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Research Article

Assessment of the Impact of Plastic Recycling on Agricultural Land Prices: A Case Study in Vietnam

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Abstract

Pollution in Minh Khai, Van Lam district is seriously contributed by plastic recycling plants. Therefore, this study evaluated the impact of plastic recycling pollution on agricultural land prices in Minh Khai, Van Lam district. Hedonic price analysis was employed in analyzing the data being collected. The results show that crop yield and quality as well as agricultural land prices in the area tend to decrease due to the impact of pollution from plastic recycling. The analysis also showed land prices are positively related to crop yields, soil quality and land size while distance to the highway and quality of the irrigation water are negatively related. Based on the hedonic price method, the research shows that the price of agricultural land increases by 0.97 VND/m² (USD 0.042 per 1000m²) when away from the plastic recycling area. It is estimated that the value of agricultural land in the district damaged by pollution is about 79 billion VND (3.4 million USD). Therefore, local authorities should implement zoning of production into concentrated areas. Hence, it is possible to invest in pollution treatment and reduce negative impacts on the external environment.

Introduction

Each year, millions of tons of plastic are produced and tending to increase more [1]. Unlike the complete plastic recycling business in developed countries, waste pickers or scavengers collect plastic waste and sort through street rubbish or landfill sites and collect materials that can be sold. After waste pickers have sorted and collected diverse types of waste, it is sold to junk buyers. Over time, these areas formed the recycling village. These villages that have been created in the past did not have plans for the proper location of plastic recycling, but rather were set up in many residential areas. Environmental condition has long been linked to land prices [2]. Understanding the determinants of land prices could provide information to guide land use management that balance the need for agricultural land resources and residential or commercial uses [3].

Among the largest Vietnamese plastic recycling villages, Minh Khai village in Van Lam district, Hung Yen province, Vietnam is the biggest plastic recycling village. Waste storage, emissions and wastewater generated from non-standard recycling processes are the main sources of environmental pollution. Pollutants that affect agricultural production indirectly affect the value of agricultural land. In these villages, farmers are starting to abandon their farms and consequently reducing the value of their agricultural lands. This may have a major impact on local agricultural production due to the reduction of production or conversion of agricultural lands. Unlike other resources, land has special characteristics. Its location and use affects the value of surrounding parcels [4].

While many empirical studies have focused on the impact of pollution on human health such as: air pollution on human health provides an overview of the impact of, including respiratory and cardiovascular diseases, cancer, and neurological disorders and suggests practical measures for preventing exposure by Sundeep Mishra & Rakesh Dhaliwal [5] and Farhad Sahebkar [6]; water pollution, including infectious diseases, reproductive and developmental problems, and cancer by Cristina M Woodhouse [7]; noise pollution, including hearing loss, cardiovascular disease, and mental health problems by B S Manjunatha [8] reviewed. Some empirical studies investigating the impact of pollution on property values [2,9-12], land and agricultural land value with different attributes [13-16].

The agricultural land value studies mentioned above mostly assess land values in terms of intrinsic soil properties or single pollutant effects such as water pollution or infrastructure quality issues. The issue of assessing the impact of pollution from plastic recycling on the value of agricultural land is still a relatively new topic, only a limited number of studies have investigated the potential impact of environmental risks associated with plastic recycling on agricultural land prices, particularly in the context of craft villages where production facilities are located within residential areas. Furthermore, there are currently no studies on the impact of plastic recycling activities on the value of housing assets or agricultural land prices in the study area although some preliminary assessment of pollution was undertaken. It is therefore important to assess more fully the impacts of pollution from plastic recycling activities especially on the value of agricultural land in this area. Assessing the impact of plastic recycling pollution in craft villages on the value of agricultural land is significant because it helps to understand the economic consequences of environmental pollution on agricultural land, which is a vital resource for food production and a source of livelihood for many communities. The study can provide insights into how environmental pollution from plastic recycling activities affects the value of agricultural land and can help policymakers, regulators, and local communities to make informed decisions about managing plastic waste and protecting agricultural land. Furthermore, the study can highlight the need to develop sustainable waste management practices and reduce plastic waste to safeguard the environment and preserve the economic value of agricultural land for future generations.

Literature Review

The development of industrial zone can cause environmental problems, such as wastewater from the production process, noise from the machinery, air pollution and can create risks to human health and reduce the value of land. Many studies have shown the negative effects of environmental problems on the value of property price, although environmental issues are still less considered in land valuation studies. Agricultural land is mainly used for farming and raising livestock for farmers [17]. In earlier research, the agricultural land market was examined, and it was found that there were distinct markets for high quality, average quality, and low quality land. Additionally, various independent variables were found to have an impact on the agricultural land market [15].

Agricultural land in different periods has different characteristics, land price depends on size, location and land use, land tax, environmental regulations, transaction regulations [18,19]. The surrounding environment affected the price of agricultural land, so it was necessary to have public policies to achieve economic efficiency for the private sector from agricultural land [17]. Farmland Index measured at nominal, real price and estimated private value for farmland which was analyzed by hedonic method [17]. Analysis by hedonic method and econometric model, concluded that agricultural land price was related with spatial dependence and functional form in agricultural land [19]. The Hedonic pricing method has been used by A.W. Oltmans et al. [20] to measure changes in agricultural land prices. In this study, the factors of road size, improvement condition, land productivity, distance to market, distance to center and other cities and a time dummy variable were used as attributes of agricultural land prices. The study showed a strong relationship between the identified attributes and farmland values but there were no spatial and temporal dependencies in the data and did not include agricultural and non-agricultural additions such as population density, income, and inflation in their analysis.

Hedonic models used in a number of previous studies have looked at farmland values using considerations of productive capacity, income potential, and non-income effects. for the value of agricultural land. In addition, Lee A. Craig et al. [13] modeled farmland prices as a function of land type, commercial conditions, transportation, and geographic and demographic variables. Historical datasets were used to measure the impact of water and rail access on the county-level value of pre-war farmland. Although these studies demonstrate the usefulness of hedonistic methods to isolate the effects of changes in factors that contribute to land value, they do not control spatial lag and serial autoregressive effect on land value.

Plastic waste needed attention in today's time, recycling to help reduce pollution [21]. The circular economy aims to protect the environment from plastic pollution, promote growth in industry and human life [22]. Research has shown that there are four stages in the circulation system: production, consumption, discharge and recycling, from which to develop a plan to control plastic waste and the need for plastic recycling [22-24]. However, the current most complicated problem of waste treatment is plastic, because plastic waste treatment causes environmental pollution in villages [25,26]. Although the benefits brought by craft villages are to create jobs, increase incomes, and reduce migration pressure from rural areas to cities, craft villages create environmental pollution and affect resource use. Many craft villages did not have a system to collect and treat industrial and solid waste, thereby causing pollution around craft villages [26]. Craft villages use outdated technology, low efficiency in using raw materials, and low awareness of environmental protection [28]. Pollution caused all kinds of air pollution, water pollution, untreated wastewater [27].

A study of S Yuvasakthi & Dinesh Kumar [16] on the economic impact of water pollution on value of crop land concluded that one unit of monetary increases in farm income, increased the value of crop land by 5.6% per ha. Also, an improvement of irrigation water quality from poor to good would increase the value of crop land, keeping the other variables constant in the highly affected areas. Likewise, the improvement in land quality from poor to good would increase the value of cropland. Furthermore, a one-kilometer increase in distance between a farm and polluted river would increase the value of cropland. The study also found that industrial water pollution caused by industrial effluents that are disposed in the river also affect the fertility and productivity of the cropland and consequently its value. Some previous studies assessing the value of agricultural land just focused on a few pollution indicators of irrigation water sources. Numerous studies have been conducted regarding the influence of industrial complexes on agricultural land value, as a result of their impact on productivity. What is not clear from the studies is the specific sources of pollution. This is especially important because the concentration of industrial production in certain areas is a very pressing issue in developing countries including Vietnam. Industrial production activities are increasingly expanding and causing more and more environmental problems. The negative effects of these activities should be determined. Each type of industrial production and industrial cluster has its own characteristics and discharges varying types of pollutants. For recycling, plastic production is no exception and needs to be assessed in a specific way [29-35].

Research Methods

Study area

Van Lam district is located in the north of Hung Yen province. It is 20 km away from Hanoi city. The total land area of Van Lam district is 74.43 square kilometers, of which 3,292 hectares (44.24%) is used for agricultural production 1,161 ha (15.6%) is allocated to residences while unutilized land area is 9.69 ha (0.13%). Van Lam has 11 commune-level administrative units: Nhu Quynh, Lac Dao, Chi Dao, Dai Dong, Viet Hung, Luong Tai, Minh Hai, Dinh Du, Lac Hong, Trung Trac, Tan Quang (Figure 1).

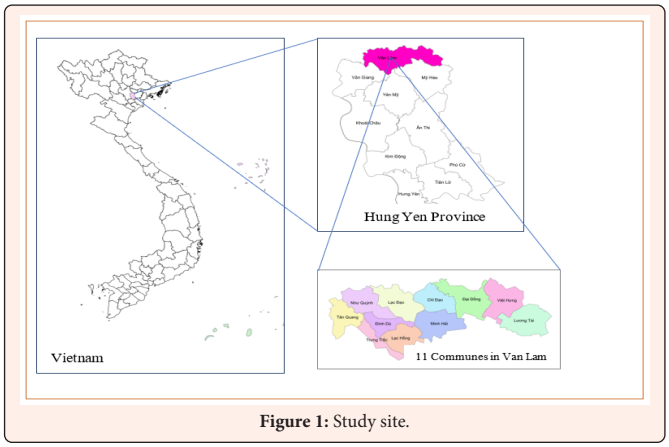

Figure 1: Study site.

The map was built by ArcMap software (version 10.8) to present the study area. The commune study selected 1 commune, named Nhu Quynh (this commune contains a plastic recycling craft village, named Minh Khai village, causing environmental pollution), the study also selected 10 other communes (without environmental pollution) to compare and control on environmental issues with Minh Khai village. A comparison of the value of land between study sites would provide information on the impacts of environmental pollution [36-38].

Minh Khai plastic recycling village is located in Nhu Quynh town. The entire stretch of the village from east to west, is surrounded by paddy fields. The total area of the village is 135 hectares, of which 104 hectares was devoted to agricultural production and 31 hectares for residential activities and secondary production.

Data Collection

A spatial sampling method was used to select households that were interviewed using the survey questionnaire. The farm household samples were chosen along varying distances from the plastic recycling centers.

The household sample size was calculated based on the Yamane's formula Slovin (1960) with 90% confidence level.

$$n = \frac{N}{1 + N.e^2}$$

Where:
n: the sample size
N: the size of population
e: significant level 10%

Based on the statistical data of Van Lam district, the population in Van Lam was about 120,804 people in 2018. Based on the population, the minimum number of respondents should at least be 100 households. It was used for mapping the different land or administrative area. Sampling was based on the spatial map. The scope of the study concerns the analysis of agricultural land prices in Van Lam district in selected areas.

There were 123 household respondents interviewed. In addition, descriptive statistics and comparative analysis were used to describe the plastic recycling processes and its negative affects to environmental quality in some recently the years.

Table 1: Number of farmer respondents in Van Lam district, 2018.

No.	Communes	Number of Households	Percentage (%)
1	Nhu Quynh (Include Minh Khai village)	39	31.7
2	Dai Dong	4	3.25
3	Dinh Du	15	12.2
4	Lac Dao	15	12.2
5	Lac Hong	5	4.07
6	Luong Tai	3	2.44
7	Minh Hai	4	3.25
8	Ngoc Quynh	9	7.32
9	Tan Quang	8	6.5
10	Trung Trac	8	6.5
11	Viet Hung	4	3.25
	Total	123	100

Hedonic pricing method

It is assumed that the price of land around the area of the village recycling plastic before the operation of plastic recycling was the same. However, due to garbage collection and recycling operations, the quality of the environment has been deteriorating. Prices near the recycling areas are expected to be lower than those that are located farther. The lesser the amount of pollution, the higher the land prices. In this study, the hedonic property price model is used to estimate the marginal implicit prices of various structural, neighborhood, and environmental attributes, including distances. Specifically, the hedonic pricing method is used determine the value of environmental attributes that affect the well-being of individuals. This is determined by getting the difference in value of the assets given the difference in environmental condition. Another question is what are people willing to pay for the improvement in environmental condition.

Hedonic price analysis was used to estimate the hedonic price function (P(H)) of agricultural land, as determined by its structural characteristics (acreage size, soil quality, etc.), neighborhood characteristics like demographic and economic characteristics of the area and other locational amenities. The two most important locational amenities that are of interest are soil and water pollution that are generated by pollutants from plastic and other toxic waste. Marginal implicit prices for these characteristics gives a measure of the amount of damage due to its proximity to the source of the pollution. A direct and simplified way of measuring these benefits would be from the hedonic price function alone.

Specification of the hedonic price function

The hedonic price function relates price of residential property to the structural, neighborhood and environmental characteristics of the property and is estimated using a simple least square regression model. Based on earlier research experiences as well as field survey practices, the hedonic price function is estimated as follows.

lnprice= f(lnproductivity, lnsize , land_quality, slope, water_quality, irrigation_ quality, lnd_residence, lnd_traffic, lnd_district, lnna_road, lnd_market, lnd_irrigation, lnd_mk)

Table 2: Description of variables in the regression model for agricultural land prices.

Variable Label	Variable Label	Unit	Expected sign
Dependent Variable			
lnprice	Natural log of agricultural land price	Thousand VND/m^2	
Independent variable			
lnproductivity	Natural log of productivity on plot land	Thousand VND/m^2	(+)
lnsize	Natural log of agricultural land size	m^2	(+)
land_quality	Land quality	1= high, 0=low/ normal	(+)
slope	Slope of plot land	1=flat, slope < 3%, 0 = slople >3%	(-)
water_quality	Water quality provided	1= high quality, 0 = low quality	(+)
irrigation_ quality	Irrigation infrastructure quality	1= high, 0 = low	(+)
lnd_residence	Natural log of distance to the residence	m	(-)
lnd_traffic	Natural log of distance to the internal trafic	m	(-)
lnd_district	Natural log of distance to the district road	m	(-)
lnd_na_road	Natural log of distance to the national road	m	(-)
lnd_market	Natural log of distance to the market	m	(-)
lnd_irrigation	Natural log of distance to the main irrigation	m	(-)
lnd_mk	Natural log of distance to the Minh Khai are	m	(+)

Quality variables such as soil quality, water quality or quality of irrigation are determined based on assessment of the respondents and the classification of soil quality by area of the local government. Group of alluvial, acidic soils and typical alluvial soils with patchy layers, light and acidic mechanical composition will be classified as low quality compared to other agricultural soils in the area. The water quality is worse than the standard QCVN 39:2011/BTNMT and the respondent evaluates the quality as unsafe will be classified as low.

The partial derivative of this function with respect to pollution gives its implicit marginal price. This price is the additional amount that the farmer would be willing to pay for choosing a land given its distance from the pollutant source, other things remaining the same. The marginal implicit price is estimated as follows.

$$Implicit\ price\ of\ pollution\ =\ \Pr ice.\left(\frac{1}{d\_mk}\right)*coefficient\ of\ d\_mk$$

Specification of the implicit demand function

The estimated implicit prices for different characteristics correspond to the individual willingness to pay (WTP) for a marginal unit of environmental good purchased. The individual chooses the level of characteristic at which their Marginal Willingness to Pay (MWTP) for that characteristic is equal to its implicit marginal price.

The inverse demand function is then obtained by regressing the implicit price as a

function of distance to pollution area, and other socio-economic features of individuals along with a demand shift variable, such as income. The regression equation for inverse demand function in general is:

$$\ln IMPRICE = f(Y, \sum sosec, \sum struc, \sum neigh, \sum env)$$

where, Y is the annual income of the household, sosec is the social economic characteristics, struc is the structural characteristics, neigh is neighbourhood characteristics, and env is environmental characteristics.

The total damage due to the impact of pollution caused by plastic recycling will be calculated for the whole district based on the estimate of damage of each group with the total land area with corresponding attributes and generalization from the survey sample. in research. The total amount of loss to the value of agricultural land due to the pollution from plastic recycling can be calculated as follows:

$$Total\ damage = \sum (TL, Pg, D)$$

Where: TL is Total area of land
Pg is Percentage of each group
D is the damage was calculated for each group

Results and Discussion

The impact of environmental pollution from plastic recycling on agricultural production

Characteristics of household respondents

The results from the household survey show that the average age of the household head is 48.9 years. The lowest is 33 and the highest is 66. The average number of household members is 4 persons/household. In the Vietnamese tradition, children live with their parents. It is not uncommon for two to three generations of the family to be living together in one household. The average number of farm labor per household for 67% of the households is 3 persons. These results show that there are enough labor available for the family.

The average number of laborers in the respondent households was 2.93 persons/household. The numbers of available household laborers for agricultural is relatively high, with 1.82 persons/household, accounting for 62.12% of the total household labor (Table 3). It can be seen that agricultural production is the main activity of the respondent households.

Table 3: Characteristics of household respondents in Van Lam, 2018.

Variables	Unit	Mean Value	Percentage (%)
Average age	Year	48.9	-
Average demographic number		4.37	-
Labor	No.	2.93	67
Agricultural labor	No.	1.82	41.6
Gender			
- Male		90	73.2
- Female		33	26.8
Agricultural income	Thousand VND	38,613.82	-
Education			
- Secondary school	No.	3	2.44
- High school			44.7
- Colleges		30	24.4
- University		35	28.5
Average area of agricultural land	m^2	1324	-
Average number of agricultural plots	plot	2.4	-

Source: Field survey data, 2018

Plastic recycling in Minh Khai

Minh Khai Plastic Recycling Village - Nhu Quynh town is located along Highway 5A, Hanoi - Hai Phong, about 20km from Hanoi and is surrounded by paddy fields. The total area of the village is 135 hectares, 104 hectares, of which, are devoted to agricultural production while 31 hectares are for residential activities and secondary production. The total population of Minh Khai village is 4200 with about 1100 households. Of this number of households, 900 or 80% of the total households in the village are involved in plastic recycling employing about 3000 people. The main products of the village are varied, e.g., hooks, PVC pipes, bags, plastic bags and plastic bottles. About 350 households produce plastic pellets, 300 households produce plastic bags and 250 households produce PVC pipes (Figure 2).

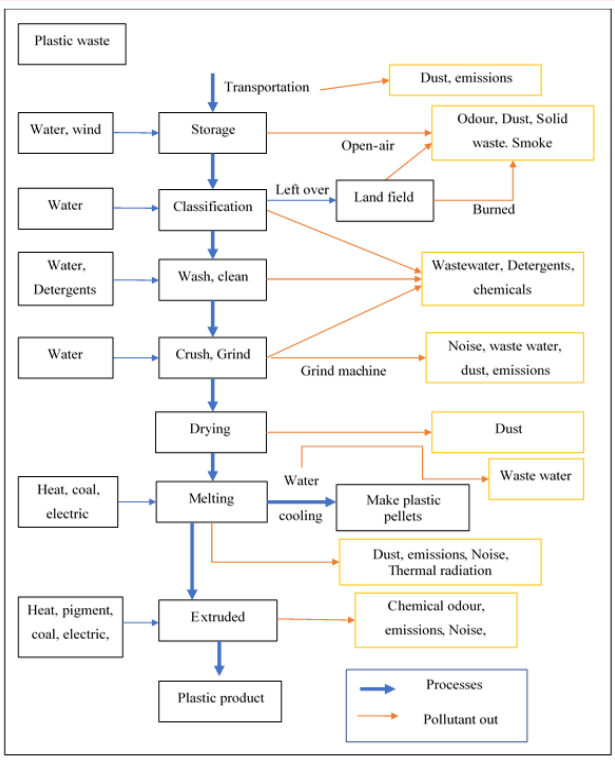

Figure 2: Plastic recycling process and source of contamination in Minh Khai, 2018. (Source: Field survey data, 2018).

Waste plastics are collected from household waste, waste plastics from old buildings, boats or raw materials used as inputs for recycling and plastics production. These plastic wastes are stacked in vacant areas such as the backyards of the residences, on the field, or along the roads of Minh Khai village. Depending on the quality and color of these waste plastics, some may be classified and cleaned for resale. The rest will be crushed and dried together with the waste plastics (the form of hard plastic LDPE). Recycling plants will process them into HDPE or LDPE for sale or used for blow molding, plastic injection into sheets or plastic bags in different sizes and colors. The process of plastic recycling in Minh Khai takes place in 7 major steps as shown in figure 3, whereby these processes create pollutants discharged into the environment such as dust, polluted wastewater and other toxic chemicals.

Assessment of the impact of pollution at plastic recycling sites on agricultural production

The pollution from plastic recycling area adversely affects the quality of the regional environment. A survey was undertaken to get the opinions of households in Van Lam district on the impact of the pollution from the Minh Khai Plastic Recycling on their villages. The results of the household survey show that 69% of respondents were affected by pollution. It also shows that households affected by pollution are relatively less productive and earning less by about VND 260 (USD 0.011) per square meter than those not affected.

In addition, the average distance of households affected by pollution from the source of pollution, the plastic recycling area, is 2250.6m, in contrast to households not affected by pollution that on average is located 6031.7m from the source of pollution. The high level of pollution from plastic recycling production has caused high levels of pollution for agricultural production of farmers near this area. Based on the responses of households, water pollution is the most serious source of pollution with 94% of total households rated as affected by pollution in Minh Khai. The next serious source of pollution that affects the agricultural production of 66% of the respondents is from dust and smoke. The next is odor that has affected 58% of respondents. Finally, there are signs of soil and noise pollution as indicated by 15% and 11% of the respondents, respectively.

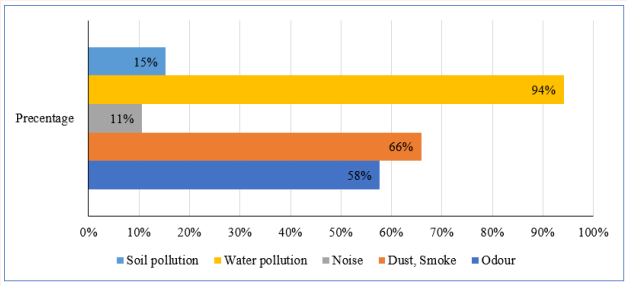

Figure 3: Types of pollution affecting household farmers in Van Lam, 2018. (Source: Field survey data, 2018)

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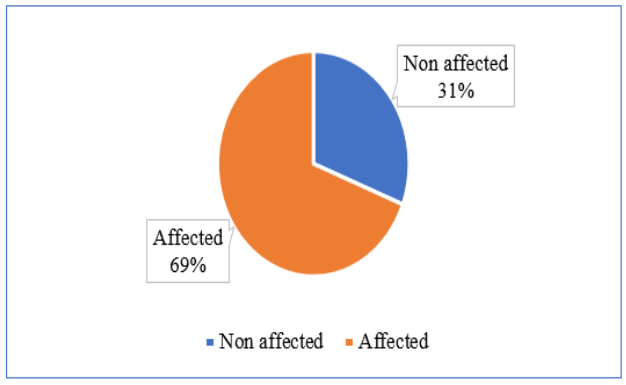

Figure 4: The percentage of respondents affected by Minh Khai Plastic Recycling 2018. (Source: Field survey data, 2018)

In order to assess the impact of pollution sources on agricultural production of surveyed households, the study evaluated the impacts using key indicators of crop yield, the risk of pest infestation, increased care and quality of agricultural products (Table 4). The majority or 69.11% of the respondents mentioned that water was contaminated with chemicals and the pH was unstable and caused the reduction in their crop productivity. In addition, dust and smoke from the production process and incineration also reduce the crop productivity.

Table 4: The percentage of affected respondent farmers by impact level in Van Lam, 2018.

Indicators	No affect	Small affect	Moderate affect	High affect	Very high affect
Crop productivity	30.89%	17.89%	23.58%	21.95%	5.69%
Disease	60.16%	30.08%	7.32%	2.44%	0.00%
Labour cost	65.85%	28.46%	3.925%	1.63%	0.81%
Product quality	37.40%	44.72%	15.45%	1.63%	0.81%

From the above assessment, it can be seen that emissions from plastic recycling in the area have had an impact on the agricultural production of the households. Besides affecting the production sector and the value of agriculture, the value of agricultural land in the area is also affected. Compilation of data shows that the average price of agricultural land traded in the area is 90 thousand VND/m^2 (USD 3.87/ m^2; USD 1 = VND 23,255). The highest is 128 thousand VND/m2 (USD 5.5) and the lowest is 59 thousand VND/ m^2 (USD 2.54).

The impact of environmental pollution from plastic recycling on agricultural land value

The agricultural land prices in the area are calculated in VND thousand/m^2. Based on household surveys, the market value of most agricultural lands that are traded are between 80 and 100 thousand VND/m^2 (USD 3.44 to 4.3) (Table 5).

Table 5: Prices from Agricultural Land Sales in Van Lam, 2018.

Group	Agricultural land price (Thousand VND)	Percentage (%)
1	Lower than 80	22
2	80 to 100	51
3	100 to 120	23
4	Over 120	4

Compilation of data shows that the average price of agricultural land traded in the area is 90 thousand VND/m^2 (USD 3.87). The highest is 128 thousand VND/m^2 (USD 5.5) and the lowest is 59 thousand VND/m^2 (USD 2.54) (Table 6).

Table 6: Summary statics of agricultural land market prices in Van Lam, 2018.

Indicator	Transacted agricultural land price
Mean	90
Std. dev.	15.08
Min	59
Max	128
Obs	123

Source: Field survey data, 2018.

The Hedonic pricing model using the STATA package was estimated and used to identify the main factors that influence agricultural land price. The software was used to carry out maximum likelihood estimation of the thirteen parameters (productivity,

size of plot land, land quality, slope of land, water quality, irrigation quality, distance of the land to residence, internal traffic, district road, national road, market, irrigation infrastructure and Minh Khai area) of the model. The hedonic pricing method was used to assess the factors affecting the price of agricultural land in the area as well as the impact of Minh Khai plastic recycling area on the land price. The results of the model estimation are listed in table 7.

Table 7: The results of regression analysis of factors affecting agricultural land price in Van Lam distric, Hung Yen Province, 2018.

Variable	Coef.	Std. Err.	P-value
lnproductivity	0.1129***	0.040424	0.007
lnsize	0.2551***	0.0168252	0.000
land_quality	0.1043***	0.019801	0.000
slope	0.0170^{NS}	0.0298827	0.571
water_quality	0.0648*	0.0336813	0.058
irrigation_quality	0.0109^{NS}	0.0185707	0.56
lnd_residence	-0.002^{NS}	0.0127842	0.877
lnd_traffic	0.0159^{NS}	0.0105486	0.137
lnd_district	-0.0034^{NS}	0.0105097	0.744
lnd_na_road	-0.0413**	0.0158706	0.011
lnd_market	-0.005^{NS}	0.0200627	0.806
lnd_irrigation	-0.0055^{NS}	0.0102767	0.618
lnd_mk	0.0245*	0.0145425	0.096
_cons	2.7255***	0.2033346	0.000
Number of obs	85		
F (13,71)	31.48		
Prob > F	0.0000		
Adj R-squared	0.8251		

Note: ***, ** and * refer to significance at 1%, 5% and 10% level, respectively, NS refer not significant.

Multicollinearity and heteroscedasticity problems were also tested. All of the correlation coefficients between two variables was less than 0.6. The variance inflation factor VIF=3.12 (less than 10) and the Cook-Wiesberg test was used indicating no serious heteroscedasticity problem. The result of the regression run indicated that the seven independent variables (productivity, size of plot land, land quality, water quality, distance of the land to national road, market, and Minh Khai area) were statistically significant and had influence on the price level of agricultural. Substituting the elasticity values obtained from the regression analysis into the transferred form, the final function is as follows:

$$pirce = e^{2.7255***}\ productivity^{0.1129***}\ size^{0.2551***}\ na\_road^{-0.0413**}\ d\_mk^{0.0245*}\ e^{0.1043***land\_quality}\ e^{0.0648*water\_quality}$$

On the basis of the data obtained from the sample of 85 farmers, the estimated regression coefficients for variable of ln productivity was 0.1129. The sign of the coefficient is positive showing the positive effect of productivity of land on agricultural land prices. The higher the land productivity, the higher the land value. Specifically, if the productivity of land increased by 1%, the value of agricultural land increased by 0.1129%. Productivity is an important factor affecting the value of land. Similarly, the regression coefficients of 0.2551 for lnsize. The sign of the coefficient is positive showing the positive effect of land size on agricultural land prices. The bigger size of the plot land, the higher the agricultural land value. Specifically, if the size of plot land increased by 1%, the value of agricultural land increased by 0.2551%. Being able to use more agricultural land also has a large impact on the value of the land. There would be economies of scale in production with bigger land sizes.

The coefficients for land and water quality are 0.1043 and 0.0648 respectively. It means that if land_quality = 1, or otherwise good soil quality, the value of land will increase by 0.1043%. Likewise, for water quality, if the water quality is good (water_quality = 1), the value of the land will be increase by 0.0648%. However, the regression coefficients were - 0.0413 and 0.0245 for distance to national road and Minh Khai area, respectively. The sign of the coefficient is negative showing the negative effect of distance to national road affecting agricultural land prices. The farther the national road from the land, the lower the agricultural land value. Specifically, if the distance of land from the national road increased by 1%, the value of agricultural land decreased by 0.0413%. Meanwhile, if the distance of the land to Minh Khai increases by 1%, the value of agricultural land increases by 0.0245%. This indicates that the pollution caused by the Minh Khai Plastic Recycling area has had a negative impact on the value of agricultural land.

The mean and estimated coefficients for each variable was used to determine their impacts on agricultural land prices in Van Lam as shown in table 8:

Table 8: Impact of various factors on agricultural land price.

Variable	Coefficient	Impact on agricultural land price (VND/m^2)
productivity	0.1129	355
size	0.2551	59.8
land_quality	0.1043	9,341
d_na_road	-0.0413	-2
water_quality	0.0648	5,803
d_mk	0.0245	0.97

The results show that a 1 unit increase in productivity would result to a land price increase 355 VND/m^2 (USD 0.0153) while 1m^2 increase in size of land would increase land price by 59.8 VND/m^2 (USD 2.6 per1000 m^2). Similarly, an improvement in land quality would increase land price by 9,341 VND/m^2 (USD 0.402) and so would the improvement in the quality of water that increases the value of land by 5.803 thousand VND/m^2 (USD 0.25). Distance to the national road also affects agricultural land prices. When the distance to the national road reduced by 1m, the price of agricultural land increases by 2 VND/m^2 (USD 0.086 per 1000m^2). However, as the land gets nearer to the Minh Khai area, the price of land is reduced by 0.97 VND/m^2 (USD 0.042 per 1000m^2).

In order to determine damage from pollution from plastic recycling activities, the average values of other variables in the model were used. From there, it is possible to determine the relationship between the price of agricultural land and the distance to the contaminated area by using hedonic pricing method. Specific are as follows:

$$price = 74.420 * d\_mk^{0.0245}\ e^{0.1043***land\_quality}\ e^{0.0648*water\_quality}$$

Based on Cobb-Douglas land price function, the elasticity is the coefficient of d_mk variable is 0.0245, which means that when the distance to Minh Khai increases, the land price increases by 0.0245%. In other words, the proximity to the Minh Khai plastic recycling reduces the market value of agricultural land. The land_quality and water_quality variables are the dummy variables. So that we have 4 cases to evaluate the damage of distance to Minh Khai area base on the land quality and irrigation water quality to the agricultural land. The results of this is showed in the table 9.

Table 9: Estimated loss of agricultural land value by quality of land and water.

			Land Quality	
			Good	Poor
Water Quality	Good	Area (%)	11	6
		Value lost (Thousand VND/m^2)	6.106	5.502
		Total damage (Thousand VND)	9,571,323	4,703,846
	Poor	Area (%)	50	33
		Value lost (Thousand VND/m^2)	5.723	5.156
		Total damage (Thousand VND)	40,776,825	24,248,223

The agricultural land value lost due to the adverse effect of the plastic recycling in Minh Khai area for good land and water quality is 6.106 thousand VND/m^2 (USD 0.263).

If land quality is poorer (with good water quality), the value lost is 5.502 thousand VND/m^2 (USD 0.237). On the other hand, the land quality is good, but water quality is poor, this value lost is 5.723 thousand VND/m^2 (USD 0.246). Moreover, if both land and water is poor quality, the value lost is 5.156 thousand VND/m^2 (USD 0.222). From the above results, the closer to the contaminated area due to plastic recycling, the more the value of agricultural land tends to decrease. Along with that, agricultural plots land with good soil conditions or good irrigation are more vulnerable than poorer plots.

Based on the land map of Van Lam district, in the maximum range of 5726m, the area of agricultural land affected by Minh Khai has an estimated 1425ha of agricultural land. The total amount of loss to the value of agricultural land due to the pollution from plastic recycling can be calculated as follows:

$$Total\ damage = \sum (TL, Pg, D)$$

Based on the percentage of land and water quality of surveyed households, the estimated loss in agricultural land value is shown in table 9. As such, the total damage caused by plastic recycling operations in Minh Khai area has significant impacts on the value of agricultural land in the area. Estimated total damage cause of pollution from Plastic recycling Minh Khai area is over 79 billion VND (USD 3,397,119).

Conclusion and Recommendations

Pollution in Minh Khai province has affected the value of agricultural land. With various pollutants in air, water as well as noise, it can be said that pollution problem in the province is chronic. This existing problem is due to the discharges from the plastic recycling plant or facilities. The effluents affected the irrigation water supply for agricultural production activities in the area while air quality problems including dust and smoke also have adverse impacts on farmers' activities.

With each percentage increase in distance from Minh Khai area, the price of agricultural land increases by 0.0245%. Or that means that for every 1-meter increase in distance, the value of agricultural land can increase by VND 0.97/m^2 (USD 0.042 per 1000m^2). This implies that agricultural land that is distant from the plastic recycling plant has higher value. However, based on the hedonic price analysis, the estimated total losses due to pollution from the plastic recycling area is about 79 billion VND (USD 3,397,119). Through the above results, plastic recycling activities in Minh Khai area have quite a lot of impact on the value of agricultural land in the area. Therefore, it is necessary to have appropriate policies to minimize the negative impact of plastic recycling as well as improve the efficiency of agricultural production. This can be done through proper zoning policies and investment on treatment facilities to abate the effects of discharges into the agricultural land. It will also be helpful if the operation of different farms is integrated into a bigger sized farm that can benefit from the economies scale and productivity and increase in land value.

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