AGRICULTURAL ENVIRONMENTAL DEGRADATION IN LATIN AMERICA: AN INDEX APPROACH IN COUNTRIES OF THIS REGION

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SUMMARY

In order to characterize the environmental degradation caused by agriculture in Latin America, this study aims to analyze the pattern of environmental degradation caused by agricultural activities in countries of the region. The measurement of this phenomenon was carried out through the construction of an Agricultural Environmental Degradation Index (AEDI), which is used as a proxy to determine the degradation of an area caused by farming. In the construction of the AEDI, it was found that some regions and states have a very high degradation pattern, as do some Brazilian states. Regarding the Latin American countries studied, the average value of the index was 8.25%. The countries with the highest levels of environmental degradation were Brazil, Argentina and Mexico, due to the fact that the economies of these countries are strongly based on agriculture. In this sense, to change this situation, the government should interfere more and there should be a greater awareness of farmers in countries that had higher levels of degradation. The lowest degradation rates were obtained in countries where the agricultural activity does not reach high levels of productivity, such as Nicaragua, Chile and El Salvador.

Introduction

The evolution of the human being within society has always been followed by changes in the environment around us. Thus, the changes that occurred in the environment have been accompanied by the use of new technologies, new techniques and new tools, aiming to maximize economic output and improve social welfare. However, some of these changes have brought problems to society. Among the main problems arising from these developments and interactions in the environment are aspects regarding the environmental quality, which is a matter of constant debate in recent decades.

In this perspective, there is a worldwide interaction with the purpose of avoiding a catastrophe on the planet, which involves investment measures and government spending in order to mobilize the population for the preservation of the environment. This mobilization occurs by the construction of mechanisms that seek to measure the sustainable development of regional locations with the objective to make this information public (Leite *et al.,* 2011; Silva *et al.,* 2012). The ideas to build environmental indicators began to emerge in the late 1980s and their aim was to assist the formulation of public policies, international agreements and decision-making of public and private entities (Braga *et al.,* 2004; Lira y Cândido, 2008).

In this scenario of environmental and socio-economic development, the issue of environmental degradation emerges. It is considered a major challenge for many countries and regions, because there is a greater understanding of the transformations the environment is suffering worldwide. Environmental degradation can be defined as the destruction, deterioration or wearing of the environment resulting from economic activities or population and biological aspects (Lemos, 2001). A set of causes are identified as responsible for the current process of degradation; however, in Latin America, this issue is strongly associated with agricultural exploitation that transforms the place where it is carried out (Reveles, 2006).

In most Latin American countries, agriculture is an important source of income and employment, and one of the main factors contributing to the generation of foreign exchange. Therefore, agriculture, in general, aims to generate economic growth and development for these countries (Echeverría, 1998). The evaluations and discussions regarding this activity within this context are relevant in determining aspects of the dynamics of local society.

The discussion involves Latin America because aspects related to agriculture and livestock farming in this region have been steeply updated in recent decades within the social sciences. Studies from previous decades are still valuable in a historical context but are not elements for empirical analyses. There is a need to increasingly renew studies in the agricultural degradation aspect through other approaches, in order to exercise more critical thinking to this field of study (Bengoa, 2003).

In this scenario, studies that aim at creating indicators that can support decision making for corrective measures are important (Braga *et al.*, 2004). This reality, in

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DEGRADACIÓN AMBIENTAL AGROPECUARIA EN AMÉRICA LATINA: UN ENFOQUE A TRAVÉS DE ÍNDICES EN LOS PAÍSES DE LA REGIÓN

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RESUMEN

A fin de caracterizar la degradación ambiental agropecuaria en América Latina, este trabajo tiene como objetivo analizar el patrón de degradación ambiental causada por la actividad agropecuaria en los países de la región. La medición de la degradación se produce por medio de la construcción de un Índice de Degradación Ambiental Agropecuaria (IDAA), el cual surge como proxy *para determinar el área de degradación de una determinada región causada por la actividad agropecuaria. En la construcción del IDAA, se verificó que algunas regiones, como algunos estados brasileños, poseen un patrón de degradación muy elevado. Con respecto a los países estudiados de América Latina, el valor medio del índice fue del 8,25%. Los países que presentaron mayores niveles de degradación ambiental fueron Brasil, Argentina y México, en razón de que sus economías tienen una muy fuerte base agropecuaria. En este sentido, para revertir esa situación debe haber mayor actuación del poder público, así como una mayor concientización de los productores rurales en los países que presentaron mayores niveles de degradación. Los menores índices de degradación se obtuvieron en países donde la actividad agropecuaria no presenta altos niveles de productividad, tales como Nicaragua, Chile y El Salvador.*

DEGRADAÇÃO AMBIENTAL AGROPECUÁRIA NA AMÉRICA LATINA: UMA ABORDAGEM DE ÍNDICES NOS PAÍSES DA REGIÃO

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RESUMO

A fim de caracterizar a degradação ambiental agropecuária na América Latina, este trabalho tem como objetivo analisar o padrão de degradação ambiental causado por atividades agropecuárias nos países da region. A mensuração da degradação foi feita por meio da construção de um Índice de Degradação Ambiental Agropecuária (IDAA), o qual surge como proxy *para determinar a área de degradação de uma determinada região causada pela atividade agropecuária. Na construção do IDAA, verificou-se que algumas regiões possuem um padrão de degradação muito elevado, como alguns estados brasileiros. Com relação aos países pesquisados da América Latina, o valor médio do índice foi de 8,25%. Os países que apresentaram maiores níveis de degradação ambiental foram: Brasil, Argentina e México, visto que eles possuem na agropecuária uma base muito forte de suas economias. Neste sentido, para converter essa situação deve ocorrer maior atuação do poder público, bem como uma maior conscientização dos produtores rurais nos países que apresentaram maiores níveis de degradação. Os menores índices de degradação ficaram em países onde a atividade agropecuária não apresenta elevados níveis de produtividade, como a Nicarágua, o Chile e El Salvador.*

the field of environmental degradation, motivated the emergence of research that seeks to quantify the problem of degradation and to explain its main causes. The measurement of this phenomenon is done through the construction of an Agricultural Environmental Degradation Index (AEDI), which is a proxy used to determine the degradation area of a region caused by agricultural activity.

The importance assigned to environmental impacts has induced many studies to quantify their rate of occurrence, seeking to identify the determinants of degradation in several locations. However, studies on degradation rates are incipient, especially those that aim to compare countries and local regions.

Agricultural Environmental Degradation

The human being, as a modifier of the natural landscape, is responsible for the changes caused in the environmental space. The issues regarding the impacts generated by environmental degradation are complex, so it is necessary for those who deal with the soil or other natural resources to use a multidisciplinary approach, as also is for those who determine and manage public policies (Balsan, 2006).

In addition, in a context marked by major changes, it is necessary to evaluate the developmental aspects. This is because some changes can lead to levels where environmental degradation may become irreversible. Thus, there is an inversely proportional relation between the sustainability of a site and its level of degradation (Rezende *et al.*, 2017).

The complexity of the aspect of environmental degradation involves issues beyond environmental discussions. Economic, social and cultural aspects are part of the theme of degradation and are also determinants and points of debate for the maximization, or not, of this phenomenon, which transcends the environmental sphere (Barcellos, 2013; Gosseries, 2015; Mello y Sathler, 2015).

Environmental degradation can be understood as destruction, deterioration, or wearing of the environment. Accordingly, the expressions 'environmental devastation' and 'environmental deterioration' are used as synonyms of environmental degradation (Lemos, 2001).

A large proportion of this phenomenon derives from agricultural activities, which have always been important in the economic context of different countries, putting aside environmental issues (Fernandes *et al.,* 2005). The most damaging aspect of environmental degradation is when the production capacity of the land is irreversibly reduced (Sampaio *et al.,* 2005; Rezende *et al.*, 2017). In addition, the environmental impacts cause other changes in the environment, which can be beneficial or not. In most cases, more importance is given to impacts that generate negative environmental consequences (Carvalho y Albuquerque, 2011).

Therefore, over the years, the issue of degradation has evolved due to the different interests of society and became more relevant within the global discussions. Most part of the environmental damage originates from human interaction with nature, especially in agriculture, to meet the demands of the market, which emerges as one of the main responsible for this process (Cunha *et al.*, 2008). Degradation is linked to a set of causes related to agricultural activity and among its determining factors is the intensive use of mechanization, fertilizers, pesticides, irrigation, deforestation, and the burning of waste (Pinto *et al.,* 2014).

The agricultural activity acts on the environment unsustainably in relation to production and causes environmental impacts such as emissions of greenhouse gases through burnings and deforestation, silting of rivers, desertification, eutrophication and salinity (Rodrigues, 2005; Engström *et al.*, 2007; El Khalili, 2009). According to Pais *et al.* (2012). The prioritization of productivity, without taking into account social and environmental responsibility, as well as the negligence regarding the disposal of waste generated from this activity, are the main causes of environmental degradation from farming.

In relation to Latin America, the issue of environmental degradation in rural areas is a constantly debated topic, as the region faces a rapid degradation of its natural resources, resulting in the loss of forests, soil erosion, contamination of rivers and weather vulnerability. Because of that, there is a loss of the natural heritage of land in Latin America since the beginning of its exploitation, from the primary exportation model to the appreciation of economic aspects through industrialization and production of today (Ramírez-Miranda, 2014). From this, the measurement of this phenomenon using appropriate assessment tools becomes very important, since it allows to acknowledge the reality of degradation in those regions (Pinto y Coronel, 2013).

The use of indices is intended to describe some aspect of a reality or to relate them (Martínez, 2004). Besides, the calculation of indices is based on scientific and appropriate methods, serving as a tool for decision-making and forecasting (Siche *et al.*, 2007). In addition, indices show the state of a certain phenomenon and are constructed by elements with a certain type of relationship (Prabhu *et al.*, 1999; Shields *et al.*, 2002). In this study, the index methodology was developed to measure degradation, so it is a measure of the proportion of environmental degradation of the studied region (Silva y Ribeiro, 2004). The work of Lemos (2001) was pioneer in the construction of this index, as it was the first to determine degradation with quantitative methods, which led to subsequent work.

Methodological Procedures

This work is based on previous studies found in the literature that used a specific methodology for the creation of a general degradation index (GDI). This index is considered a proxy for environmental degradation of a studied region (Silva y Ribeiro, 2004). The study is classified as quantitative and descriptive, since it contains observations and analyses that register and correlate phenomena without manipulating them (Rampazzo, 2002).

From previous studies on this subject in Brazil (Lemos, 2001; Silva y Ribeiro, 2004; Fernandes *et al.,* 2005; Cunha *et al.*, 2008; Pais *et al.*, 2012; Pinto y Coronel, 2014; Pinto *et al.,* 2014, 2015) we note the multidimensional nature of environmental degradation, since the magnitude of this problem requires the consideration of a set of variables of local characteristics. Because it involves variables that address different aspects, the use of multivariate analysis, specifically the factor analysis technique, is the most suitable for this purpose (Cunha *et al.*, 2008).

Factor analysis using the principal components method was applied in this study to measure the magnitude of the degradation process. The factor scores obtained with this technique enabled the construction of the AEDI, which was used to measure degradation in the Latin American scenario.

The technique of factor analysis addresses the issue of checking the correlations among a significant group of variables, defining a set of common latent dimensions, which are known as factors. This method has as main objectives to summarize and reduce data, enabling the identification of representative variables in a group of variables, in order to use it in subsequent multivariate analysis (Hair *et al.*, 2009).

A factor analysis model, according to Mingoti (2005), is usually presented in a matrix form, and it can be expressed as

$$X_i = a_{ij}F_j + \varepsilon_i \qquad (1)$$

where $X_i = \left(X_1, X_2, \ldots X_p\right)^t$: transposed vector of the observable random variables; a_{ij}: matrix (p×m) of fixed coefficients named as 'factor loadings' that describe the linear relationship of X_i and $F_j; F_j = \left(F_1, F_2, \ldots F_p\right)^t$: transposed vector(m<p) of latent variables that describe the unobservable elements of the sample; and $\left(\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_p\right)^t$: transposed vector of random errors corresponding to measurement errors and to the variation of X_i that is not explained by the common factors F_j.

Because the variables of this study have different scales, it is necessary to standardize them. This procedure is important due to the problems that data at different scales, or processed incorrectly, can provide to the research (Greene, 2008). Thus, it is desirable to make comparable the objects of study, reducing the effects of different scales (Bassab *et al.,* 1990). The standardization procedure of the variables is given by

$$Z = \frac{\left(X_i - \overline{X}\right)}{s}, \; i = 1, \ldots, n \qquad (2)$$

where Z: standardized variable, X_i = variable being standardized, $\overline{X}$ = mean of all observations, and S: standard deviation.

Through the standardization of observable random variables X_i, they can be replaced by the vector of standardized variables Z_i in order to solve the problem of scale unit differences as shown in Eq. 2 (Mingoti, 2005). Thus, Eq. 1 can be rewritten as

$$Z_i = a_{ij}F_j + \varepsilon_i \qquad (3)$$

For the construction of the Agricultural Environmental Degradation Index (AEDI), it is necessary to estimate the scores associated with each factor after the orthogonal rotation. In this study, we applied the use of orthogonal transformation of the original factors by the Varimax method, which results in a simpler structure to interpret, since it maximizes in one single factor the correlations of each variable (Hair *et al.*, 2009).

In order to verify if the factor analysis used adjusts to the data of the model, we used two suitability procedures for factor analysis, the Barlett's test of sphericity and the Kaiser-Meyer-Olkin criterion (KMO). The first provides the statistical probability that the correlation matrix has significant correlation between, at least, some of the variables; that is, it compares the population correlation matrix to the identity matrix. If the data are suitable for this analysis, the result of this test should be the rejection of the null hypothesis; that is, there is equality of the matrices. The KMO test checks the adequacy of data from the creation of an index ranging from 0 to 1, which compares the simple and partial correlations between variables, so values >0.5 demonstrate that the data are adequate for factor analysis (Mingoti, 2005; Hair *et al.*, 2009).

After this analysis the AEDI can be built. The construction of the index is in accordance to the calculation methodology by Cunha *et al.* (2008), Pais *et al.* (2012), and Pinto *et al.*

(2014, 2015). The AEDI is constructed from the aggregation of the factors obtained, as shown in Eq. 4:

$$AEDI_i = \sum_{j=1}^{P} \frac{\lambda_j}{\sum \lambda_j} F^*_{ji} \qquad (4)$$

where $AEDI_i$: general degradation index of the i-th analyzed subdivision; j: the j-th characteristic root; p: number of factors extracted from the analysis; $F^*_{ji}: j-th$ factor score of the i-th analyzed subdivision; $\sum \lambda_j$: sum of the characteristic roots in relation to the p factors extracted, in which $\lambda_j / \left(\sum \lambda_j\right)$ concerns the relative participation of the factor j in explaining the total variance captured by the p factors extracted.

It is worth mentioning that the calculation methodology of the index uses the symmetrical distribution procedure around the zero mean of the factor scores of each municipality. In order to prevent large negative factor scores to increase the magnitude of the indices associated to the subdivisions with negative factor scores, it is necessary to bring them all to the first quadrant (Lemos, 2001). This procedure should be performed prior to the estimation of the AEDI and it is expressed algebraically by

$$F_{ji} = \frac{\left(F_{ji} - F_j^{min}\right)}{\left(F_j^{max} - F_j^{min}\right)} \qquad (5)$$

where F_{ij}: factor scores; F_j^{max}: maximum value observed for thej-th factor score associated to the i-th subdivision; and F_j^{min}: minimum value observed for the j-th factor score associated to the i-th subdivision.

The universe of this study is the Latin American region, which includes countries of the three subdivisions of the American continent. These countries are grouped in this region due to their colonization characteristics, which were very similar in some aspects. The main similar characteristic is the language spoken in these countries, all derived from the Latin (Spanish, French and Portuguese). With an area of ~21,069,501km^2, this region consists of 20 countries and two overseas departments, which are the French Guiana and Puerto Rico. The countries are divided into the three subdivisions of the American continent, that is, South America, Central America and North America. In the latter, only Mexico is considered a Latin American country.

The samples were obtained considering countries that have published their agricultural censuses, in a structured manner, since the year 2000, and contained the variables of agricultural environmental degradation. Given these criteria, the sample of this study is restricted to 10 countries, namely Argentina, Brazil, Chile, El Salvador, Mexico, Nicaragua, Panama, Paraguay, Peru and Uruguay. More specifically, the study sample consists of the subdivisions in states/provinces/departments/regions of each country. Altogether, 238 subdivisions were researched, which are considered as the objects of this analysis.

For the construction of the index, we used 11 variables which were collected from each agricultural census of the 10 countries being analyzed (INIDE 2001; INDEC, 2002; IBGE, 2006; INE, 2007; INEGI, 2007; DCEA, 2008; El Salvador, 2008; DIEA, 2011; INEC 2011; INEI,2012). The variables are based on the availability of data sources and on the determinants of agriculture, as pointed out in the literature, particularly those related to labor, business conditions, environment, economic development and infrastructure (Wong and Carvalho, 2006; Silva *et al.,* 2010; Peral *et al.,* 2011; Costa *et al.*, 2013). Among the variables used are: production area of agricultural activity, number of agricultural establishments, number of individuals living in households linked to agricultural activities, number of individuals working in agricultural activities, mechanization of properties, number of tractors, use of liming and technical assistance, amount of plant production, amount of animal production, total production amount, amount of the main product, degraded production area.

Data were collected from the agricultural censuses of the indicated countries and were processed through the Statistical Package for Social Sciences (SPSS) 20.0 and Microsoft Excel 2010 software.

Results and Discussion

In order to verify if the variables are appropriate for the factor analysis, we carried out the Bartlet test, which showed a significance value of 0.000, rejecting the null hypothesis of equality of matrices, demonstrating the appropriateness of this type of analysis (Mingoti, 2005). The KMO test was also performed to confirm the adequacy of the factor analysis. The result obtained was 0.663, which being >0.5, it indicates that the use of factor analysis is viable (Hair *et al.*, 2009).

By using the method of principal components and the orthogonal Varimax rotation method by factor analysis, the six variables were grouped into two factors that are able to explain 77.66% of the total variance of the data. From the definition of the number of factors, the factor loadings and the commonalities associated with each of them can be analyzed from Table I.

By the application of factor analysis using the Varimax method, it is noteworthy that the 11 variables used for the study were reduced to three elements of agricultural degradation. These three grouped aspects can explain 77.66% of the total variance of the data. The commonalities represent the justification capacity in each variable, since those with values >0.5 or close are acceptable, and values >0.6 indicate a greater contribution of a variable to explain a given factor. The information found for the commonalities shows that all variables have their variability explained by three factors.

From the values obtained there is the possibility to check the AEDI of the available subdivisions of Latin American countries. Table II shows the subdivisions with highest and lowest AEDI. Analyzing the table we see high environmental degradation rates, since there are subdivisions that had values close to the maximum value of the index, including the Brazilian state of Sergipe with an AEDI of 100%. In relation to the most degraded regions, the supremacy of the Brazilian subdivisions stands out, because from the 20 major subdivisions with higher AEDI average, 14 are Brazilian states. This may be justified due to the historical structure of Brazil, where agriculture has always been the source of degradation in the country, since the beginning of its economy. The Brazilian states

TABLE I
FACTOR LOADINGS AFTER ORTHOGONAL ROTATION AND COMMONALITIES

Variables	Factor Loadings			Commonalities
	F1	F2	F3	
x1	0.64	0.23	0.54	0.75
x2	0.85	0.07	-0.5	0.73
x3	0.94	0.17	-0.11	0.91
x4	0.94	0.15	-0.24	0.91
x5	0.52	0.39	0.28	0.51
x6	0.85	0.17	-0.23	0.81
x7	0.17	0.97	-0.19	0.98
x8	0.31	0.81	0.86	0.75
x9	0.19	0.97	0.67	0.98
x10	0.55	0.23	0.34	0.50
x11	-0.70	-0.70	0.86	0.75

Numbers in italics denote the highest factor loadings of the variable in a factor.

TABLE II
HIGHEST AND LOWEST AEDI AVERAGE OF VARIOUS REGIONS AND STATES

Highest DI	Country	AEDI	Lowest DI	Country	AEDI
Sergipe	BR	100%	Easter Island	CL	0%
Rio Grande do Norte	BR	96.09%	Huasco	CL	0.03%
Mato Grosso do Sul	BR	93.70%	Cuscatlán	EL	0.04%
Amazonas	BR	92.68%	Tocopilla	CL	0.07%
Minas Gerais	BR	84.20%	Cabanas	EL	0.08%
Mato Grosso	BR	63.45%	San Salvador	EL	0.09%
Espírito Santo	BR	45.86%	Embera Comarca	PA	0.10%
Bahia	BR	38.43%	La Union	EL	0.10%
Roraima	BR	36.72%	Morazán	EL	0.11%
Pará	BR	35.61%	Antofogasta	CL	0.12%
Goiás	BR	34.93%	Cautín	CL	0.14%
Maranhão	BR	33.96%	Callao	PE	0.14%
Chaco	AR	33.44%	Talagante	CL	0.15%
Paraíba	BR	32.40%	Ahuachapán	EL	0.16%
Chubut	AR	31.40%	Antartica Chilena	CL	0.17%
San Luis	AR	29.84%	Santiago	CL	0.18%
Santa Cruz	AR	28.68%	San Vicente	EL	0.19%
Pernambuco	BR	28.37%	Santa ana	EL	0.21%
Puno	PE	27.38%	Aysen	CL	0.22%
Veracruz Llave	MX	26.70%	Chalantenango	EL	0.23%

are major producers of grains and use advanced corrective techniques which significantly help the country in productivity, but it results in concomitant degradation (Araujo *et al.*, 2010).

The productive chain in Brazil is based on agriculture, especially the cultures of soybean, which is its main product, corn, beans and wheat. It is also noteworthy that the Brazilian states rely on the cultivation of fruits and livestock farming, including cattle, pork and poultry.

From the analysis of Table II it is clear that there is heterogeneity among the provinces of Peru, since the province of Puno has one of the highest AEDIs (27.38%) and the province of Callao has one of the lowest (0.14%). This is explained by the fact that some territories are more degraded than others, so it is necessary to have greater control, monitoring, and balance and regulation practices of devastation in some areas (Ramirez-Miranda, 2014).

The results obtained are worrying because the intensive use of liming and fertilizers act on the environment causing negative impacts, such as the silting of rivers, fires, loss of biodiversity. It can be inferred that the use of these agricultural practices are responsible for environmental degradation. This is proven within the Brazilian agricultural context, because from the beginning of the production cycle of soybean and other cultures, the original vegetation is affected and, consequently, modifies the climate of the regions (Pinto *et al.,* 2014).

According to Table II Argentina is, after Brazil, thee second largest country with the highest AEDI, corresponding to the Chaco province. This high degradation is the result of its economy, strongly based on livestock farming.

The ranking according to the average AEDI for the 10 Latin American countries studied is presented in Table III. In general, it can be seen in this table that the agricultural degradation in the region is rather variable, as the average AEDI shows a standard deviation of 0.16. When evaluating the minimum and maximum AEDI of the countries, a great disparity between the regions is seen, since some subdivisions reached values very close to the maximum index and even to its maximum (100%), as in the case of Sergipe in Brazil. On the other hand, some subdivisions reached values very close to the minimum, and even a minimum (0,00%), as in the case of the Easter Island in Chile. The heterogeneity of the results proves the complexity of the agricultural issues in Latin America, which are due to the different dimensions of the countries of the region (Ramirez-Miranda, 2014).

The high values of the index can be explained by the modernization in the subdivisions of the analyzed countries, which are increasingly using remedial methods that cause negative impacts to the soil. Thus, the Brazilian states in particular, are the ones with a more concerning position regarding the agricultural activity and require public policies to reduce this problem (Balsan, 2006).

Provinces of Brazil, Argentina and Mexico were at the top of the ranking with the greatest degradation. Furthermore, no subdivision from these countries showed a very low AEDI, which is plausible because the economies of these countries are more dependent on agriculture and hence present higher impacts on degradation within their subdivisions (Reveles, 2006).

It is important to highlight that many of the results relate to the significant growth of agricultural production in Latin America in recent decades. However, this growth is concentrated in some regions and particular products, and it is linked to producers who have better access to foreign markets. In this context, there has been an increase in inequalities among producers, with a reduction in the number of small farmers in those regions (David *et al.*, 2000; Silva *et al.*, 2010).

The disparities are also explained in terms of degradation caused by livestock farming, as environmental degradation is most evident in regions with higher productivity in livestock activities and has is smaller in regions with lower productivity

TABLE III
COUNTRY RANKING OF AVERAGE AEDI IN LATIN AMERICA

Country	Position	Average AEDI	Maximum AEDI	Minimum AEDI	Number of cases	Standard deviation
Brazil	1	34.70%	100%	0.76%	27	0.32
Argentina	2	13.48%	33.44%	2.39%	23	0.10
Mexico	3	9.50%	26.70%	0.58%	32	0.07
Peru	4	7.28%	27.38%	0.14%	25	0.06
Panama	5	4.42%	14.83%	0.10%	12	0.04
Uruguay	6	2.95%	10.58%	0.36%	19	0.02
Paraguay	7	2.12%	4.51%	0.35%	17	0.01
Nicaragua	8	1.73%	4.62%	0.61%	15	1.01
Chile	9	1.02%	5.14%	0.00%	52	0.01
El Salvador	10	0.07%	0.84	0.04%	14	0.00
Total		8.25%	100%	0.00%	236	0.16

(Pinto *et al.,* 2014). In this study, the lowest productivity is shown for three countries that presented the lowest rates of degradation, that is, Nicaragua, Chile and El Salvador. Furthermore, the increased livestock productivity can be seen in three countries that had higher levels of degradation, that is, Brazil, Argentina and Mexico (Reveles, 2006; Ramírez-Miranda, 2014).

Final Considerations

Environmental degradation is a worldwide problem and has several consequences on environmental, social and economic conditions of society. In the Latin American scenario, there is an emerging literature on the topic; however, it has not been characterized empirically, nor degradation compared throughout the whole territory or in countries of this region. This work aimed to examine environmental degradation from an index approach for countries in Latin America.

In the construction of the Agricultural Environmental Degradation Index (AEDI), it was found that some regions have a very high standard of degradation. With respect to the average of the studied sample, the value of 8.25% can mask the situation in some countries with high degradation rates originated from agricultural activities. In order to revert this situation, there should be greater action from the government as well as a greater awareness of producers from those countries with higher levels of degradation.

Brazil, Argentina and Mexico are the countries with highest levels of agricultural environmental degradation, as their economies are based on agriculture. The lowest degradation rates obtained were for countries where the agricultural activity does not have a high productivity, such as Nicaragua, Chile and El Salvador.

The study was limited to a specific time period, so it was not possible to analyze the dynamics of degradation over time. Besides, the research did not raise other aspects related to the development of those regions and the measurement of this phenomenon was limited to capturing information through the studied index. In addition, it should be emphasized that the study did not use a standardized database and the data were collected individually from the censuses of each country. For future work, environmental degradation should be studied over a longer period of time in order to find patterns in this phenomenon, as well as to relate it to other aspects, such as economic and social characteristics, and compare the results to those obtained other continents and countries.

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