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# A HEDONIC ANALYSIS OF AGRICULTURAL LAND PRICES IN PAKISTAN'S PESHAWAR DISTRICT

**Salman Khan, Ghaffar Ali, Syed Attaullah Shah, Abbas Ullah Jan, Dawood Jan and M. Fayaz**
Department of Agricultural & Applied Economics, The University of Agriculture Peshawar, KPK (25000), Pakistan

**Abstract**
This study investigates determinants for agricultural land prices in Peshawar district of Pakistan. A linear hedonic model is used to analyze data set on sale prices of agricultural land parcels and their agricultural, location and environmental characteristics. Results show that agricultural land price is affected positively by soil fertility, amount of irrigation water and closeness to agricultural market. Among location characteristics, distance to city, distance to main road and distance to nearest houses have significant effects on land prices. Agricultural land located closer to city, main road or houses has significantly higher price compared to a more distant land. Environmental degradation such as polluted freshwater bodies has negative effect on nearby agricultural land prices. Based on these findings and review of relevant literature, the study recommends government intervention for conservation of agricultural land, investment in developing agricultural infrastructure such as dams, irrigation canals, roads, transport, agricultural markets, etc., and provision of subsidized fertilizers and other inputs to increase farmers' returns and change their perception to favour using their land for agriculture.

**Keyword:** Hedonic analysis, agricultural land prices, urbanization, Peshawar, Pakistan, agricultural land loss, agricultural, location and environmental characteristics, spatial autocorrelation

## 1. INTRODUCTION

Land is an important natural resource, used as an input factor in economic activities, such as agricultural, forestry, industrial, residential and commercial uses. The economic allocation of land depends on returns from these alternative uses. Land is utilized for that alternative generating maximum return. However, in agricultural based economies such allocation of land could threaten food security if agricultural sector is not performing well. Rapid increase in human population and urbanization in most of the Asian countries have resulted utilization of agricultural land for residential and commercial uses (Ghaffar, 2015; Govindaprasad and Manikandan, 2014; Samiullah, 2013; Azadi *et al.*, 2010). In Pakistan total cultivated farmland has increased by 11 million hectares since 1947 (GoP, 2015). Despite this expansion, loss in agricultural land was also observed in many parts of the country, specifically, the Khyber Pakhtoonkwa province (KPK). Agricultural land in KPK has been reduced from 2.10 million hectares in 1996-2000 to 1.78 million hectares in 2010-14 (GoP, 2015). This loss is around 15 percent of the total land in 1996, and with this rate around 50 percent of the land will be lost in the next five decades. The loss of agricultural land could reduce

Corresponding author's
Name: Syed Attaullah Shah
Email address: syedshah313@gmail.com

domestic food production and could threaten national food security in future. In this scenario, the study of determinants of agricultural land prices could help in designing sound policies for agricultural land conservation.

According to Drescher *et al.* (2001) "understanding the determinants of land prices could provide policy makers with information to guide the development of land use management tools that balance need for agricultural land resources and economic growth". In the beginning, the theories of David Ricardo and Von Thunen laid the foundation of agricultural land price and are still used in current research. Ricardian land model explain the existence of land rents from differences in fertility/ land qualities. Von Thunen's model uses location of agricultural land to cities, agricultural market and transportation costs for explaining land prices. Then the bid rent theory was developed in the context of urban land uses and urban land values (see for example Mills and Hamilton, 1994). Agricultural land is utilized for residential or commercial use if their bid is higher than the bid of agriculture. This theory better explain why agricultural land is utilized for alternative uses, such as residential or commercial uses, and why its price raises.

Land has special characteristics compared to other inputs: Its supply is fixed, has a fixed location, and its use affects the use and value of surrounding parcels (Koomen and Buurman, 2000). Also, each parcel of land is different from others in their agricultural, location and environmental characteristics. Information about society's preferences and willingness to pay for land characteristics play important role in its allocation for alternative uses. At aggregate level, society's behavior within the land market help in formulation of urban and rural planning. The main objective of this study is to use hedonic analysis to investigate determinants for agricultural land prices in Peshawar district of KPK.

Hedonic pricing model (HPM) is popular among economists for the study of land prices. It is also a powerful tool, used by environmental economists, for measuring the value of freshwater and air pollution (O'Donoghue *et al.*, 2015). HPM decomposes a land parcel into its characteristics and assumes that implicit markets for land attributes combine to form price for the land. The implicit price for a characteristic can be assessed within a parcel's entire sale price because market for individual characteristic does not actually exist. According to Freeman (1979), land corresponds to a class of products differentiated by their structural, neighbourhood and environmental characteristics. This creates hedonic hypothesis that each good (parcel of land) is considered a bundle of characteristics, and its price depends on those characteristics. Agricultural economists are also familiar with HPM. A number of studies have used HPM to examine determinants of agricultural land prices (Kostov, 2009; Guiling *et al.*, 2009; Plantinga *et al.*, 2002; Ready and Abdalla, 2005; Maddison, 2000; are few of them); however, such studies are rare in Pakistan. So, this research work is important one from that point of view. Results from this study have important implications for designing policies for improvement in agricultural land productivity and conservation.

The reminder of this paper is organized as follow. Section 2 discusses the methodology; section 3 present results from data analysis; and section 4 make conclusion and policy recommendations.

## 2. METHODOLOGY

### 2.1. Sampling of the study area

Peshawar, the capital of KPK, is located in the north-west of Pakistan, close to the Pak-Afghan border. The total area of the district is 1,257 kilometres square and estimated human population is more than 4 million[1] (2015). During the past two decades increased human population consumed

[1] Estimated based on total population (2.983 million) and growth rate (3.26 percent) figures in 1998 Census Report

around 8,748 hectares of farmland, mostly for residential uses (Khan, 2015; Samiullah, 2013). This loss in agricultural land could threaten our national food security in future (Khan, 2015).

**Figure 1: Peshawar city and surrounding villages**

For selection of agricultural land parcels for data collection, Peshawar district is divided into 5 different parts[2] and then north-western part is purposively selected where urban encroachment into agricultural land is alarming. Agricultural farms in the selected area are irrigated by Kabul River and are famous for production of wheat, corn, sugarcane and vegetable crops. The north-western part is further divided into different villages and then based on distance from Peshawar city (main G.T. road) the following four villages are randomly selected: (1) Lalazar colony; (2) Palosai; (3) Lakari; and (4) Darmangi.

## 2.2. Data collection

The most difficult part is collection of accurate and reliable data on land sales. The only source is the land transaction records with property dealers. Thus for real sale prices of agricultural land transaction records with local property dealers are utilized for the period 2013-15. In total, 142 agricultural land parcels[3] records are obtained. Data on other important variables are collected through field visits, use of geospatial technology (Google earth, 2015) and discussion with local people.

## 2.3. Hedonic analysis

The hedonic analysis for land pricing is conducted in two stages. First, the hedonic pricing model is estimated by regressing land sale prices over different characteristics. Then in the next stage, the

[2] Town 1, Town 2, Town 3, Town 4 and Peshawar Cantt. Twon-3 was selected purposively.

[3] Transactions record of 34 land parcels from Lalazar area, located at a distance of 3000 meters from G.T. road Peshawar city; 36 from Palosai, located at a distance of 10000 meters from G.T. road; 28 from Lakari, located at a distance of 12000 meters from G.T. road; and 44 from Darmangi, located at a distance of 5000 meters from G.T. road.

estimated model in the first-stage is used to derive the marginal willingness to pay (MWTP) function for a land characteristic. This study is limited to the first stage only.

We structured our hedonic pricing model for agricultural land prices based on land theories, empirical studies and ground realities. In general form, the model is specified as;

$$P_{hi} = f(P_i, Ni, Qi) \quad \text{.........................} (1)$$

Where $P_{hi}$ is the agricultural land price per 25.29 square meters[4] (marla), $P_i$, $N_i$ and $Q_i$ represent the agricultural, location and environmental attributes for the $i^{th}$ agricultural land.

Most empirical studies on HPM used agricultural and non-agricultural factors, such as rents derived from crops and livestock production, farm location, population density, infrastructure, and urban access. For this study, variables are selected based on land theories, empirical studies and current scenario of urbanization pressure with associated environmental problems (air and water pollution). A list of those variables is provided in table 1. Variables such as government tax on agricultural land, village population and per capita income are almost same across selected villages and that's why are not included in the model.

By differentiating this function with respect to a characteristic 'j', one could derive the society's marginal willingness to pay (MWTP) for that characteristic.

$$MWTP = \frac{\partial P_{hi}}{\partial x_{ij}} \quad \text{..................} (2)$$

Hedonic price functions can take on a number of different functional forms, such as linear, semi-log, double-log or quadratic. As the main objective of this study is to identify important determinants of agricultural land prices for policy recommendation and not to derive the MWTP for different characteristics, a linear functional form is used. Linear HPM is the simplest of all functional forms in terms of coefficients interpretation. However, society's MWTP for a land characteristic diminishes with its use; the linear model has the disadvantage of misrepresenting it.

## 3. RESULTS

### 3.1. Summary statistics

In the study area, average farm size is 2.5 acres and average adjusted sale price is Rs.185352 per 25.29 square meters (marla). There are more than 1000 houses per village with average household size of 8 individuals and average area of 10 marlas.

Summary statistics on agricultural, location and environmental characteristics of selected land parcels are provided in table 1. Agricultural characteristics are soil fertility, irrigation facility, type of irrigation facility and quantity of irrigation water. The table shows that 70 percent of the land parcels are fertile and suitable for intensive production of wheat, sugarcane, maize, rice and vegetable crops[5]. All land parcels have canal water facility for irrigation and the average distance from main irrigation canal is 1127 meters (m). Kabul River is the main source of water supply to canal system. Descriptive statistics for location characteristics show that 50 percent of the land parcels are located within 5000m to Peshawar city, 24 percent are within 6000 m to farm market and 50 percent are within 200m to nearest property (houses). These parcels are located at an average distance of 530 m from a main road.

[4] 25.29 square meters, locally called a marla, is a land measuring unit widely used in study area.
[5] Tomato, onion, peas, potato, turnip, cauliflower, spinach, etc.

**Table 1: Summary statistics**

| Variable | Mean | Std. Dev. |
|---|---|---|
| Price per 25.29 meter square land parcel | 185352.10 | 174996.10 |
| Soil fertility | 0.70 | 0.46 |
| Distance to main road (meters) | 530.00 | 274.00 |
| Distance to irrigation canal (meters) | 1127.46 | 884.47 |
| Distance to city centroid (= 1 if less than 6000 meters) | 0.50 | 0.50 |
| Distance to farm market (= 1 if less than 5000 meters) | 0.24 | 0.43 |
| Property within 200 meters | 0.50 | 0.50 |
| Distance to polluted stream (meters) | 390.14 | 229.19 |

**Source:** Survey data, 2013-2015

In western Peshawar air and water pollution are serious threats to local human population. Field visits confirmed around 100 industries in western Peshawar and most of them were releasing chemical pollutants into Hayatabad stream. The stream flows towards north and drains main settled areas of the north-western Peshawar (Khan, 2015). Major concern for local communities is the impact of polluted water on nearby residents. Agricultural land parcels and houses located close to polluted stream have comparatively low prices (Khan, 2015). That's why distance from polluted stream is used as a price determining factor for agricultural land parcels. The table shows that the average distance of selected land parcels from polluted stream is 390 m.


**Figure 2: Areal images of the selected villages**

**Source:** Google Earth Images (2015)

### 3.2. Post estimation diagnostic tests

Ordinary least square (OLS) estimation approach is used to estimate the linear hedonic pricing model. Before using the estimated results for policy recommendations, post estimation diagnostic tests are conducted to check for multicollinearity and hetroscadasticity problems. Variance inflation factor (VIF) test is conducted to check for multicollinearity. The given table shows that mean VIF value is 2.30. This means that there is no multicollinearity problem in the estimated model. A Breusch-Pagan test is used for detection of heteroscadasticity problem. The chi square ($\chi^2$) value is 0.12 and the *p* value is 0.724. The *p* value indicates the probability of rejecting the presence of heteroscadastic variance of the error term. The value of 0.724 means the probability of rejecting the presence of heteroscadasticity problem is 72 percent. Thus there is no hetroscadasticity problem.

Tests are conducted to check for spatial autocorrelation problem in the estimated model. Spatial autocorrelation refers to the positive or negative correlation of observations based on proximity to other observations. This interconnection is a direct result of Tobler's (1970) first law of geography that states "everything is related to everything else, but near things are more related than distant things." The existence of spatial autocorrelation does not provide minimum-variance unbiased linear estimators.

There are two types of spatial autocorrelation spatial error dependence and spatial lag dependence. The first refers to the correlated errors that occur among the independent variables. It is also called spatial heteroscedasticity. The second refers to the correlated errors that occur between the dependent variables. It can be said to be true spatial autocorrelation. LM and Robust LM tests are used to check for both types of spatial autocorrelation problem. Results show that LM and Robust LM statistics are insignificant for spatial error and spatial lag dependence within 10000 meters range (see Table 2).

**Table 2: Post estimation diagnostic tests**

| Problems | Diagnostic tests | Results | |
|---|---|---|---|
| | | Statistic | P-value |
| Multicollinearity | VIF test | Mean VIF = 2.230 | - |
| Hetroscadasticity | Breusch-Pagan test | $\chi^2$ = 0.12 | 0.724 |
| Spatial error dependence | Lagrange multiplier | LM = 0.269 | 0.604 |
| | Robust Lagrange multiplier | RLM = 0.364 | 0.546 |
| Spatial lag dependence | Lagrange multiplier | LM = 0.001 | 0.978 |
| | Robust Lagrange multiplier | RLM = 0.096 | 0.757 |

**Source:** Survey data (2015)

### 3.3. OLS estimated results

OLS estimated results for HPM are given in Table 3. Results show that coefficients for variables that describe location of agricultural land have the expected signs and are statistically significant. The coefficient value for property within 200 meters is 7853.97 and is statistically significant at 10 percent level of significance. The positive coefficient value implies that holding other characteristics constant the price of an agricultural parcel would be higher by Rs.7854 if located within 200 meters to nearest property. Distance from main road has a negative significant coefficient. The coefficient value of -227.13 indicates that holding other variables constant, the price per marla for agricultural land would decrease by Rs. 227 with increase in distance from main road by 1 meter. It shows that agricultural land located near a main road has higher price compared to one located faraway. Agricultural land near an urban area is expected to have higher price as compared to one located in a faraway rural area. The estimated coefficient value for this variable is positive and is statistically significant. The coefficient value of 96103.15 indicates that holding other characteristics constant, the price per marla for an agricultural land located within 5000 meter to Peshawar city would be greater by Rs. 96103 compared to one located more than 5 km way from Peshawar city. This indirectly shows the urbanization which leads to increase in land demand for residential and commercial uses has indirect positive effect on agricultural land prices. The closer an agricultural land to a market, lesser will be the transportation cost on agricultural produce and more will be the return. This increase in net return appears in land prices. Result shows that the coefficient for this variable is positive and statistically significant. The value of 51657.42 indicates that holding other characteristics constant, the price per marla for an agricultural land would be greater by Rs. 51657 than the agricultural lands located more than 5Km away from a market.

Agricultural characteristic is judged with land potential to produce crops and vegetables. Similarly, distance from main irrigation canal in meters is used as a proxy variable for availability of irrigation water. Results show that the coefficient for soil fertility is positive and statistically significant. The coefficient value of 72446.15 indicates that holding other characteristics constant, the price per marla for a fertile agricultural land would be greater than a less fertile land by Rs. 72446. The coefficient for distance from irrigation canal is negative and statistically significant. The negative sign indicates that agricultural land price decreases by around Rs. 37 with increase in distance from main irrigation canal by one meter.

Agricultural fields are used for various recreational activities. Environmental degradation, such as polluted freshwater bodies, prevents such outdoor recreational activities on nearby agricultural land and its cost appears as loss in value of those nearby parcels. Thus a positive and significant relationship is expected between distance from polluted stream and agricultural land price. Greater the distance from the polluted stream, greater will be it's per marla price. The table shows a coefficient of 124.07 and is statistically significant with a p-value of 0.000. The coefficient value indicates that price per marla of agricultural land would increase by Rs.124 with increase in distance from polluted stream by 1 meter.

**Table 3: Estimated hedonic pricing model**

| Land value per 25.29 square meters (Marla) | Coefficient | t-value | P-value |
|---|---|---|---|
| Location characteristics: | | | |
| Property within 200m (1 if yes, otherwise 0) | 7853.97 | 1.97 | 0.052 |
| Distance from main road (meters) | -227.13 | -6.34 | 0.000 |
| City within 5 km (1 if yes, otherwise 0) | 96103.15 | 5.76 | 0.000 |
| Agricultural characteristics: | | | |
| Distance from irrigation canal (meters) | -36.75 | -3.84 | 0.000 |
| Soil fertility (1 for fertile soil otherwise 0) | 72446.15 | 5.76 | 0.000 |
| Market within 5km (1 if yes, otherwise 0) | 51657.42 | 2.00 | 0.050 |
| Environmental characteristics: | | | |
| Distance from polluted stream (m) | 124.07 | 4.22 | 0.000 |
| Constant | 187012.80 | 4.94 | 0.000 |

*$R^2$ = 0.82 F statistic (p-value) = 92.72 (0.000) m = meter km = kilometers*

## 4. CONCLUSION AND POLICY RECOMMENDATIONS

Understanding the determinants of land prices provide policy makers with information to design policies for improvement in agricultural land's productivity and conservation. The main objective of this study is to use hedonic analysis to investigate determinants for agricultural land prices in Peshawar district of KPK. Factors which increase agricultural land productivity also indirectly increase the price of land. Results from hedonic analysis show that agricultural characteristics such as soil fertility, sufficiency of canal water for irrigation and closeness to an agricultural market have positive effects on agricultural land prices.

In the study area urbanization and population pressure has resulted residential and commercial encroachment on agricultural land. This loss in agricultural land could reduce domestic food production in future. Agricultural land located closer to a city, highway or houses has potential for residential and commercial uses. The pressure of urbanization has the potential to raise the market value of agricultural lands. Findings from hedonic analysis of agricultural land prices show that agricultural land located closer to city, highway or houses has significantly higher price compared to a more distant land.

The hedonic analysis also investigates for the effect of environmental degradation on agricultural land prices. Results show that proximity to polluted Hayatabad stream has negative effect on agricultural land prices. Local people use agricultural fields for different recreational activities. Pollution prevents such outdoor recreational activities on nearby agricultural land and the cost appears as loss in prices of nearby fields.

Based on these findings the study recommends government intervention for;

- Regulation of land market through laws and taxes that could favor conservation of agricultural land. There is no law to restrict construction on agricultural land in KPK.
- Investment in development of agricultural infrastructure such as irrigation canal, roads, transport, agricultural markets, etc. and provision of subsidized fertilizers and other inputs to farming community to directly or indirectly raise their returns from agriculture and change their perception to favor using land for agriculture.
- Control over informal and illegal residential settlement and the implementation of technology based pollution control policy for industrial units to control the problem of air and water pollution in the urban area and the spillover of negative effects to adjacent rural areas.



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