University of Idaho
College of Agricultural and Life Sciences

Department of Agricultural Economics and Rural Sociology

# DETERMINING THE EFFECTS OF LAND CHARACTERISTICS ON FARMLAND VALUES IN SOUTH-CENTRAL IDAHO

**by**

**Orestes Vasquez, Khaliela S. Wright, James R. Nelson, and Joel R. Hamilton***

**Department of Agricultural Economics and Rural Sociology**
**University of Idaho**

**Paper presented**
**in**
***WAEA Land Value Economics Session***

**At**

**2002 AAEA – WAEA Annual Meeting, Long Beach, CA, July 2002**

**A.E. Research Series No. 02-05**

**Departmental Working Paper Series**

***Vasquez is a former Graduate Research Assistant, Wright is a Graduate Research Assistant, Nelson and Hamilton are both Professors,**

**College of Agricultural and Life Sciences**
**University of Idaho**
**Moscow, ID 83843-2334**

# DETERMINING THE EFFECTS OF LAND CHARACTERISTICS ON FARMLAND VALUES IN SOUTH-CENTRAL IDAHO


## Abstract

This study focused on evaluating the effects of different attributes that impact irrigated farmland values in South-central Idaho. Results indicate that study area farmland values are largely determined by agricultural productivity (profitability) related factors. However, estimated "development increment values" for parcels that seemed to be under development pressure in the study area are explainable by nonagricultural variables.


## Introduction

Historically Idaho's economy has been driven by the utilization of land for agriculture or other industries driven by natural resources. Consequently, the value of land was dependent on its usefulness in the production of a commodity. As population increases, the demand for land-based amenities grows. This results in a substantial conversion of land from agricultural uses to non-agricultural uses.

In this study, regression techniques were used to try to establish and evaluate determinants that affect irrigated cropland values in South-central Idaho. In addition, income multipliers were used to identify farmland parcels that are under development pressure, and to partition the values of such parcels into agricultural values and development increment values. Such information will be useful to lenders, appraisers, policymakers, investors and farmers as they strive to understand how different attributes are responsible for shifts in market equilibrium prices for farmland when changes in economic, political and social environments occur.

## Literature Review

Assessing land values is a task that has been approached many ways by investigators. One simple and highly effective approach uses mail-in surveys of participants in land transaction and valuation activities. Surveyed market participants generally include appraisers, loan officers, government assessors, investors and producers (Texas Chapter ASFMRA, 1999; Janssen and Pflueger, 1998). While such studies provide very useful descriptions of land values in particular areas, they lack the scientific rigor to actually determine which attributes affect changes in land values, and the effects they have on land values.

Other lines of study have focused on the discounted cash flows of future cash streams from farmland investments (Elad, et al., 1994; and FAO, 1997). The proper valuation of land tracts is a measure of the productive capabilities they have to offer. A financial asset's market value is the capitalization of the present value of its income generating potential (Bodie, et al., 1998). According to FAO and Elad, this is an arbitrary measure due to market imperfections, especially the reaction of market protagonists to their expectations of future cash flows (development, amenities, etc).

Regression models have been used to evaluate the effects of both agricultural productivity variables and of environmental and amenity or development related variables on values of farmland. Taylor (1991) found that price for non-irrigated wheat land in Phillips County, Colorado depended on two attributes, soil quality and number of acres in a transaction. McLeod, et al. (1999) found that variables such as scenic view, elk habitat and fishery productivity were statistically significant in determining land values in Wyoming. Xu, et al. (1993) found that individual characteristics especially land improvements, are significant determinants of land values in Washington State. Boisvert, et al. (1997) found that productivity, spatial orientation and environmental vulnerability affect land values.        .

Torell and Bailey (2000) used regression to analyze the effects of different attributes on the value of New Mexico ranches. They found that using a discount rate of 7 percent, only 27 percent of the market value of large northeast New Mexico ranches was justified by returns on livestock. They also found that smaller ranches had a distinct market since only 16 percent of the market value could be explained by livestock returns. They concluded that smaller parcels are more influenced by nonagricultural factors than larger parcels, therefore distinct markets exist for different tract sizes. Faux and Perry (1999) encountered a similar situation when using hedonic modeling in assessing irrigated water value in Malheur County, Oregon. They found that more expensive land has a greater number and a greater variety of attributes leading to greater variance in price of a tract.

The concept of using income multipliers to estimate land values can be traced back as far as 1740 in an article written by Thomas Miles. In his book, *The Concise Practical Measurer; or a Plain Guide to Gentlemen Builders*, he states that to estimate the present value of the land, the rent should be multiplied by a specified number of years.

Although the concept has evolved over time, its use has remained as a unit of comparison across sales with similar characteristics. Appraisers commonly use income multipliers to compare properties with regular and constant returns (especially rental housing and commercial buildings). They generally define income multipliers as the ratio between the sale price of a property and its effective gross income (Appraisal Institute, 1996). However, although income multipliers have been used extensively in the appraisal field as a tool for valuing real property, due to their conceptual simplicity they have received little academic attention (Boykin, 1994).

Income multipliers have been criticized for failure to account for the remaining economic life of comparable properties. This is a legitimate criticism if buildings of different ages are being appraised, but it is not a relevant criticism relative to valuing land (with life into perpetuity).

Boykin (1994) established a relationship between Price earnings ratio (P/E ratio), used to value a particular stock, and the income multiplier as a unit to value real estate. Many investors use P/E ratios as good benchmarks to value securities. The advantage of the P/E ratio is the simplicity of its application and the availability of information. He concluded that the same could apply to income multipliers as a simple and direct method of valuing real estate.

Ratcliff (1971) cites a University of California study in which 84 income property appraisal reports were prepared, with a comment that, if the appraisers would have only used the income multipliers for their final values they would have been within 1% of the appraised values. Another study cited by Ratcliff (1971) is of 385 sales in the Vancouver, British Columbia metropolitan area. He used income multipliers to predict sale prices for different types of properties and compared the predicted sale prices with the actual sale prices. He found that the differences ranged from 4 to 8 percent. He concluded that income multipliers are good predictors because they are market derived and do not rely on personal judgment. If decisions of market participants are based on the same variables, then income multipliers of similar properties will have the same ratios. Also, he pointed out that, usually, future sales reflect past market activity, and income multipliers modify themselves over time.

## Study area and data

In the study reported herein, the authors used data from Farm Credit Services (FCS) on 453 sales of irrigated cropland in a 75 miles (east to west) by 40 miles (north to south) area in South-central Idaho (Figure 1) to evaluate irrigated cropland values. This region of southern Idaho is commonly known as the Magic Valley. The Snake River flows through the region from east to west, and is the primary source of the region's irrigation water. Within the region there are approximately 988 thousand acres of highly productive irrigated cropland, some irrigated pastureland, and quite a lot of dry, high desert range. Major crops in the Magic Valley are potatoes, sugar beets, wheat, dry beans, alfalfa and corn (mostly for silage) (Idaho Agricultural Statistics Service, 2000).

The data analyzed for this study included information on sale prices of the tracts sold, on dates of sale (year and month), on types of irrigation systems on tracts, and on tract-locations, sizes and rents. With the help of geographical information system (GIS) specialists at the University of Idaho, more data were gathered. These were locational and aesthetic attributes of parcels, including distances to towns in the area, distances to major road systems, presence of water bodies on or near tracts, estimated slopes of tracts, estimated elevations of tracts and estimated productivity of soils present in tracts.

Data were gathered from the 2000 US Census on some socioeconomic variables for the study area counties. These variables were: population, median family income and population density.

A list of variables that were used in this study is presented in Table1. The dependent variable Salepr is the price paid for each tract of land. Any values of improvements were excluded from these prices.

## Methods and Results

### Regressions on Total Value of Farmland

An initial regression was run using all of the data. It was further broken down by parcel size. Theoretically, values of smaller parcels are affected differently by attributes than are values of larger parcels (Torrel and Bailey, 2000). Therefore a Chow test was implemented to determine the appropriate tract size at which the database could be divided. The tracts were divided by size (less than and greater than 40 acres, 60 acres and 80 acres respectively). These categories were used as the basis for the unconstrained models while using the runs of the entire database as the basis for the constrained model. The Chow test revealed that the data could be broken into parcels of greater and less than 80 acres. The test resulted in an F value of 5.46, which led to the rejection of the null hypothesis that the different tract sizes belong to the same market.

Breaking down the data also resulted in the elimination of heteroskedasticity. Again theory suggests that larger parcels have larger variances in price than smaller parcels (Xu, et.al., 1993; Torrel and Bailey, 2000). Tests of first and second moment specification were used to determine the presence of heteroskedasticity in the database. It tests a joint null hypothesis that indicates that errors are homoskedastic, the errors are independent of the regressors and the model is correctly specified. This test was presented by White in the May, 1980 issue of *Econometrica*. For the model that included all the areas, the null hypothesis of no heteroskedasticity was rejected at a significance level of less than .001. However, for the less than and greater than 80 acres models, the null hypothesis could not be rejected at a significance level of 0.10. Based on the results of the Chow test and the test for heteroskedasticity, the model that included all tract sizes was dropped and the less than and greater than 80 acre models were used in the analysis.

Table 2 shows the results obtained from running the regressions for the less than and greater than 80 acres models. Variables that were not significant were dropped from each of the models. The fit of the greater than 80 acres model was higher (0.91) than the fit of the less than 80 acres model (0.51).

Both models were checked for multicollinearity. In the model for parcels less than 80 acres, the variable "Gooding County" was fairly highly correlated with "Jerome County" (0.75) and with net farm income for the county (0.73). Since Jerome and Gooding counties are dummy variables, their collinearity depends strictly on the size of the sample (Kmenta, 1997), therefore it is not affecting the results. The rest of the variables had low correlations (lower than 0.7). Collinearity does not affect the coefficient's unbiased estimates, but it will lead to biased variance. However eliminating Gooding County or Net farm income variables could cause undesirable consequences leading to a biased estimator. To avoid this probable situation, the variables were kept in the model.

In the model for parcels greater than 80 acres, the variables size and elevation were found to be highly correlated (0.84). The other variables had correlations lower than 0.70. Since both variables were judged to be likely factors affecting farm value, both variables were left in the model to avoid possible biased estimators if eliminated.

Agriculture related variables were important determinants of land value in both models, and variables that are clearly not related to agriculture did not prove to be significant in either of the models. Yet there is clear evidence from observing the "sprawl" in many rural areas of the region that there is development pressure on farmland in the region. Evidently this pressure is not so great as to make the non-agriculture related variables significant in the models discussed above. So these authors attempted to measure development pressure, so that such a measure could be used to partition data on parcels of farmland into those experiencing substantial development pressure and those not experiencing such pressure.

## Partitioning Farmland Values

In a paper presented at the 2001 Pacific Northwest Regional Economic Conference, Nelson and Schumaker made a case for utilizing income multipliers (IM's), defined as the ratio of market value of farmland to gross land rent from agriculture, to quantify the effects of development pressure on farmland values. Farmland values have two components: 1) agricultural value—value due to income producing potential as a result of direct agricultural production, and 2) development value increment which is the difference in actual value of a parcel and its agricultural value. Because agricultural and development uses of land are mutually exclusive, the total value of a parcel must be equal to the total market value (agricultural value + development increment) of the land. Therefore, as development pressure increases, the IM increases, other factors remaining constant.

Income Multipliers (IM) were determined for all of the farmland parcels considered in this research by dividing total sale value of each tract by gross rent of the tract. Regression models were developed, with IM's as dependent variables and the variables presented in Table 1 as independent variables, for all sales parcels, then run iteratively as parcels with low IM's were removed. Goodness of fit of models improved during this iterative process until all tracts with IM's less than 20 were eliminated. IM's less than 20 indicate that agricultural returns to land values are greater than 5% of land value, suggesting that little, if any, of the land value is attributable to development (all is attributable to agriculture). On the other hand, tracts with IM's that are greater than 20 have an additional value that does not seem to be attributable to agriculture. In this case, the influencing factor is likely to be residential or commercial development. A Chow test was run which documented that parcels with IM's greater than 20 are from a different population than those with IM's less than 20.

## Regression Analysis of Development Increment Values for Farmland Parcels with High (>20) Income Multipliers

Regression analysis of development increment values for farmland parcels with high (>20) income multipliers yielded the results shown in Table 3. The model yielded a highly significant F-test, implying an important interaction of the variables in the model.

Not all of the signs of the coefficients were consistent with expectations. Proximity to roads had a positive coefficient. This indicates that development pressure is greater for parcels farther from roads than for those closer to roads, which was not consistent with expectations. However, the roads considered in the model include U.S. highways, state highways and major county connecting roads. There are many other local roads in the study area. Many are paved; most of the rest are gravel roads of very high quality, well maintained and travelable in all seasons. Under these circumstances it seems reasonable that being away from U.S., state and county highways might add desirability to a parcel as a possible location for a rural residence.

Anecdotal evidence (discussions with rural residents) indicates that such residents often prefer to live on a high quality, low traffic local road rather than on a highway where there is more traffic moving at higher speeds. They often made comments about privacy and about dangers to children and pets. Given this information, it is possible that the appropriate sign for close to roads is positive.

In the model, distance to any road is highly correlated with distance to any town. This can be explained by the fact that, since roads lead to towns, and many people desire to live in or near a town, there is a higher occurrence of roads near towns. Because both variables were judged to be likely factors affecting development, they were left in the model to avoid possible biased estimators if eliminated.

This model states that, for an average study area parcel with an IM greater than 20, approximately 17.3% of its value is derived from non-agricultural factors. An increase in the distance of one meter from the nearest road will increase the parcel price by $5.00 or for every kilometer farther away from a road the parcel price will increase by

$5,000.00. On the other hand, an increase of one meter from a population center of 500 persons or more will decrease the parcel price by $1.50 or for every kilometer farther away from town, parcel price decreases $1,500.00.

## Conclusions and Implications

Econometric models were used in this study to determine the effects of different attributes that impact irrigated farmland values in South-central Idaho. Initial results indicate that study area farmland values are largely determined by agricultural productivity (profitability) related factors. However, further results indicate that, in the study area:

- Farmland parcels that are under development pressure can be identified with statistical methods,
- Development increment values (differences in actual values of a parcels and their agricultural values) can be estimated for such parcels, and
- These development increment values can be explained by non-agricultural, amenity based variables.

Agricultural related determinants of values of farmland are well understood and well documented in the literature of agricultural economics. However, development pressure has substantial influence on farmland prices in many areas of the U.S. today, and such pressure is increasing. The results of this study suggest that income multipliers and other coefficients that measure development pressure (possibly ratios of development increment values to total parcel values) can be used to effectively evaluate development pressure on farmland.

Information about determinants of study area farmland values, as discussed in this paper, should be of interest to land owners, appraisers, assessors, real estate brokers and developers in the study area. In addition, information about the impacts of development pressure on farmland, should be especially useful to local government officials and decision makers with nonprofit entities who are working to preserve farmland and agricultural areas by use of such mechanisms as purchasable development rights, transferable development rights and farmland trusts.

More research on evaluating development pressure on farmland is needed, especially to consider whether the ideas and methods presented in this study can be applied effectively in other areas.  The authors of this paper are working on a study similar to the one reported herein for an area of southwestern Idaho that is under much more development pressure than the area considered in this research.

References


Bodie, Z., et al.. *Essentials of Investments*, Third Edition. Irwin McGraw Hill, Boston, 1998, 611p.

Boisvert, R., et al. "Spatial Productivity and Environmental Determinants of Farmland Values." *American Journal of Agricultural Economics*, 79,5 (1997): 1657- 1664.

Boykin, J.H. and M.T. Gray. "The Relevance and Application of the Gross Income Multiplier." The Appraisal Journal. April 1994: 203-208.

Chicoine, D. "Farmland Values at the Urban Fringe: An Analysis of Sale Prices." *Land Economics*, 57,3 (1981): 353-362.

Elad, R. L., et al. "Hedonic Estimation Applied to the Farmland Market." 26,2 (1994):351-366.

FAO. "Agricultural Land Prices." United Nations. New York, June, 1997. http://www.fao.org/sd/LTdirect/LTan0016.htm

Faux, J. and G. Perry. "Estimating Irrigation Water Value Using Hedonic Price Analysis: A Case Study in Malheur County, OR." 75,3(1999): 440- 452

Idaho Agricultural Statistics Service. *Idaho Agricultural Statistics – 2000*. Boise, ID, 2000.

Janssen, L. and Pflueger, B. "South Dakota Agricultural Land Market Trends 1991-1998." C 262, Agricultural Experiment Station, USDA, South Dakota State University, Brookings, South Dakota, June 1998.

Kennedy, G. A., et al. "An Empirical Analysis of the Louisiana Rural Land Market." Bulletin No. 857, Louisiana State University Agricultural Center, Louisiana Agricultural Experiment Station, March 1997, 54 pages.

Kmenta, Jan, *Elements of Econometrics*, Second Edition. University of Michigan Press, Ann Arbor,1997.

McLeod, D.M., et al. "The Contribution of Environmental Amenities to Agricultural Land Values: Hedonic Modeling Using Geographic Information Systems Data." Paper presented at the Western Agricultural Economic Association Meeting, July, 1999.

Miles, Thomas. *The Concise Practical Measurer: or, A Plain Guide to Gentlemen Builders.* Printed for C. Ward and R. Chandler, London, 1740.

Nelson, James R., et al. "Use of Agricultural Land Values and Capitalization Rates (or Income Multipliers) to Evaluate Demand for Farmland Conversion to Nonagricultural Uses." *Southwestern Economics Journal*, 4, 2, Forthcoming, fall 2001.

Palmquist, R.B. "Land as a Differentiated Factor of Production: A Hedonic Model and its Implications for Welfare Measurement." *Land Economics*, 65, (February 1989):23-28.

Palmquist, R. B. and L.E. Danielson. "A Hedonic Study of the Effects of Erosion Control and Drainage on Farmland Values." *American Journal of Agricultural Economics*, 71(1989): 55-62.

Ratcliff, R. "Don't Under Rate the Gross Income Multiplier." The Apprasial Journal. April 1971: 264.

Taylor, R.G. "Implicit Demand for Farmland Characteristics." Unpublished Ph.D. Dissertation. Department of Agriculture and Resource Economics, Colorado State University, 1991, 95p.

Texas Chapter ASFMRA. "1998-1999 Trends in Texas Agricultural Land Values." 6106 Vance Jackson #2, San Antonio, TX, 1999.

Torell, L.A. and S.A. Bailey. "Is the profit motive an Important Determinant of Grazing Land Use and Rancher Motive?" Paper presented at the Western Agricultural Economic Association meetings, July, 2000.

White, H. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica*, 48, 4 (1980):817-838

Wright, Khaliela S., et al. "Protecting Farmland From Development – How to Determine Which Lands Are Under the Most Pressure." Paper presented at the Southwestern Economics Association meetings, New Orleans, March 2002.

US Census Bureau. "United States Census Data 2000." United States Department of Commerce, 2000. http://factfinder.census.gov/servlet/BasicFactsServlet

Xu, F., et al. " Measuring the Contributions of Site Characteristics to the Value of Agricultural Land." *Land Economics*, 69, 4 (1993):356- 369.

Figure 1. Idaho's Magic Valley

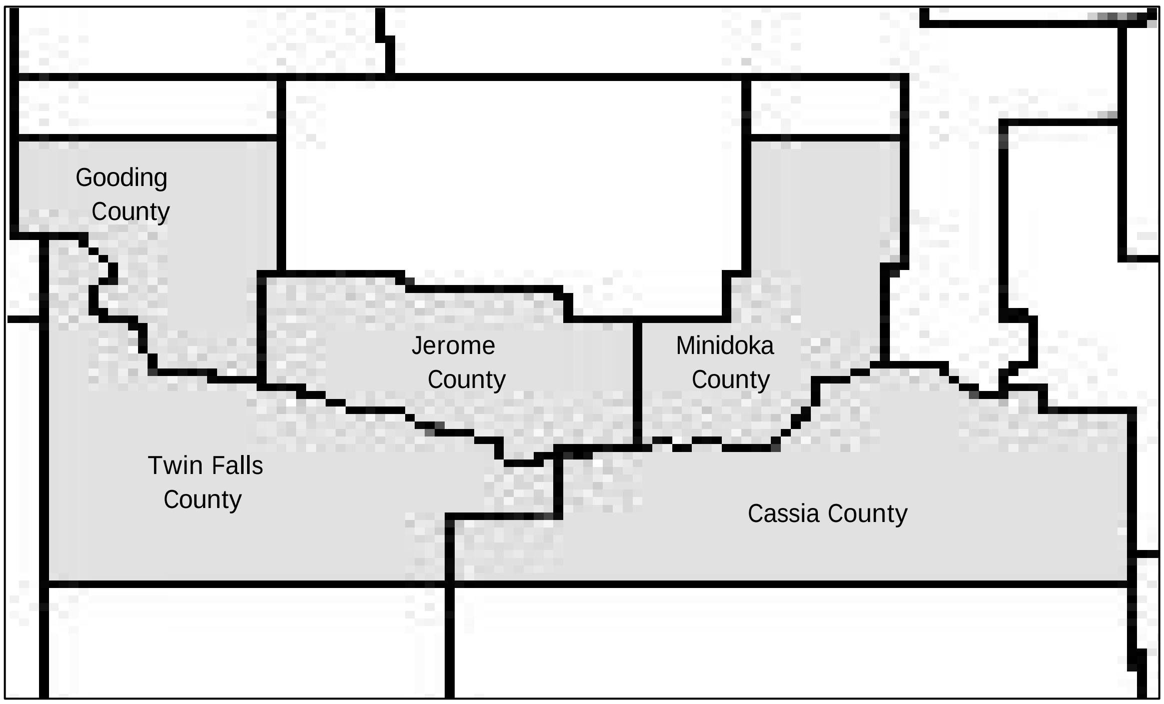


**Table 1. Regression model variables**

| Symbol | Variable | Expected sign |
|---|---|---|
| *Continuous variables* | | |
| Salepr (dependent) | Price of tract | |
| CloseRD | Distance to nearest highway (mt) | (-) |
| Size | Size of tract (acres) | (-) |
| Dist500 | Distance to towns (mt)>500 people | (-) |
| Distall | Distance to towns(mt) with population>0 | (-) |
| Elev | Elevation in meters | (?) |
| Slope | Slope of tract | (-) |
| Soils | Average land capability class (1-7) * | (-) |
| Popu | County population | (+) |
| Nifarmc | Net farm income by county ($) | (+) |
| Dcows | Population of dairy cows in county | (+) |
| *Discrete variables (1,0)* | | |
| Irri (1-2) | Type of Irrigation(furrow=0, other=1) | (+) |
| Yrsale (1993-1994) | Year sale occurred | (+) |
| Water | Presence of water bodies | (-) |
| Cassia | Located in Cassia County | (?) |
| Gooding | Located in Gooding County | (?) |
| Jerome | Located in Jerome County | (?) |
| Mind | Located in Minidoka County | (?) |
| Tfall | Located in Twin Falls County | (?) |

* Highest capability class for agricultural land is 1, and lowest capability class is 7.

**Table 2. Regression Results for Models of Parcels Less Than 80 Acres and Parcels Greater Than 80 Acres**

| | | Less than 80 acres | | | Greater than 80 acres | |
|---|---|---|---|---|---|---|
| **Variable** | | **Coefficient** | **t-statistic** | | **Coefficient** | **t-statistic** |
| Intercept | | 219,550.30 | 3.80*** | | 770,677.20 | 4.54*** |
| Gooding | | -54,726.62 | -3.62*** | | | |
| Jerome | | -35,663.10 | -3.62*** | | -92,100.00 | -3.74*** |
| Size | | 1,743.57 | 11.37*** | | 1,484.20 | 46.65*** |
| Yr 1994 | | | | | -64,960.00 | -2.10** |
| Yr 1996 | | 29,372.33 | 4.01*** | | | |
| Yr 1997 | | 32,887.9 | 4.28*** | | 88,201.18 | 3.02*** |
| Yr 1998 | | 51,892.8 | 6.22*** | | 153,511.20 | 6.22*** |
| Yr 1999 | | 26,740.2 | 1.82* | | | |
| Irr2 | | 22,182.85 | 3.21*** | | | |
| Elev | | -188.75 | -4.39*** | | -540.8 | -5.34*** |
| Slope | | -2,742.40 | -1.87* | | | |
| Soils | | -13,296.10 | -2.02** | | -60,023.00 | -2.02** |
| Nifarmc | | 0.79 | 4.13*** | | 1.80 | 3.83*** |
| $R^2$ | | 0.54 | | | 0.91 | |
| F-value | | 20.35 | | | 284.83 | |
| N | | 233 | | | 220.00 | |
| *Significant @ 0.005 | | | | | | |
| **Significant @ 0.05 | | | | | | |
| ***Significant@ 0.01 | | | | | | |

**Table 3. Results of Regression Analysis of Development Increment Values for Farmland Parcels with High (>20) Income Multipliers**

| Variable | | Coefficient | t-statistic |
|---|---|---|---|
| Intercept | | 6569.641 | 0.90 |
| SalePR | | 0.172866 | 15.92*** |
| CloseRD | | 5.005201 | 2.99** |
| Dist500 | | -1.50277 | -2.05* |
| | | | |
| $R^2$ | | 0.78 | |
| N | | 80 | |
| | | | |
| ***Significant @ 0.001** | | | |
| ****Significant @ 0.005** | | | |
| *****Significant@ 0.05** | | | |
| | | | |
| | | | |