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Three-mensional sustainability profile in the agricultural valley autlán-El Grullo-El Limón, Jalisco, Mexico

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Abstract

In the last decades, a high awareness of the environmental, economic and social impact studies as a result of productive activities, including agriculture, has been promoted worldwide. This need led to a compelling need to make a shift towards agriculture under the sustainability approach. The IRS Methodology used in this research allowed a specialized study of ecological, social and economic issues. Based on the objectives and hypotheses of this study, we concluded that the sustainability of the Autlán-El Grullo-El Limón Valley located in the state of Jalisco, Mexico is very low; there is a difference between municipalities and communities and between the contributions of dimensions. The evaluation allowed detecting the deficiencies that can have the model at the time of its execution, in such a way, that it allows improving its processes.

IRS, Sustainable, Autlán, El Grullo, El Limón

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Introduction

In the last decades, a high awareness of the environmental, economic and social impact as a result of productive activities including agriculture has promoted worldwide. This impact has led to the imperative need to make a shift towards agriculture under the sustainability approach. All of this has allowed the development of different methodologies to evaluate sustainability in agricultural production systems through various weights and analysis strategies (Kú, *et al.*, 2013).

The Sustainable Development (SD) promotes an integral and equitable development mainly in its three dimensions; Social and environmental.

From the perspective of DS, economic growth is understood as not synonymous with development and that increasing quantity does not induce improvements in quality. Its formulation comes to express a rejection of the belief that science and technology infallibly lead to an improvement of the human condition. Sustainable development challenges fundamental tenets of capitalism as unlimited economic growth. It shares an ideology of solidarity, redistributive justice, and egalitarian ethics, and is concerned with the rapid development of the world's population (Ferras & Paredes, 1999).

Sustainable development, as a model under construction, presents its work, its innovation, its construction, its invention, to overcome the old and current problems of humanity. It is, therefore, a different way of thinking, doing and living based on the needs of its actors, and is different from what some authors already pointed out as a patchwork of continued growth, as their detractors are supposed to confuse. (WECD, 1987, Brown, *et al*., 1987; Bowers, 1997).

Ruckelhauss (1989) points out that the achievement of sustainable development could be balanced through with the Neolithic agricultural revolution and the Industrial Revolution. Apparently, this is a new utopia, a new challenge for humanity, an opportunity for development models. This agricultural revolution is a utopia, which unlike previous ones, has greater tools for its achievement, but also, its challenges are more significant (Casas, 2002).

The present study, from the perspective of Ruckelhauss, carried out the evaluation of the Sustainability of the several productive communities located in the Agricultural Valley Autlán-El Grullo-El Limón, Jalisco, Mexico. The study was performed through the application of the Relative Index Sustainability (IRS) designed by Casas and Cols (Casas, et al., 2009) which allows quantifying sustainability and identifying the key elements of a strategy for regional agricultural development.

The relative sustainability index (IRS) is an ad hoc methodology to evaluate sustainability at the community or agro-ecosystem level proposed by Casas et al. (2001), which in this essay is described and complemented for its application. The IRS starts with the vision of the concept of sustainability.

Given the relatively recent creation of the IRS proposal, it is desirable to give general indications of its development. The IRS assumes that Sustainable Development could achieve with some degree of development and integration of its economic, social and environmental dimensions. Ideally, sustainability concept is represented as a triangle in which the combination of the dimensions coincides and whose values are> 0.5 on a scale of 0 to 1. Values <0.5 denote an absence of sustainability. Finally, the lack of the contribution of its dimensions (Casas *et al.*, 2001).

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Methodology

The IRS methodology integrated variables of three different natures (social, economic, environmental) and the units in a dimensionless product.

To this end, a process of standardization of environmental variables such as water, soil, biodiversity, management and area of crops (temporary, irrigation, chemical or organic fertilizers and productivity levels) was carried out.

Social variables are characteristics of the human population, their density, employment, health, food, education, migration, social participation, politics, and instruments.

Finally, economic variables are such as technological and capital goods and tools to carry out their activities and the balance of their economic activities (income-expenditure).

This methodology was not a specialized study of ecological, social and economic issues. The themes and variables selected were considered, as those in which there is more or less coincidence to evaluate sustainability.

The variables that have been chosen to assess sustainability in this study are not the only ones nor restrictive to be modified to the needs of the objectives of other studies.

The study was carried out on four components. The first is a characterization of the valley in generic terms. The second with the application of IRS quantified the sustainability and contribution of the dimensions (environmental, social and economic) of the region, municipalities, and communities. It also allowed the quantitative and qualitative identification of the core strategy variables for regional agricultural development.

The third component was complemented based on the analysis of the information obtained from the 19 producers leaders and representatives of Federal, State and Municipal institutions. And finally, the fourth component was the analysis of Strengths, Opportunities, Weaknesses and Threats (SWOT), which ranked the variables according to their importance to promote regional agricultural development. All variables are presented in a list according to the hierarchy of the current valley situation of the valley concerning the primary constraints to sustainable development. The hierarchy of SWOT variables is characterized in agricultural terms.

The sustainability assessment considered the information of 153 units of family farming, and 18 final variables (six social, six economical, and six environmental) in the nine communities located in the Agricultural Valley of the Autlán, El Grullo, and El Limón municipalities, Jalisco Mexico.

Sample Size:

The sample size was determined statistically according to Rendón and Cervantes (1991) with a 7.5% variance ratio.

The sample size was increased in the communities where the sample size was 153 producers to have more certainty during the process of quantifying sustainability on applying the IRS. The proportional distribution of the sample to each ejido or community can be seen it in Table 1.

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Municipality	# of Producers	% of Producers	N
Autlán de Navarro, Jalisco, México			
Ahuacapán	126	21	29
El Chante	132	22	30
Lagunillas	73	12	17
El Grullo, Jalisco, México			
Ayuquila	49	8	11
El Aguacate	11	2	8
Puerta del Barro	25	4	10
El Limón, Jalisco, México			
La Ciénega	126	21	28
San Juan de Amula	43	7	10
San Miguel	20	3	10
Total	**602**	**100**	**153**

Table 1 Distribution of agricultural producers by community interviewed in the Municipalities of Autlán, El Grullo, and El Limon, Jalisco, Mexico

Geographic area location of the study:

The present research was carried out in the Autlán-El Grullo-El Limón Agricultural Valley, Jalisco, Mexico, with geographic coordinates 19 ° 35 'to 19 ° 54 N and 104 ° 07' to 104 ° 29 'W (INEGI, 2000).

Figure 1 Geographical location of the municipalities that make up the Autlán-El Grullo-El Limón Agricultural Valley, Jalisco

The communities that were the object of study are: for the Municipality of Autlán de Navarro: Ahuacapán, El Chante, and Lagunillas. For the Municipality of El Grullo: Ayuquila, El Aguacate, and Puerta del Barro. For the Municipality of El Limón: La Ciénaga, San Juan de Amula, and San Miguel, respectively (see Table 1).

Criteria for selection of communities

For the selection of the communities, it obeyed the predominant conditions of the valley that the communities presented as they are: plain and slopes, with areas of irrigation and temporary.

The technique of the survey consisted in the systematic interrogation of individuals to know the functioning of the economic, environmental and social logic of the system, through its subsystems (family, agricultural, forestry, and livestock), which allowed capturing the qualitative and quantitative elements Of sustainability. Both the guides and the questionnaires were structured according to the elements of strategic planning. In the reagents, care was taken to use a language appropriate to the members of the communities studied.

Application of surveys

The survey technique consisted of the systematic use of a questionnaire to the individuals living in the communities mentioned above. All the subjects studied were of both sexes and adults and could read and write.

All respondents were aware of the objective of the survey and the nature of the ongoing research. They were also asked to answer the questionnaire voluntarily and were made aware of the policy of confidentiality of data provided by them.

The aim of the survey was to know the functioning of the economic, environmental and social logic of the system, through its subsystems (family, agricultural, forestry, and livestock), which allowed capturing the qualitative and quantitative elements of sustainability.

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Before the general application of the questionnaire, it was applied to 25 producers, to verify the understanding of the questions, and clarification of doubts and, thus, to eliminate design errors that might arise in the instrument. The reliability of the questionnaires was determined throughout Spearman and Brown's Split-half reliability test (cited in Mason and Bramble (1997), which included a sample of 17 producers from the three municipalities, resulting in r = 0.74.

The application of the IRS quantified the sustainability and contribution of the dimensions (environmental, social and economic) of the region, municipalities, and communities.

The IRS determination was complemented by a third component based on the analysis of the information obtained from interviews with 19 producer leaders and representatives of federal, state and municipal institutions.

Sustainability

The concept of sustainability used in this research was developed based on (*f*) the relationships between humans (social dimension), the transformation they make of nature through the instruments and available technology (economic dimension), and the Capacity of nature to develop and recover from human activity (environmental dimension). Where: S = sustainability and the environmental dimension (Da), social dimension (Ds) and economic dimension (De). The degree of sustainability obtained for any system depends on the contribution or inhibition of each dimension. Under the scope of our Model, we assumed that sustainable development is a process in time and space.

The calculated values was a relative value of modern development, so sustainability index is estimated with the IRS, which includes the same components of sustainability, That is, IRS = *f* (Da, Ds, De).

Process of Selection of Variables in the IRS

The original variables were selected based on their greater ecological, economic and social variation among the communities, based on the higher values of the standardized canonical coefficients of the new variables, called discriminant functions. To compare the interest groups, in this case, the communities, a series of multivariate statistics tests were applied.

Quantification and Qualification of Sustainability

The rating of each variable was related to its tendency towards sustainability and the location of the average real values in an interval that has been established on a scale proposed by the evaluator. Variable's limits are defined by a proportional range (Xp). Xp is the Minimum value average and the absolute maximum that the variable takes between communities. The Likert's scale (Casas, et al., 2009) is a discrete assessment scale that proposes the evaluator to convert natural values into classes; these classes are whole natural numbers that can vary, from -5, to +5.

	Range Condition for average values:		
Range condition for variable values	**Are positives and trend is positive †**	**Are negatives and trend is positive, or trend is 0**	**Are positives y negatives with a positive trend**
Value = ± 1	$X \leq X_{(1)} + X_{pr}$	$X > X_{(5)} - X_{pr}$	$X \leq 0 \pm X_{pr}$
Value = ± 2	$X_{(1)} + X_{pr} > X \leq X_{(1)} + 2X_p$	$X_{(1)} + 3X_p > X \leq X_{(1)} + 4X_p$	$\pm X_{pr} > X \leq \pm 2X_p$
Value = ± 3	$X_{(1)} + 2X_p > X \leq X_{(1)} + 3X_p$	$X_{(1)} + 2X_p > X \leq X_{(1)} + 3X_p$	$\pm 2X_p > X \leq \pm 3X_p$
Value = ± 4	$X_{(1)} + 3X_p > X \leq X_{(1)} + 4Xp$	$X_{(1)} + X_{pr} > X \leq X_{(1)} + X_p$	$\pm 3X_p > X \leq X \pm 4X_p$
Value = ± 5	$X > X_{(5)} - X_{pr}$	$X \leq X_{(1)} + X_{pr}$	$X > X_{(5)} - X_{pr}$

Note: † X is the value of the variable under evaluation in each community; X (1) is the lowest absolute value of the evaluated communities that the variable takes; X (5) is the largest absolute value of the variable in the communities; And X_{pr} is the proportional part of the evaluation space of the variable divided by five (X (5) X (1)/ 5.

Table 2 Transformation and qualification of the real values of a variable continue on a discrete scale, using five ranges, according to its tendency to promote (+) or inhibit (-) sustainability.

Results

The variables showed differences in the averages between the communities for the evaluation of sustainability, which are listed by dimension: Environmental, Social, and Economic in Tables 1, 2 and 3.

With the 18 variables (see Table 3) a database was created in which the discriminant function analysis procedure was applied, and from this analysis, the following results are obtained.

The analysis showed that the first three discriminant functions (FD1, FD2, and FD3) contain the highest proportion of variance (81.24%). This analysis demonstrated that the model is appropriate given the nature of the variables (see Table 4).

With the applications of the equations used in this study, the sustainability of the Autlán-El Grullo-El Limón Agricultural Valley presented an IRS of 0.5512 or 10.24% of sustainability (see Table 4). In which sustainability qualifies as very low. The dimension with no contribution to sustainable development is the environmental dimension with an IRS of (0.4775%), which becomes its limiting. In fact, except for two communities; Ciénega and San Juan de Amula in the municipality of El Limón, which are barely in the minimum contribution, the rest of the seven communities presented values lower than 0.5. So this dimension is growing, lacking development to make contributions to sustainable development, and therefore requires more attention. Although the IRS is almost similar between the Autlán municipalities of Navarro, El Grullo and El Limón; 0.5516%, 0.5363%, and 0.5597%, respectively, their sustainability rating identified the difference between them.

El Grullo presented the relative sustainability lower than Autlán and EL Limón, with 7.26%, 10.32%, and 11.94% sustainability, respectively. The communities within the municipalities also presented differences in their sustainability in the range of 4.04 to 14.00%.

The difference is remarkable when comparing the communities of the three municipalities. Thus, Ayuquila is the community that relatively presented the lowest sustainability with 4.04%, whereas San Juan de Amula of the Municipality of El Limón, is the community that showed a greater sustainability (14%). The rest of the communities are between 7 and 12% sustainability. These results are shown in Table 4.

In summary, sustainability at the valley level classified as very low with an IRS of 0.55 or 10.25% of sustainability. The environmental dimension under a scope of at the regional level presents no contribution to sustainable development, with an IRS of (0.48%), considered as a limitation for the sustainable development of the region.

List	Variable	Units
De1	Family Wages	$
De2	Per capita expenditures	$
De3	Time dedicaced to farming activities	Month
De4	No farming work	Number of indivuals
De5	Farming prfit	$
De6	Annual Per capita balance	$
Ds1	Age	Years
Ds2	Family school level average	Years
Ds3	Educational gender equity	Years
Ds4	Nutricional index	Units
Ds5	Bedroom density	Units
Ds6	Income family participation	%
Da1	Per capita surface	Ha
Da2	Production stability	Tons./ha
Da3	Consumed electric energy average	Kwatts/annual
Da4	Raining season surface	Ha
Da5	Sugar cane cultivated area	Ha
Da6	Corn cultivated area	Ha

Table 3 Description of the studied variables: Economic (De), Social (Ds) and Environmental (Da) selected to quantify sustainability

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discriminant functions	Canonical Correlation	Autol Canonical Correlation	Standard error	Cuadrado Canonical Correlation	Values	Eigenvalues of INV(E)*H =CanRsq/(1-CanRsq)		Accumulated
						Difference	Proportion	
FD1	0.7926	0.7516	0.0301	0.6282	1.69	0.9418	0.4744	0.4744
FD2	0.6542	0.5809	0.04639	0.4279	0.74	0.2921	0.21	0.6844
FD3	0.559647	0.475437	0.055706	0.313205	0.456	0.2207	0.128	0.8124
FD4	0.436438	0.254832	0.065661	0.190478	0.2353	0.0348	0.066	0.8784
FD5	0.408698	.	0.067562	0.167034	0.2005	0.0669	0.0563	0.9347
FD6	0.343323	.	0.07155	0.117871	0.1336	0.0584	0.0375	0.9722
FD7	0.264521	0.178734	0.075435	0.069972	0.0752	0.0516	0.0211	0.9934
FD8	0.152049	-0.015633	0.079236	0.023119	0.0237	.	0.0066	1

Table 4 Contribution of the discriminant functions to the population variance

Municipality	Community	DE	DS	DA	IRS	% de Contribution to sustainability	Sustainability Assess	Attention Priority
7	Autlán	0.5735	0.5701	0.4735	0.5390	7.80	Very low	6
	Casimiro	0.6431	0.5705	0.4627	0.5588	11.76	Very low	6
	El Chante	0.5988	0.5944	0.4855	0.5996	11.92	Very low	6
		0.5991	0.5708	0.4758	0.5516	10.32	Very low	6
El Grullo	Autlán	0.5303	0.5878	0.4424	0.5202	4.04	Very low	6
	Puerta del Barro	0.5766	0.6166	0.4366	0.5433	8.66	Very low	6
	El Grullo	0.5875	0.575	0.4875	0.5500	10	Very low	6
		0.5620	0.5942	0.4528	0.5363	7.26	Very low	6
El Limón	La Colonia	0.5940	0.5857	0.5011	0.5603	12.06	Very low	6
	San Miguel Hidalgo	0.5966	0.5933	0.4533	0.5477	9.54	Very low	6
	San Juan de Ocotán	0.6066	0.5833	0.5200	0.57	14	Very low	6
		0.5972	0.5868	0.4951	0.5597	11.94	Very low	6
Dimension Contribution		0.5915	0.5847	0.4775	0.5512	10.24	Very low	6
Dimension assess			Very low contribution	Very low contribution	Very low contribution			
% of contribution			18	16.94	4.5			
Attention Priority			6	6	6			

Table 5 Sustainability Assessment and Contribution of Dimensions for Sustainable Development in three municipalities of the Autlán-El Grullo-El Limón Agricultural Valley based on statistical data

Discussion

In the valley, there is dynamic in sustainability between municipalities and communities, the Municipality of El Limón presents higher values both in contribution and in dimensions and its IRS. El Grullo presented the lowest values of relative sustainability trend. Autlan, at this moment, is in an intermediate situation in values of sustainability in the contribution of its dimensions, as well as in the IRS. This dynamic can be explained by a degradation of the environmental variables due to a greater exploitation of natural resources, as well as deterioration in the social and economic variables. These effects were more marked in El Grullo and Autlán, and not so much because the Conditions in the municipality of El Limón, but relatively has deteriorated less with respect to the other two municipalities studied, but nevertheless, goes in the same trend as Autlán and El Grullo.

The standardized canonical coefficients identified the variables Z2 (annual external income), Z7 (Agricultural Utility), Z17 (Balance) of the economic dimension and variables X1 (Per Capita) and X18.1 (Maize) of the environmental dimension; as the variables that had the highest standardized canonical value (Table 5). It should be remarkable that although the social dimension did not identify variables with a high standardized canonical value, it was proposed to select the variables of this dimension that presented the highest values, assuming that they contain the greatest social variation among communities. Among the social variables that showed this characteristic are Y2 (Age) and Y9 (Density of room). By using these variables or related activities, a strategy proposal was elaborated as an element of strategic planning.

Conclusions

Based on the objectives and hypotheses of this research, it is concluded that the sustainability of the Autlán-El Grullo-El Limón Valley located in the state of Jalisco, Mexico are very low. Also there being a difference between municipalities and communities and between the dimensional contributions. According to Casas (1994), Claussewitz (1942), Luck & Prell (1968), Colón and Rodríguez, Bateman and Snell, El BID, Kauffman (cited in Cano & Olivera, 2008), the evaluation made it possible to detect deficiencies Have the model at the time of its execution, in such a way, that it allows to improve its processes.

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Therefore, the evaluation process of the Sustainable Regional Development Plan for the Autlán - El Grullo and El Limón Agricultural Valley; It is proposed to be carried out every three years based on a diagnosis and to the qualitative and quantitative variables resulting from the evaluation of sustainability through the Relative Sustainability Index applied for the Autlán-El Grullo-El Limón Agricultural Valley.

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