Agricultural Land Valuation-Hedonic Pricing and Geostatistical Advances: A State-of-the-Art Review

Valoración de tierras agrícolas-Precios hedónicos y avances geoestadísticos: Una revisión del estado del arte

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Abstract

This review examines international research on agricultural land valuation using hedonic pricing methods and geostatistical techniques. It brings together conceptual frameworks, functional forms, spatial econometric models, and empirical findings from key regions such as the United States, Europe, China, Australia, and Latin America. The main sections of the paper present comparative tables that summarise 23 studies applying log-linear or log-log models, R^2 values, and estimated marginal effects of irrigation water and other attributes. The review highlights methodological advances, identifies ongoing challenges in modelling spatial dependence and heterogeneous terrains, and outlines research gaps for developing robust valuation frameworks applicable to irrigated arid zones.

Keywords

hedonic pricing • land valuation • geostatistics • irrigation water • spatial econometrics • land characteristics

Resumen

Esta revisión examina investigaciones internacionales sobre la valoración de tierras agrícolas mediante métodos de precios hedónicos y técnicas geoestadísticas. Integra marcos conceptuales, formas funcionales, modelos econométricos espaciales y hallazgos empíricos de regiones clave como Estados Unidos, Europa, China, Australia y América Latina. Las secciones principales del trabajo presentan tablas comparativas que resumen 23 estudios que aplican modelos log-lineales o log-log, valores de R^2 y efectos marginales estimados del agua de riego y otros atributos. La revisión destaca los avances metodológicos, identifica los desafíos persistentes en la modelización de la dependencia espacial y la heterogeneidad territorial, y señala brechas de investigación orientadas al desarrollo de marcos de valoración robustos aplicables a zonas áridas bajo riego.

Palabras clave

precio hedónico • valoración de la tierra • geoestadística • agua de riego • econometría espacial • características del terreno

Introduction

The valuation of agricultural land is a fundamental issue in resource economics, rural development, and agricultural policy planning. In regions facing increasing water scarcity, such as the Mendoza River Basin in Argentina, accurately determining the economic value of farmland and its key attributes, particularly irrigation water, becomes increasingly relevant. Hedonic pricing models have long served as a robust methodology for decomposing the observed price of land into its constituent attributes, offering insight into the implicit values assigned to physical, economic, and environmental characteristics.

Recent advances in spatial econometrics and geostatistical modelling have enriched this analytical approach. These methods accommodate spatial dependence and geographical heterogeneity in data, both critical in explaining land price variations. This review provides a state-of-the-art synthesis of literature employing hedonic models-with a focus on the marginal contribution of irrigation water-and highlights geostatistical innovations designed to improve model robustness.

The article is structured as follows:

- Theoretical Framework: Hedonic Pricing and its Extensions, introduces the theoretical framework of hedonic pricing and its main extensions, establishing the analytical foundations for understanding land price formation based on the valuation of individual attributes.

- Irrigation Water as an Economic Attribute in Agricultural Land Markets: Hydrological Context, Use, and Value in the Mendoza River Basin, presents the hydrological, physical, and institutional context of irrigation water in the Mendoza River Basin, showcasing its importance as a production factor.
- Hedonic Models in the Estimation of Agricultural Land Prices: Foundations and Empirical Applications analyses, the conceptual foundations and international empirical applications of hedonic pricing in farmland markets.
- Methodological Advances: Spatial Hedonic and Geostatistical Models in Agricultural Land Valuation, outlines methodological innovations, including spatial and geostatistical extensions.
- Results: Review of Major Studies, compiles the main findings from comparative studies, and the conclusion summarises the lessons and gaps identified.

Theoretical Framework: Hedonic Pricing and its Extensions

The valuation of agricultural land is a cornerstone of rural economics and agricultural policy planning. Hedonic pricing models have proven to be a robust methodology for decomposing the price of land into its constituent attributes. This approach assumes that the price of a heterogeneous good (such as land) can be explained by the sum of the implicit values of its physical, economic, and environmental characteristics.

The hedonic pricing method (HPM) is rooted in the idea that a good can be valued based on its characteristics. In the case of land, the price is decomposed into the value of attributes such as soil quality, infrastructure, crop type, location, and access to irrigation water. Formally, a simple hedonic model is expressed as:

$$P=f(X1,X2,...,Xn)+\epsilon$$

where:

P = the land price

X1,...,Xn = its observable attributes

ϵ = the error term.

The conceptualization of this method is found in the seminal work by Rosen, S. (1974).

Functional Forms and Interpretation of Elasticities

In practice, the most widely used functional forms are the log-linear and log-log models. This choice not only helps stabilize variance but also facilitates the interpretation of coefficients:

- Log-linear model: $\ln(P)=\beta 0+\sum j=1n\beta jXj+\epsilon$. Here, the coefficient βj is interpreted as the approximate percentage change in price for a one-unit change in attribute Xj. For example, if the coefficient for the dummy variable 'access to irrigation' is 0.19, this means that the price of the land increases by approximately 19% in properties with irrigation.
- Log-log model: $\ln(P)=\beta 0+\sum j=1n\beta j\ln(Xj)+\epsilon$. In this case, the coefficient βj is interpreted as the elasticity of price with respect to attribute Xj. A coefficient of 0.45 for lnDist (distance) indicates that a 1% increase in distance is associated with a 0.45% decrease in price, which is very useful for comparing the relative importance of attributes across different scales.

Limitations and Methodological Advances

Although traditional hedonic models are highly useful, they present several limitations. Ignoring spatial dependence-the tendency for geographically close observations to be more similar-can bias coefficient estimates. To address this issue, several key methodological advances have been developed:

1. Spatial Hedonic Models

These models explicitly incorporate spatial autocorrelation. The most common approaches are:

- Spatial Lag Model (SLM)

Includes a spatially lagged dependent variable (Wln(P)) to capture the influence of neighbouring property prices.

- Spatial Error Model (SEM)

Assumes that spatial correlation lies in the error term, indicating omitted variables with a spatial structure.

2. Mixed Models (Hierarchical): These models nest administrative or ecological units (*e.g.*, district within a department) to capture variability at different levels and address the problem of non-independent observations.
3. Heteroskedasticity: Unequal price variance across different regions or districts (heteroskedasticity) is addressed through methods such as weighted least squares or variance structures like *varIdent*.
4. Geostatistics: Geostatistical methods, such as kriging, interpolate values in unsampled areas, providing a basis for mapping prices or attributes like soil quality from limited data.

Together, these methodological advances strengthen the ability of hedonic models to provide more robust and accurate estimates, particularly in rural land markets characterised by high environmental and institutional complexity, such as that of Mendoza.

Irrigation Water as an Economic Attribute in Agricultural Land Markets: Hydrological Context, Use, and Value in the Mendoza River Basin

Hydrological and Territorial Framework

The Province of Mendoza, Argentina, has an extremely arid hydrological regime, with average annual rainfall of around 220 mm. Agricultural production is concentrated in irrigated oases that occupy only 4 per cent of the provincial territory yet sustain 99 per cent of the population and most socioeconomic activity. Mendoza contains the largest collective irrigated area in the country (approximately 267,889 ha), accounting for about 20 per cent of the national total. The province's water supply system extends across five major rivers: Mendoza, Tunuyán, Diamante, Atuel, and Malargüe.

Water managers must balance competing domestic, agricultural, industrial, and environmental uses. Agriculture accounts for 93.75% of total water demand, compared with 5.45% for domestic use and 1% for industry. Given its strategic role, irrigation water directly affects land value, production efficiency, and territorial sustainability. The Department of Irrigation (Departamento General de Irrigación, DGI) oversees water management using tools such as the Hydrological Balance, Annual Runoff Forecast, and Automatic Measurement Networks. Economic instruments such as Virtual Water and Water Footprint indicators are also promoted.

Hydrological Crisis and Territorial Pressures

Between 2009 and 2022, Mendoza underwent the longest dry cycle in its recorded history, with 12 of 13 years classified as drought years. Reduced snowfall, pronounced climate variability, and sediment accumulation in reservoirs (for example, a 20 per cent loss of storage capacity in the Potrerillos Dam) have severely constrained water availability. Recent runoff forecasts (2019-2022) reported flows below 70 per cent of historical averages, prompting the implementation of extraordinary management measures.

Recent evidence from irrigated areas in eastern Mendoza shows a marked increase in abandoned cropland - 92 per cent between 2002 and 2020 - driven by water scarcity, accessibility constraints, crop type, and socio-economic vulnerability (Guida-Johnson *et al.*, 2024).

Against this backdrop of growing hydrological stress, limited irrigation availability raises production costs, reduces yields, and ultimately undermines the economic viability of farms. When adaptive capacity is constrained, these pressures frequently result in land abandonment, urban encroachment, or declining land values. In the Mendoza River Basin -the focal area of this review - Bacaro *et al.* (2017) documented over 28,000 hectares of abandoned irrigated land, illustrating how prolonged water shortages and structural pressures contribute to land-use decline within the basin itself. The increasing urbanisation of peri-urban irrigated zones further intensifies land-use conflicts and adds complexity to farmland valuation dynamics.

Water Rights System and Institutional Framework

Mendoza's irrigation system operates under a legally defined and hierarchically organised framework administered by the Department of Irrigation (DGI). The 1884 Water Law defines several categories of rights: definitive concessions (granted to users prior to 1884, with absolute priority), eventual concessions (granted after 1884, receiving between 50 and 80 per cent of the volume allocated to definitive users), and precarious permits-temporary and revocable authorisations for the use of surplus or drainage water that do not confer full ownership rights and therefore imply lower legal security (Pinto *et al.*, 2019). From a distributive perspective, because these permits were introduced after the 1884 Water Law, they are classified as *eventual* rather than *definitive* rights and thus occupy the lowest tier within the allocation hierarchy established by the Administrative Tribunal's 1929 ruling, receiving proportionally smaller water entitlements (Pinto, 2001). The DGI also manages drainage or summer reinforcement water, which it reallocates to stabilise irrigation supplies, a function described in the Hydrological Balance Report (DGI, 2016). In addition, the use of groundwater follows a specific regulatory regime that requires the authorisation of drilling, technical inspection of works, and systematic monitoring of aquifers. The DGI issues new extraction permits or replacement permits, applying technical and legal criteria that depend on hydrogeological conditions -such as recharge areas, confined or semi-confined aquifers, and natural spring zones- described in a recent diagnostic report prepared in collaboration with Mekorot (DGI, 2023).

Under Mendoza's legal framework, the right to use water is accessory to the land (*derecho de agua accesorio al inmueble*), meaning it cannot be sold or transferred independently from the property to which it belongs (Gobierno de Mendoza, Ley de Aguas, 1884). Unlike in other countries where water rights may be traded separately from land ownership, this principle in Mendoza legally binds water to the land, integrating their economic values within agricultural markets. Consequently, the economic value of irrigation water is capitalised in the value of irrigated land, reinforcing its dual role as both a productive input and a territorial asset in agricultural markets.

Relevance for Land Valuation

Understanding irrigation water as a marginal value attribute is crucial for land markets in arid basins like Mendoza. This review frames irrigation access as a key explanatory variable in hedonic models and connects it with productivity, soil quality and locational advantages.

Hedonic Models in the Estimation of Agricultural Land Prices: Foundations and Empirical Applications

Theoretical Background and Key Determinants

Hedonic pricing decomposes land value into its observable characteristics. Classical determinants include productivity, land use, and crop prices, while recent studies emphasise physical attributes (*e.g.*, slope, soil quality), irrigation infrastructure, secure water rights, urban proximity, land-use regulations, and macroeconomic expectations. The literature reports diverse model specifications and outcomes depending on geographical context.

In the United States, Faux and Perry (1999) estimated marginal irrigation water values ranging from USD 9 to 44 per acre-foot, whereas Roka and Palmquist (1997) and Miranowski and Hammes (1984) developed broader theoretical frameworks. In Spain, Gracia *et al.* (2004) linked rural population growth with land demand, and Decimavilla and Sperlich (2008) highlighted the effects of urban pressure and irrigation expansion, while in Chile, Troncoso (2005) and Schönhaut (1990) applied hedonic models based on classified advertisements, reflecting data constraints. In Argentina, research remains less developed, with persistent challenges related to spatial adaptation, data consistency, and regional heterogeneity.

Valuing Irrigation Water as a Scarce Environmental Resource

Indirect valuation approaches use land prices to infer the economic value of irrigation water. Bos (1999) reported a gross productivity of USD 0.22 per m^3 for viticultural and fruit systems, whereas Valencia (2012) estimated a marginal value of USD 3.2 per m^3 in northern Mendoza. Garrido (2004) identified marginal productivities of USD 0.586 per m^3 for flows of 1,100 hm^3, and Cano (1967)-as cited by Pinto (2005)-documented up to thousandfold increases in land value following the allocation of irrigation rights.

In Spain, Gracia *et al.* (2004) observed that irrigated land values were twice those of rainfed parcels, and Berbel (2007) calculated capitalised irrigation water values at €3.46 per m^3, with rental values ranging between €0.14 and €0.35 per m^3. Microeconomic models integrate soil fertility, on-farm improvements, infrastructure, and crop suitability, with irrigation rights consistently emerging as a key determinant of land value.

As Bencure (2019) and Sardaro (2020a) argue, sustainable land use requires incorporating water valuation into territorial policy. This study therefore emphasises the combined modelling of land and water to capture their economic interdependence, drawing on both traditional hedonic estimation and spatial analytical methods.

Methodological Advances: Spatial Hedonic and Geostatistical Models in Agricultural Land Valuation

Spatial Dependence and Econometric Tools

Geostatistics and spatial econometrics have strengthened the explanatory power of hedonic models by explicitly addressing spatial autocorrelation and heterogeneity. Spatial Lag Models (SLM), Spatial Error Models (SEM), and General Spatial Models (GSM) capture inter-parcel interactions and correct for spatial bias. Geostatistical techniques such as kriging enable interpolation in unobserved areas, producing predictive maps that support taxation, zoning, and policy design.

Journel and Huijbregts (1978) and Matheron (1963) formalised these principles through regionalised variable theory, introducing analytical tools such as variograms and spatial weights matrices. Applications in Illinois (Huang *et al.*, 2006), Spain (Dray *et al.*, 2006), and Argentina (Balzarini, 2014) validate these approaches. Huang *et al*. (2006) applied spatial lag models with AR(1) errors to 64,000 transactions, achieving better model fit and correcting for serial correlation.

Wang (2018) advocated the use of structural spatial panel models based on farm-level data, although limited data availability remains a constraint. Córdoba *et al.* (2021a) implemented a machine-learning approach-Spatial Quantile Regression Forest (S-QRF)-to estimate land values using big data and geospatial information, outperforming traditional regression and kriging methods.

Empirical Evidence and Comparative Findings

Yoo *et al.* (2013) introduced interaction terms and robust errors into hedonic models for urbanising areas of Arizona, identifying water rights as capitalizable urban assets. Mukherjee and Schwabe (2014) estimated interactions between salinity and water depth in California using GSM, revealing non-linear effects on irrigated land value. Lehn and Bahrs (2018) in Germany and Guadalajara *et al.* (2019) in Spain employed SEM and SLM frameworks with robust variance estimators to capture demographic, urban, and livestock-related spillover effects.

Kostov (2009) applied Bayesian semi-parametric additive models in Northern Ireland, highlighting soil and drainage as key determinants of land value. Across these studies, spatial models consistently outperform OLS specifications in diverse contexts, confirming the centrality of geographic information in hedonic land price analysis.

Results: Review of Major Studies

Two comparative tables summarise the reviewed studies. Table 1 (page 230-231) compiles classical works alongside more recent studies on the hedonic pricing method and the economic valuation of irrigation water, whereas table 2 (page 232-233) presents contemporary literature that integrates spatial and geostatistical approaches applied to agricultural land valuation.

Table 1 (page 230-231) summarises key studies applying the hedonic pricing method to the valuation of agricultural land and irrigation water. The results consistently confirm the positive and significant contribution of irrigation access or water rights to land values across diverse regions and crop systems. In addition to water-related attributes, other important determinants include soil quality, parcel size, distance to markets and urban centres, infrastructure, crop type, and physical improvements such as drainage systems or vineyard facilities. Early contributions established the theoretical and empirical foundations of the method, while more recent studies, such as Tauro *et al.* (2024), demonstrate its continued relevance for analysing how irrigation service type, reliability, and a wide range of physical, locational, and institutional attributes are capitalised into farmland prices.

Table 1. Comparative analysis of studies on hedonic valuation of agricultural land and the marginal contribution of irrigation water.

Tabla 1. Análisis comparativo de estudios sobre valoración hedónica de tierras agrícolas y la contribución marginal del agua de riego.

Author(s) / Year / Journal	City / Study Area	Model Functional Form	R^2	Key Significant Variables	Marginal Contribution of Irrigation Water	Main Conclusions
Faux, J. & Perry, G. (1999). *Land Economics*	Malheur County, Oregon, USA	Linear (heteroskedasticity-weighted adjustment)	0.92	Soil quality with irrigation water, estimated value of buildings, proximity to urban centres	Estimated implicit value of irrigation water ranges from $9 per acre-foot in less productive land to $44 per acre-foot in more productive land.	Irrigation is a significant determinant of agricultural land value. Water value is more capitalized in productive soils.
Chicoine, D. (1981). *American Journal of Agricultural Economics*	Illinois, USA	Log-linear	0.70	Soil quality, distance to markets, property size, infrastructure	Positive coefficient for irrigation access	Irrigation access increased land price, soil quality was the most influential variable.
Palmquist, R. & Danielson, L. (1989). *Land Economics*	North Carolina, USA	Linear	0.65	Soil type, topography, lot size, distance to cities	Positive and significant coefficient for irrigated plots	Land with irrigation capacity was significantly more valuable.
Fraser, I. & Hilder, C. (2007). *Australian Journal of Agricultural and Resource Economics*	Australia (Wine Region)	Log-log	0.82	Age of vines, grape variety, cultivated area, winery infrastructure	Positive coefficient for water availability (rights or wells)	Irrigation water is a key factor in vineyard price; vine age and grape variety also influence value.
Donoso, G. *et al.* (2013a). *Economía Agraria y Recursos Naturales*	Chile (from Coquimbo to Los Lagos)	Log-linear interaction effects and urban pressure, correcting for heteroscedasticity	0.60	Buildings, drip irrigation, fruit trees, distance to urban centres, agricultural exports relative to agricultural GDP	% of drip irrigation positively affects price (29%)	Land price increases with high-value crops, irrigation infrastructure, and urban development pressure.
Gracia, A. *et al.* (2004). *Estudios Agrosociales y Pesqueros*	Zaragoza, Spain	Log-linear	0.70-0.85	Crop type, area, soil quality, slope, altitude, urban proximity	No €/m^3 value estimated, but irrigation regime is significant	Legal water access, electrical availability, and urban potential influence agricultural land valuation.

Source/Fuente: our elaboration/elaboración propia.

Author(s) / Year / Journal	**City / Study Area**	**Model Functional Form**	**R^2**	**Key Significant Variables**	**Marginal Contribution of Irrigation Water**	**Main Conclusions**
Sardaro, R. *et al.* (2020b). *Land Use Policy*	Southern Italy, Provinces of Foggia and Bari	Linear	0.72	Access to irrigation water, rural infrastructure, proximity to urban centres, crop type, active territorial development policies	Access to irrigation increases land value by approximately 15% to 20%, depending on crop type and geographic area	Rural land markets reflect territorial, environmental, and productive dimensions, while pricing is strongly influenced by development policies and irrigation access
Caballer, V. & Guadalajara, N. (2005). *Estudios Agrosociales*	Spain	Log-linear	0.74	Area, yield, land quality, frost risk, location, tourism, climate	"Irrigation water" increases price by ~63%	Area, yield, location, and climate explain land value and profitability; models applicable to farmland valuation.
Díaz Visquerra, M. *et al.* (2014). *CEPAL Review*	Guatemala (14 departments)	Reduced log-linear	0.79	Area, distance to municipal centre, road infrastructure, natural region	Water value not estimated	Price per hectare depends on physiographic location, size, and road accessibility; useful for rural financing.
Decimavilla, E. & Sperlich, S. (2008). *Agricultural Economics Review*	Spain	Log-linear	0.68	Soil quality, property size, land slope, irrigation water, distance to regional capital	Irrigation water (dummy), acting as a speculative factor that increases land value in urbanized areas	Identifies speculative pressure. The methodology is useful for land-use planning and agricultural land management policies
Berbel, J. & Mesa, P. (2007). *Economía Agraria y Recursos Naturales*	Guadalquivir Basin, Spain	Quasi-hedonic method	R^2 not reported	Price differentials by crop and region	Water capital ~€3.46/m^3; water rental value €0.14-0.35/m^3 depending on rate	Water is a key determinant; capital and rental water values estimated based on capitalization rates.
Tauro, E. *et al.* (2024). Italian *Review of Agricultural Economics*	Apulia region, Italy (olive groves)	Log-linear (Hedonic model using FADN data)	0.78 (Model 1)	Type of irrigation service, irrigated surface area, irrigation volume, plant density, slope, altitude	Self-supply service premium ≈ 41% higher land value compared to collective service (e^β - 1 ≈ 0.4125)	The type and reliability of irrigation service (self-supply vs collective) is capitalised into land value; self-supply lands achieve higher values.

Source/Fuente: own elaboration/elaboración propia.

Table 2. Spatial and geostatistical model applications with irrigation and environmental variables.
Tabla 2. Aplicaciones de modelos espaciales y geoestadísticos con variables de riego y ambientales.

Author (Year)	Study Area	Crop Analysed	Model Applied	R^2	Significant Variables	Main Conclusions
Yoo, J. *et al.* (2013)	Phoenix, Arizona, USA (semi-arid urbanizing area)	Farmland (151 transactions between 2001-2005)	Semi-log hedonic (OLS with robust errors)	0.3734 (M1) - 0.4819 (M3)	Water rights (+), land size (–), slope (-), distance to highways (–), % developed land (DEV3000), interactions water×DEV3000 (+) and water×city (+ Phoenix/Mesa; - Buckeye)	Water rights increase prices by 28% to 87%. Higher willingness to pay in urbanized and developed land areas.
Mukherjee, M. & Schwabe, K. (2014)	Central Valley, California, USA (629 plots, 2004-2010)	Irrigated agriculture	Log-log (General Spatial Model - GSM)	0.949 (M1) - 0.951 (M2)	Groundwater depth (+ with salinity), salinity (–), depth×salinity, orchards/ vineyards (+), distance to cities (–), population density (+), Storie index (+), precipitation, CVP water supply (mean +, variability -)	Salinity is critical and omission leads to bias. Proximity to saline water tables reduces value. Projected salinity increases imply significant damages.
Lehn, F. & Bahrs, E. (2018)	North Rhine-Westphalia, Germany (municipal data 2013)	Arable land	Linear (General Spatial Model – GSM)	0.4819 (Adj. R^2)	Spatial lags (+), change in used agricultural area (-), population density (+), population change (+), distance to major cities (+), livestock density (+), agri-environmental payments (-), farm size (U-shaped)	Urbanization and livestock drive prices. Fiscal regulation can reinforce increases. Spatial spillover effects amplify local impacts.
Huang, H. *et al.* (2006)	Illinois, USA (data 1979-1999)	Farmland	Log-log with spatial lag and AR(1) errors	0.798 (OLS) - 0.854 (ML)	Soil productivity (+), parcel size (-), quality (improvement +), distance to Chicago (-, highly influential), other cities (-), rural-urban code (-), lagged CPI (-), population density (+), per capita income (+), hog farm density (-)	Values show spatial and temporal correlation. Non-productive factors also matter. Hog farms negatively impact value; larger scale mitigates diseconomies.
Córdoba, M. *et al.* (2021b)	Córdoba Province (Argentina)	Mixed cropping (soybean, maize, wheat)	sQRF (Spatial Quantile Regression Forest)	0.73	Soil productivity index, appraisal zones, crop types, lease, distance to port	sQRF achieves high precision, captures complex spatial relationships, and outperforms linear regression and kriging. Generates digital valuation maps with uncertainty.
Kostov, P. (2009)	Northern Ireland	General agriculture (grazing, dairy)	Semiparametric additive hedonic (Bayesian via MCMC)	Not reported	Soil quality, drainage capacity, cattle density, distance to urban area, road access	Semiparametric models avoid functional form bias. No significant spatial dependence detected, nonlinear effects prevail.

Source/Fuente: our elaboration/elaboración propia.

Author (Year)	Study Area	Crop Analysed	Model Applied	R^2	Significant Variables	Main Conclusions
Mallios, Z. *et al.* (2009)	Municipality of Moudania, Chalkidiki region, Greece	Olive trees (70% of the irrigated area), fruit trees and vegetables	Log-Linear, three variants: OLS, SLM, SEM	OLS: 0.7141 SLM: 0.7389 SEM: 0.7774	Irrigation (dummy), elevation, plot area, distance to key features (sea, settlements, urban center, local and national roads), presence of olive trees	Irrigated land significantly increases value (105.07%), with SEM and GIS enhancing spatial valuation accuracy over OLS.
Zhang, J., & Brown, C. (2018)	Inner Mongolia Autonomous Region, China	Pastures (circulation of grazing rights)	OLS, Pseudo R^2 in quantile regressions, Moran I	OLS: 0.3929, Pseudo R^2: 0.2570 and 0.2650	Type of pasture, Land area, Irrigation condition, Distance to national highway, Contract type, Local per capita income, Contract term	Irrigation raises land prices by up to 30%, with locally driven, segment-specific effects and no spatial autocorrelation.
Demetriou, D. (2015)	Land consolidation area in Choirokoitia, Larnaca District, Cyprus, Greece	Citrus, olives, various fruit trees, and cereals	Linear, GIS environment for automated valuation	0.799	Negative: parcel size, slope, proximity to a stream, and distance from residential zones. Positive: access via registered roads, irrigation rights, and parcel orientation	The AVM approach reduced valuation time and cost (80%). High levels of accuracy and reliability (only a 15% sample of land parcels).
Guadalajara, N. *et al.* (2019)	Aragón, Spain (municipal data 2017)	Agricultural land (almonds, vineyards, fruits, grasslands, etc.)	Log-linear (SLM and SEM)	0.9510 (OLS) - 0.9610 (SEM)	Irrigation availability (+, 2.2×), parcel size (+, 5.7% per ha), income (+), population (+), density (+), average age (- for vineyards), cadastral value (+), natural reserves (+, 11-12.9%), altitude (mixed effects)	Spatial models outperform OLS. Both agricultural and non-agricultural factors matter. Larger parcels increase value (mechanization effect). Heteroskedasticity suggests omitted variables.
Giuffrida, L. *et al.* (2023).	Upper Treviso plain, Veneto region, Northern Italy	Arable crops (84.4%) and vineyards (11.8%)	Spatial Lag of X (SLX) Model – Generalised Spatial Two-Stage Least Squares (GS2SLS); comparison with OLS	0.483 (OLS) – 0.508 (SLX)	Soil permeability (+), distance to urban centres (–), low flood risk (+), airport and power line restrictions (–), corporate buyers (+ 25–43 %), professional farmers (+ 14.9 %), sales between relatives (– 19 %)	Spatial regression identifies direct and spillover effects: farmland prices increase near urban centres and low risk areas and decrease with easements. Buyer type and corporate ownership strongly influence price formation, with the SLX model outperforming OLS in capturing local spatial effects.

Source/Fuente: own elaboration/elaboración propia.

Table 2 (page 232-233) summarises recent studies that incorporate spatial econometric and geostatistical techniques into the hedonic valuation of agricultural land. These approaches enable a more accurate representation of spatial dependence, neighbourhood interactions, and environmental heterogeneity.

The findings highlight that land values are influenced not only by irrigation availability but also by spatially structured factors such as soil productivity, proximity to markets and urban centres, accessibility, and exposure to environmental risks. Spatial models-including SLM, SEM, GSM, and SLX-consistently outperform traditional OLS specifications, providing improved model fit and capturing both direct and spillover effects in farmland price formation.

Overall, most studies employ log-linear or log-log functional forms, with R^2 values typically ranging from 0.60 to 0.79, and only a few models reaching higher explanatory levels between 0.89 and 0.95. Classical hedonic models estimated through OLS or mixed-effects approaches (table 1, page 230-231) generally achieve higher R^2 values, reflecting well-defined relationships under relatively homogeneous conditions. In contrast, spatial and geostatistical models (table 2, page 232-233) tend to report lower or more moderate R^2 values, as they correct for spatial autocorrelation, account for heterogeneous terrains, and include additional sources of variability that reduce overall fit but enhance model realism and predictive accuracy.

Key predictors include soil quality, farm size, infrastructure, urban proximity, and crop type. Irrigation water-whether expressed as legal rights, technological access, or proximity to canals-consistently shows positive and significant effects on land value. The economic valuation of irrigation water varies across contexts, from US dollars per acre-foot in the United States to euros per cubic metre in Europe, with some studies estimating rental or capitalised values. Collectively, these findings highlight the dual role of water as both a productive input and a territorial asset.

Conclusion

The hedonic pricing method remains a foundational approach in agricultural land valuation, capable of isolating the marginal effects of key attributes such as irrigation water, infrastructure, and crop type. In arid and semi-arid regions such as Mendoza, where water scarcity and land-use pressures converge, understanding these marginal values is critical for sustainable resource management.

Incorporating spatial econometric and geostatistical methods significantly enhances model performance and improves the representation of geographic patterns and contextual complexities. Researchers still face challenges related to data availability, model specification, and the integration of socio-political variables, but the reviewed literature provides a rich basis for further exploration.

Future research should refine these approaches, particularly for developing countries experiencing climatic and demographic transitions. Enhanced data integration, remote sensing, and open-source GIS tools may offer promising avenues for more dynamic and granular valuations.

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