricultural lands. Philippine Geographical Journal, 34(1), pp. 27–40.

Creswell, J.W. and Creswell, J.D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Los Angeles: Sage.

Gura, I. and Mnkeni, P.N.S. (2019). Dataset on the use of the Soil Management Assessment Framework (SMAF) in evaluating the impact of conservation agriculture strategies on soil quality. Data in Brief, 22, pp. 578–582.

Gujarati, D.N. and Porter, D.C. (2009). Basic Econometrics. 5th ed. New York: Douglas Reiner.

International Valuation Standards Council (IVSC) (2016). Bases of Value. London: IVSC.

Jimenez, L.C.Z., Queiroz, H.M., Cherubin, M.R. and Ferreira, T.O. (2022). Applying the Soil Management Assessment Framework (SMAF) to assess mangrove soil quality. Sustainability, 14, 3085.

Kleynhans, T.E. and Opperman, J.M. (2005). Determination of priorities of buyers regarding value contributing characteristics of farm land in the Stellenbosch district, South Africa. Agrekon, 44(4), pp. 496–510.

Middelberg, S.L. (2014). Agricultural land valuation methods used by financiers: The case of South Africa. Agrekon, 53(3), pp. 101–115.

Pienaar, P. (2013). Farm valuations in practice. Agri Land Price Index.

Ramafoko, L.P. (2022). Investigation of land price determinants in selected districts of the Western Cape. MSc dissertation. Stellenbosch University.

Reed, L.L. (2009). A reinterpretation of the value attributes of agricultural land for the valuation of farms bought for lifestyle purposes. Doctoral dissertation. Stellenbosch University.

Reed, L.L. and Kleynhans, T.E. (2009). Agricultural land purchases for alternative uses - Evidence from two farming areas in the Western Cape Province, South Africa. Agrekon, 48(3), pp. 332–351.

Royal Institution of Chartered Surveyors (RICS) (2019). Valuation of Rural and Agricultural Land. 3rd ed. London: RICS.

Royal Institution of Chartered Surveyors (RICS) (2020). RICS Valuation - Global Standards 2020. London: RICS.

Swanepoel, P.A., du Preez, C.C., Botha, P.R., Snyman, H.A. and Habig, J. (2015). Assessment of tillage effects on soil quality of pastures in South Africa with indexing methods. Soil Research, 53, pp. 274–285.

Wessels, J.P. and Willemse, B.J. (2013). The factors influencing the value of agricultural land in South Africa. Journal of the South African Institution of Valuers, 5(1), pp. 23–34.