J. Technol. Manag. Innov. 2007, Volume 2, Issue 1.

Journal of Technology Management & Innovation

Received February 14, 2007/ Accepted March 12, 2007

AN ENVIRONMENTAL IMPACT ASSESSMENT SYSTEM FOR RESPONSIBLE RURAL PRODUCTION IN URUGUAY

Geraldo Stachetti Rodrigues*, Aelita Moreira Viñas[1]
Embrapa Environment, Environmental Management Laboratory.
Caixa Postal 69, Jaguariúna, São Paulo, CEP 13820-000, Brazil

* Corresponding author. Tel.: +55-19-38678735; fax: +55-19-38678740.
E-mail: stacheti@cnpma.embrapa.br (G.S. Rodrigues).

Abstract

The present paper presents EIAR-Uruguay as an environmental management tool for indicating PPR's participating farmers which practices and technology need improvements, and to facilitating the evaluation of the Project's accomplishments. This experience has been recently brought to Chile in the 'II PROCISUR (Cooperative Program for the Technological Agricultural and Agro-industrial Development of the South Cone) Course on Models for Environmental Management of Rural Activities', held in Chillán on the 13th and 14th of December 2007, resulting in promising prospects to offer support for the 'Clean Production Initiative' being forwarded in this country.

Key words: environmental impact assessment, technology appraisal and recommendation, environmental certification, sustainable rural development

Executive resume

Under the auspices of the World Bank and the Global Environmental Facility, the "Ministerio de Ganadería, Agricultura y Pesca del Uruguay (MGAP)" initiated an "Integrated Natural Resources and Biodiversity Management Project" (known as "Responsible Production Project – PPR"), intended to bring managerial and technological innovations onto the country's rural sector. Projections are to offer, until the 2011 horizon of PPR, one tenth of the forty thousand small and medium size farmers of the country financial support for their conversion to responsible production, following the guidance of a dedicated environmental management system. The 'Rural

[1] Ministerio de Ganadería, Agricultura y Pesca del Uruguay. Proyecto "Integrated Natural Resources and Biodiversity Management Project" known as "Proyecto Producción Responsable" , Ministerio de Ganadería, Agricultura y Pesca del Uruguay

Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay) devised for this objective consists of a set of 57 integrated indicators spanning five dimensions of sustainability, namely (i) Landscape Ecology, (ii) Environmental Quality (Atmosphere, Water, and Soil), (iii) Socio-cultural Values, (iv) Economic Values, and (v) Management and Administration. The System is formulated with weighing matrices formulated to consider benchmark compliance values for the indicators, validated in two contrasting situations representative of the spectrum of typical rural establishments addressed by PPR – a small horticulture and a medium livestock production establishment. Almost five hundred of the small and medium size farmers will apply the method to measure the baseline in the 2007 – 2011 period. It will be applied in the beginning and at the end of the financing, in order to measure their sustainability.

The present paper presents EIAR-Uruguay as an environmental management tool for indicating PPR's participating farmers which practices and technology need improvements, and to facilitating the evaluation of the Project's accomplishments. This experience has been recently brought to Chile in the 'II PROCISUR (Cooperative Program for the Technological Agricultural and Agro-industrial Development of the South Cone) Course on Models for Environmental Management of Rural Activities', held in Chillán on the 13th and 14th of December 2007, resulting in promising prospects to offer support for the 'Clean Production Initiative' being forwarded in this country.

1. Introduction

The "Cooperative Program for the Technological Agricultural and Agro-industrial Development of the South Cone" (PROCISUR) has supported in the later years a Technological Sustainability Platform. The objective is to promote Eco-certification Standards for the Agricultural Production, in order to improve the competitiveness of the regional rural sector. Given this converging objective with the Rural Development Policy of the "Ministerio de Ganadería, Agricultura y Pesca del Uruguay" (MGAP), consolidated in the "Responsible Production Project" (PPR) (under the auspices of the World Bank and the Global Environmental Facility), it has been proposed to formulate a methodological tool directed at the environmental management of the responsible rural production.

The ensuing "Rural Environmental Impact Assessment System for Uruguay" (EIAR-Uruguay) consists of a set of weighing matrices formulated to evaluate sustainability indicators for a given agricultural activity introduced or modified in a rural establishment. The EIAR-Uruguay System has been adapted from the earlier APOIA-NovoRural System (Rodrigues & Campanhola, 2003), conformed at Embrapa Environment (Brazil) to support the environmental management of agricultural activities and to promote the sustainable development of rural communities and territories (Rodrigues, 2005; Rodrigues et al., 2006).

The formulation of EIAR-Uruguay, as well as the associated Manual and Field Protocols (http://eltorodepicasso.com/ministerio/index.php), has been possible due to the organization of an inter-disciplinary and inter-institutional working group, with technicians and researchers from the Direction of Soils and Waters of Uruguay (RENARE – MGAP), the Inter-American Institute for Agricultural Cooperation (IICA), the School of Agronomy of the University of the Republic of Uruguay, and Embrapa Environment, by intermediation of PROCISUR.

The System has been adapted according with Uruguayan biomes composition and environmental characteristics, taking into consideration the main rural activities and applicable legislation. The System adaptation proceeded in workshops and critical analysis meetings was followed by field trials involving all personnel, as well as farmers and their associated agronomy technicians. The final assessments were composed into 'Individual Environmental Management Reports' issued to the participating farmers, containing recommendations of adequate alternative management practices and technology adoption for improvement of the environmental performance of the establishments. With such a procedure, EIAR-Uruguay offers the basis for recommending, evaluating and documenting the adoption of Best Management Practices and technology innovations for PPR's participating rural establishments, and to facilitating the reporting of the Project's accomplishments, as demanded by the supporting Agencies.

2. A dedicated System for Environmental Impact Assessment of Rural Activities – EIAR-Uruguay

The EIAR-Uruguay System consists of a set of environmental indicators weighing matrices (Rodrigues, 1998) formulated towards the systemic assessment of a rural activity, according to five sustainability dimensions: i) Landscape Ecology, ii) Environmental Quality (Atmosphere, Water and Soil), iii) Sociocultural Values, iv) Economic Values, and v) Management and Administration. These dimensions are integrated to encompass the productive farm system within the local environment and market setting (Figure 1). The rural establishment conforms the spatial scale of analysis, which is performed by quantitatively and analytically assessing the effects of the rural activity on each and every indicator constructed for these five dimensions, and automatically calculating the impact indexes, according to appropriate weighing factors.

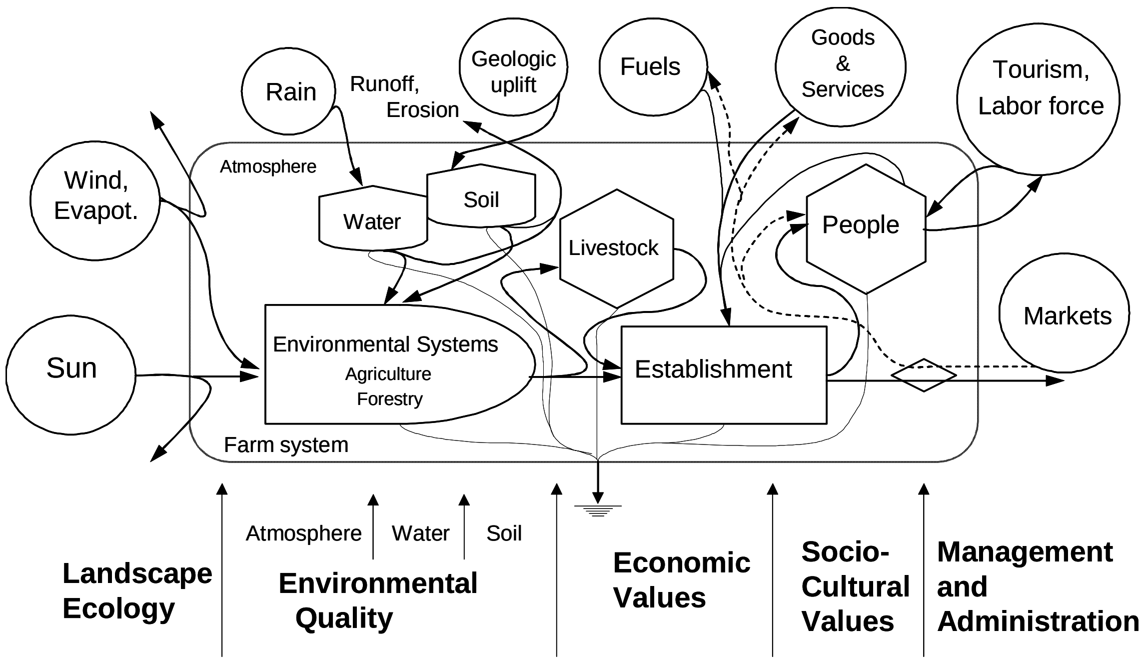


Figure 1. 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay) insertion of sustainability dimensions considered for the construction of environmental indicators. The farm system diagram is represented with system language symbols, according to Odum (1996). Natural and manmade sources are organized hierarchically from left to right and coupled with natural storages and environmental production units. These production units sustain the consumer units of the human economy, that on the one side harbor all market transactions, and on the other side connect by recycle and control feedbacks with the environment.

The System integrates fifty-seven indicators, constructed from a literature review of Environmental Impact Assessment methodologies (Dee et al., 1973, Canter, 1979; Neher, 1992; Bockstaller et al., 1997; McDonald & Smith, 1998; Girardin et al., 1999; Bosshard, 2000; Rodrigues et al., 2000; Rossi & Nota, 2000; Rodrigues & Campanhola, 2003; Monteiro & Rodrigues, 2006), group discussions and workshops. The indicators were selected, constructed, and organized as to encompass the range of possible environmental effects directly defined as impacts, and to be applicable in its entirety to any rural productive activity. The complete set of indicators of the EIAR-Uruguay System, and their respective measurement units sought out in field and laboratory analyses can be seen in Tables 1 to 5.

Table 1. Integrated indicators in the Landscape Ecology Dimension of the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), and specific measurement units used in field- and laboratory-obtained data.

Dimensions and indicators	**Measurement units for field and laboratory data**
Landscape ecology dimension	
1. Physiognomy and conservation state of natural habitats	• Percent area of the establishment
2. Management condition of productive areas	• Percent area of the establishment
3. Management condition of confined activities (agricultural/non-agricultural and animal raising)	• Percent profit of the establishment, excluded non confined activities
4. Fauna corridors	• Preserve area (ha) and number of fragments
5. Landscape diversity *	• Shannon-Wiener index (calculated)
6. Productive diversity *	• Shannon-Wiener index (calculated)
7. Reclamation of degraded areas *	• Percent area of the establishment
8. Incidence of endemic disease vector sources	• Number of sources
9. Risk towards ecologically significant species	• Number and status of (sub)populations
10. Landscape degradation hazards	• Number of influenced areas

(*) Indicators expressed by two related measures, the impact index and the relative or proportional variation, each converted into utility value.

Table 2. Integrated indicators in the Quality of Environmental Compartments Dimension of the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), and specific measurement units used in field- and laboratory-obtained data.

Quality of environmental compartments dimension	
Atmosphere	
11. Suspended particles/smoke	• Percent of time with occurrence
12. Foul odors	• Percent of time with occurrence
13. Noise	• Percent of time with occurrence
14. Carbon oxide emissions	• Percent of time with occurrence
Water	
15. Dissolved oxygen *	• Milligram O_2 / liter
16. Coliform count *	• Number of colonies /100 ml
17. Biochemical Oxygen Demand (BOD_5) *	• Milligram/liter
18. pH *	• pH
19. Nitrate *	• Milligram NO_3/liter
20. Phosphate *	• Milligram P_2O_5/liter
21. Turbidity *	• Nephelometric units
22. Chlorophyll a *	• Microgram chlorophyll/liter
23. Conductivity *	• Micro Siemens/cm
24. Visual water pollution	• Percent of time with occurrence
25. Pesticides potential impact	• Percent of treated area
Groundwater	
26. Coliform count *	• Number of colonies/100 ml
27. Nitrate *	• Milligram NO_3/liter
28. Conductivity *	• Micro Siemens/cm

Maintenance of soil productive capacity	
29. Soil organic matter content	• Percent organic matter content
30. pH *	• pH
31. Na exchangeable	• Milliequivalent/100 g
32. P resin *	• ppm P Bray
33. K exchangeable *	• Milliequivalent/100 g
34. Mg (e Ca) exchangeable *	• Milliequivalent/100 g
35. Potential acidity (H + Al) *	• Milliequivalent/100 g
36. Sum of cations *	• Milliequivalent/100 g
37. Cation exchange capacity (CEC) *	• Milliequivalent/100 g
38. Cation saturation *	• Percent saturation
39. Erosion potential	• Percent of area of the establishment

(*) Indicators expressed by two related measures, the impact index and the relative or proportional variation, each converted into utility value.

Table 3. Integrated indicators in the Sociocultural Values Dimension of the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), and specific measurement units used in field- and laboratory-obtained data.

Sociocultural values dimension	
40. Access to education	• Number of people
41. Access to basic services	• Access, true or false (1 or 0)
42. Comfort standards	• Access, true or false (1 or 0)
43. Conservation of historic, artistic, and archaeological legacy	• Number of monuments/events/sites
44. Quality of employment	• Percent of workers
45. Occupational health and safety	• Number of people exposed
46. Local opportunity for higher qualification employment	• Percent of workers

Table 4. Integrated indicators in the Economic Values Dimension of the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), and specific measurement units used in field- and laboratory-obtained data.

Economic values dimension	
47. Establishment net profit	• Tendency of attributes (1 or 0)
48. Diversity of profit sources	• Proportional share of profit sources
49. Profit distribution	• Tendency of attributes (1 or 0)
50. Current indebtedness level	• Tendency of attributes (1 or 0)
51. Establishment value status	• Proportional share of value changes
52. Habitation quality	• Proportional share of residents

Table 5. Integrated indicators in the Management and Administration Dimension of the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), and specific measurement units used in field- and laboratory-obtained data.

Management and administration dimension	
53. Manager profile and dedication	• Occurrence of attributes (1 or 0)
54. Commercialization conditions	• Occurrence of attributes (1 or 0)
55. Residues management	• Occurrence of attributes (1 or 0)
56. Chemical residues management	• Occurrence of attributes (1 or 0)
57. Institutional relationships	• Occurrence of attributes (1 or 0)

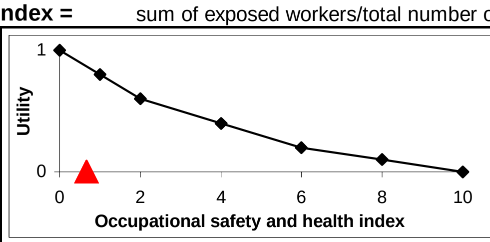
The data required for filling many of the indicators weighing matrices consist of administrative and historical knowledge of the farm manager, and are obtained in an interview supported by a structured questionnaire. Other indicators, related to soil and water quality are obtained by instrumental field and laboratory analysis. All indicator weighing matrices are constructed (MS-Excel®) to translate indicator variables and attributes into environmental impact indices expressed graphically relative to a utility function (scale normalized from 0 to 1, with the benchmark compliance value set at 0.7; Bisset, 1987) for the indicator (Figure 2). These utility functions express the environmental performance benchmarks for each particular indicator, and were derived from sensitivity and probability tests, case-by-case for each indicator (Girardin et al., 1999).

Table of numer of people exposed

Occupational safety and health	**Source of risk -**	**Peril factors:** Ionizing radiation	Explosives	Flamable materials	High voltage	**Harm factors:** Noise	Vibration	Heat / cold	Humidity	Chemical agents	Biological agents
Total number of workers -	15					1		9			

Occupational safety index = sum of exposed workers/total number of workers 0.7

IOccupS	**Utility**
10	0
8	0.1
6	0.2
4	0.4
2	0.6
1	0.8
0	1



Best fit equation for Utility

Rational function: y=(a+bx)/(1+cx+dx^2)

Coefficients:

a =	1.00
b =	-0.10
c =	0.15
d =	0.00

U-IOccupS= 0.85

Figure 2. Typical weighing matrix of the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), showing the Occupational health and safety indicator (after Rodrigues & Campanhola, 2003).

The composition of the utility functions for environmental performance for the indicators is based on sensitivity and probability tests, case-by-case for each indicator (Girardin et al., 1999). In the probability test one defines the limits of scale (maximum and minimum) and the compliance value (0.7) for the indicator, according with try-and-error numerical resolution of the indicator index (in the present case, sum of exposed workers / total number of workers). In the sensitivity test one defines the meaning of the change brought about by the evaluated activity, its direction (whether positive or negative) and its quantitative relationship to an established performance baseline, according with defined benchmarks. These tests allow the construction of a table of correspondence between the indicator index (IOccupS) and the utility values, which are then shown graphically. This correspondence relationship is then mathematically effected by a best fit equation, resulting in the expression of the impact index in utility values (U-IOccupS, in the present case 0.85.

The results of the evaluations are presented graphically in printable form, expressing the performance of the evaluated activity for each one of the indicators, comparatively to the defined benchmark. The results for all indicators are then combined by mean utility value for each dimension considered, composing a synthesis graph of impact for the five dimensions of assessment and the activity as a whole.

The EIAR-Uruguay System has been developed after the following principles:

- ✓ Allow the impact assessment of any rural activity, in establishments of varied scales and environmental settings;
- ✓ Consider indicators relative to the ecological, economical, socio-cultural, and management impacts;
- ✓ Contribute towards early detection of critical negative impacts, favoring management practices and technology innovation adoption to correct those impacts;
- ✓ Express results in a direct and simple fashion, both for farmers, and for technicians and decision-makers;
- ✓ Offer an integrated impact index for the activity, favoring the environmental management of the establishment and the eco-certification of its production.

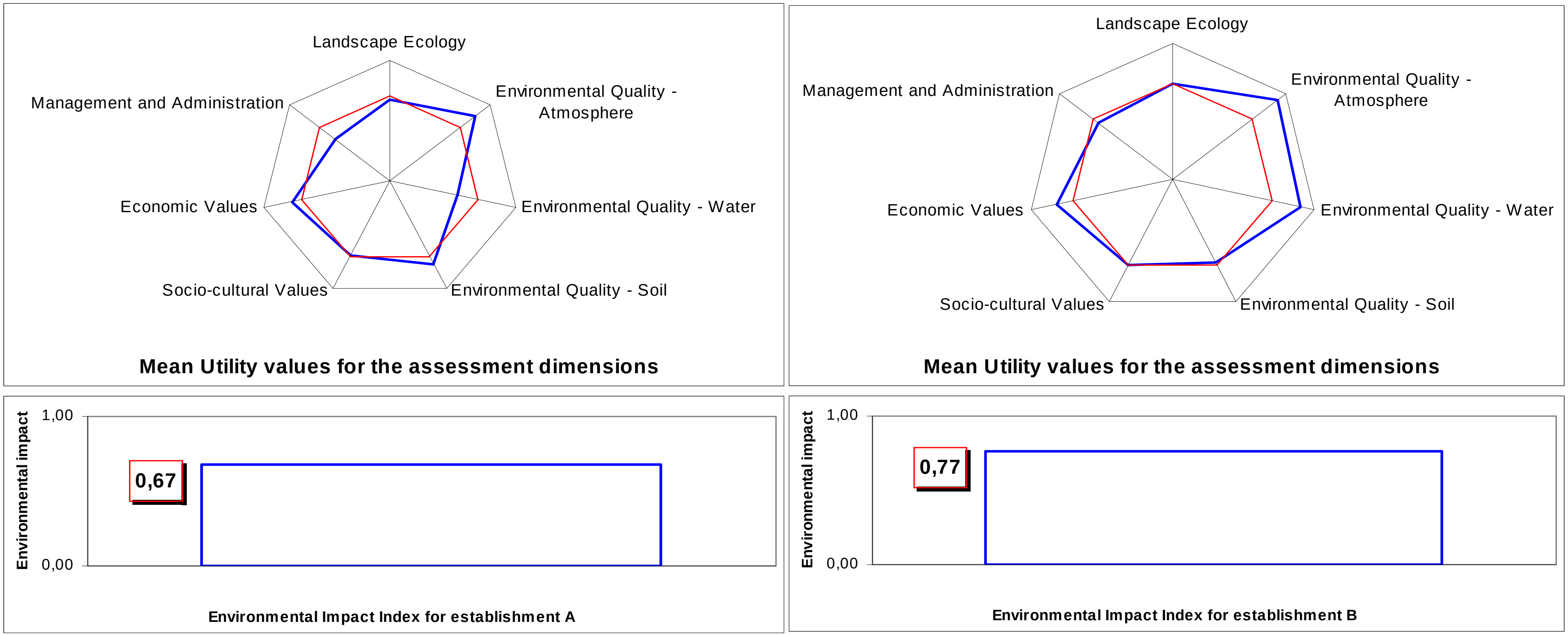
3. Field validation of EIAR-Uruguay

Field surveys were carried out in two establishments selected among PPR applicants in August 2006. The establishments were chosen as to encompass the range of typical production scales and activities sought out as defined in the Project's objectives. Establishment A represented the small scale (5 ha) type, dedicated to diversified horticulture carried out in greenhouses and field conditions, and including several accessory productive activities for the family's own consumption. Establishment B represented the medium size (480 ha) type, dedicated to extensive cattle production.

In the field surveys, the establishments' limits, soil and water sampling sites, and proportions of areas occupied by productive activities or natural habitats were estimated by GPS reference points taken in the field and plotted onto satellite images and maps. Some water quality indicators (O_2, pH, Conductivity, Turbidity) were measured in the field with a Horiba (U-10) Multi-parameter Probe. Nitrate was measured with a Merck RQ-Flex field colorimeter. Coliform levels were estimated using Technobac (AlphaTecnoquímica) culture media slips. Water samples were brought to the laboratory for Phosphate and Chlorophyll content analysis with a HACH spectrophotometer. Soil samples were analyzed for all routine chemical parameters. Other indicators were checked according with documents and personal knowledge of the farmers.

4. Results and Discussion

The results of the environmental impact assessment case studies carried out with the EIAR-Uruguay System in the two representative establishments are presented in Figure 3. Contrasting Environmental Impact Indices were obtained for the two establishments, the one dedicated to horticulture reaching 0.67, right below the benchmark compliance value defined in EIAR-Uruguay (0.70); and the one dedicated to livestock production reaching 0.77, quite above the defined benchmark. The main sustainability dimension causing such a contrast in favor of Establishment B was Water Quality (indices = 0.53 and 0.90, for establishments A and B, respectively), with some influence caused also by the Economic Values Dimension (indices = 0.78 and 0.82). On the other hand, Soil Quality was somewhat better for Establishment A (index = 0.77), than for Establishment B (0.68), clearly due to the more intensive use of soil amendments and fertilizers applied in horticulture, as compared even with the improved pastures of Establishment B.



Establishment A **Establishment B**

Figure 3. Results obtained with the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), for two establishments with contrasting management and production systems, in Canelones and Maldonado Departments, Uruguay, August 2006.

The observed Water Quality contrast was mostly due to low O_2 levels, associated with high BOD_5 and Turbidity, besides very high Coliform bacteria presence both in surface and groundwater, and high Nitrate levels in groundwater in Establishment A. On the other hand, aside from transient lightly depressed O_2 levels, all indicators of water quality considered in EIAR-Uruguay were well above the benchmark compliance value in Establishment B (Table 6). The groundwater contamination detected in Establishment A is most certainly due to the long standing intensive occupation of the area, and to the inappropriate location of the shallow well where samples were taken, in the proximity of the greenhouses, the animal corrals, and the family dwellings.

Table 6. Water Quality indicators, corresponding parameter analytical results and associated utility values obtained with the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), for two establishments with contrasting management and production systems, in Canelones and Maldonado Departments, Uruguay, August 2006.

Indicators and measurement units	Estalishment A			Establishment B		
	Parameter value before	Parameter value after	**Utility value**	Parameter value before	Parameter value after	**Utility value**
Dissolved oxygen (mg / L)	8.5	2.1	**0.28**	5.7	5.7	**0.61**
Coliforms (number / 100 ml)	1560	2760	**0.15**	0.0	0.0	**1.00**
BOD_5 (mg / L)	4.5	3.5	**0,54**	2.7	2.7	**0.70**
pH	8.7	8.9	**0.54**	6.4	6.4	**0.91**
Nitrate (mg / L)	< 2.5	< 2.5	**0.73**	< 2.5	< 2.5	**0.73**
Turbidity (Nephelometric units)	87	91	**0.01**	20	20	**0.94**
Chlorophyll µg / L	22.2	27.5	**0.82**	4.5	4.5	**1.00**
Conductivity (µS / cm)	1.1	1.01	**0.95**	0.14	0.144	**0.95**
Visual pollution (percent of time present)	100% wo	100% wo	**1.00**	100% wo	100% wo	**1.00**
Pesticides (percent of area sprayed)	100% area increase in frequency and variety	100% decrease in toxicity	**0.80**	100% area without	100% area without	**1.00**
Coliforms groundwater (number / 100 ml)	2100	2100	**0.16**	0.0	0.0	**1.00**
Nitrate groundwater (mg / L)	53	53	**0.01**	0.2	0.18	**1.00**
Conductivity groundwater (µS / cm)	1.11	1.11	**0.95**	55	55	**0.87**
Water Quality Index			**0.53**			**0.90**

The indicators of the Management and Administration Dimension in Establishment A showed important opportunities for improvement (utility value = 0.55), demanding only small investment and managerial effort (Figure 4). In this Dimension, the Manager profile and dedication indicator has been shown to be the only one reaching the benchmark compliance value defined in EIAR-Uruguay (utility value = 0.83, complying with Local residence, Exclusive dedication to rural activities, Capacitation for the activity, Family engagement, and Utilization of accounting system; lacking only Planning system). Deficiencies were observed concerning provisions for:

1. Market insertion (utility value = 0.63), owing this performance due to lacking Brand-name, Advertisement, and Productive enchainment; and complying with Direct sales provision, Local processing and storing, Own transportation, and Cooperative sales;

2. Residues management (utility value = 0.40), low performance due to lacking provisions for Selective collection and Composting, and Adequate final destination; and complying with Reuse and Sanitary disposal for domestic residues;
3. Chemicals management (utility = 0.40), which lacks Infrastructure for adequate storage, Individual protection equipment use, and Appropriate destination for used containers; and complies with Spaying equipment calibration, and Treatment register;
4. Institutional relationship (utility value = 0.50), lacking Defined technological affiliation, Inspection and certification, and Periodic training for employees; and complying with Formal technical assistance, and Association.

All these indicators can be easily complied with, demanding only minor investment and managerial effort, which may be provided by the 'Responsible Production Project', thus contributing to improve Establishment A's socio-environmental performance.

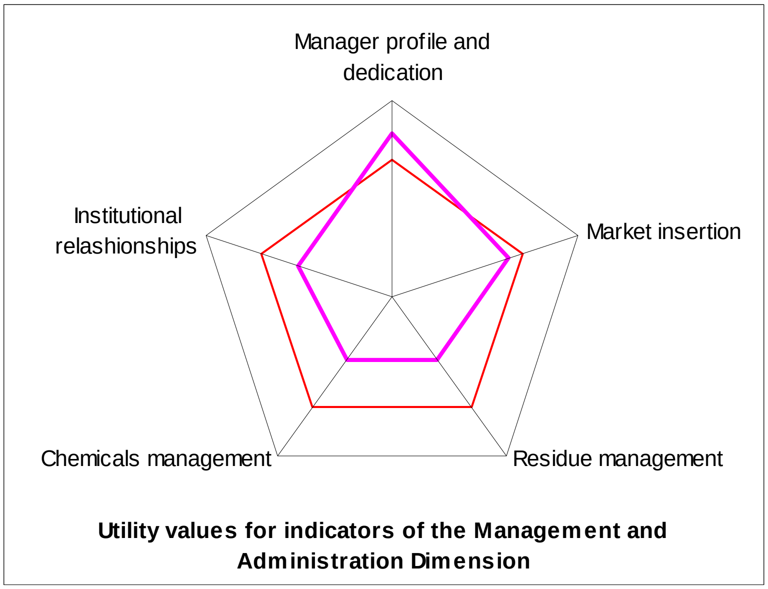


Figure 4. Results obtained with the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), for the Management and Administration Dimension of sustainability in Establishment A, Uruguay, August 2006.

In its turn, Establishment B presented lower indicator performances for the indicators of Landscape diversity and Productive diversity (indices = 0.38 and 0.24, respectively) in the Landscape Ecology Dimension (aggregate utility value = 0.71, Figure 5). This result stems more from the productive suitability of the region for livestock husbandry and the natural homogeneity of the local biome, comprised essentially by subtropical prairies, than to any strategic choice of the farmer.

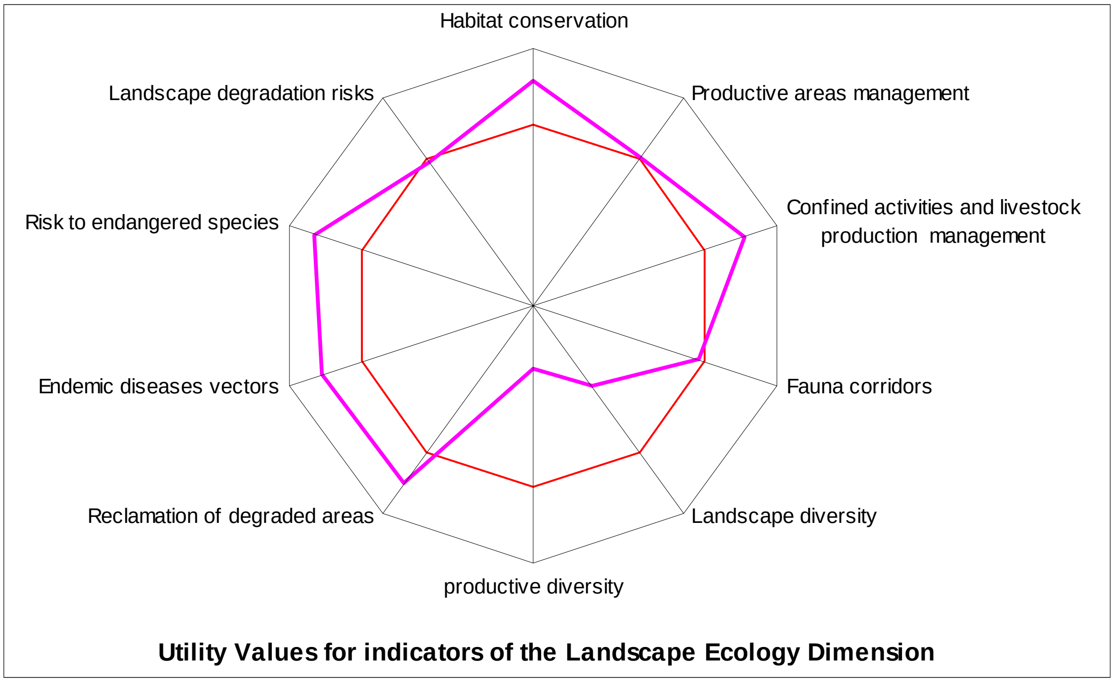


Figure 5. Results obtained with the 'Rural Environmental Impact Assessment System for Uruguay' (EIAR-Uruguay), for the Landscape Ecology Dimension of sustainability in Establishment B, Uruguay, August 2006.

The results just summarized were presented to the farmers in Individual Environmental Management Reports, stressing the opportunities for performance improvement for the establishments, with indications of best management practices and technologies, according with EIAR-Uruguay set of indicators.

5. Conclusion

The EIAR-Uruguay System has been shown to be a comprehensive environmental management tool, amenable to field application by trained technicians, and adequate for distribution and use at low cost, generating objective reports in printed format of easy interpretation. The System facilitates the detection of critical impacts for management practices and technology uses corrections, as well as the quantification of favorable impacts, which may contribute towards sustainable resources exploitation and natural habitats conservation. The EIAR-Uruguay 'environmental impact index' is proposed as a yardstick for the eco-certification of rural establishments, pursuant to integrating ecological integrity, economic vitality and socio-cultural equity measures for local sustainable development. These results are instrumental for the collective organization of local farmers for the sustainable origin labeling of their production, improving the opportunities for especial market insertion.

The EIAR-Uruguay System has been made public in an event held at the 'Mercosur Building' in Montevideo on November 29th of 2006, together with its Technical Manual, Field Data Collection Instructions, and Individual Environmental Management Report template. Following this event, an intensive course was offered to the agronomy technical assistants associated with PPR, preparing the implementation of the System as a managerial tool for the rural sector in the country.

This experience carried out in Uruguay has been recently brought to Chile, during the 'II PROCISUR Course on Models for Environmental Management of Rural Activities,' held at the INIA Quilamapu in Chillán last December, resulting in promising prospects to offering support for the 'Clean Production Initiative' being currently forwarded in this country. It is expected that a dedicated R&D project will be forwarded in order to promote the adaptation of the System to the specific needs of the INIA Quilamapu and characteristics of Chile's environment and main productive activities, resulting in a customized Environmental Management System with similar conceptual framework as the APOIA-NovoRural and the EIR-Uruguay.

6. Acknowledgements

The institutional support offered by Embrapa Environment (Brazil), the 'Ministerio de Ganadería, Agricultura y Pesca del Uruguay' (MGAP), the Inter-American Institute for Agricultural Cooperation (IICA), and the 'Cooperative Program for the Technological Agricultural and Agro-industrial Development of the South Cone' (PROCISUR) is gratefully acknowledged. The World Bank and the Global Environmental Facility offered the financial support for this study, under the provisions of the 'Proyecto Producción Responsible' (PPR). The formulation of EIAR-Uruguay would not have been possible without the diligent contribution of researchers and technicians who participated in the working groups formed for adapting the System, as follows: from Embrapa Environment - Cláudio César de Almeida Buschinelli and Izilda Ap. Rodrigues; from IICA - Guillermina Cantou; from the MGAP-RENARE -José Bico, Alfredo Bruno, Jorge Carricaburu, Carlos Crérici, Aarón Kacevas, Américo Kurucks, Fernando Olmos, and Carlos Víctora; from MGAP-PPR - Nicolas Marchand, and Natalia Martínez; from MGAP-UPTC - Vicente Plata; from the Instituto Plan Agropecuario - Marcelo Pereira; from the School of Sciences of the University of the Republic of Uruguay - Elena Rodó; and from the School of Veterinary Medicine of the University of the Republic of Uruguay - Humberto Tomasino. We are especially grateful to the farmers Mr. Javier Barbano and Mr. Diego Núñez and their associated technicians Ing. Agr. Daniel Barrerra and Ing. Agr. Ismael Paradeda.

7. References

Bisset, R., 1987. Methods for environmental impact assessment: a selective survey with case studies. In: Biswas, A. K.; Geping, Q., Eds. *Environmental Impact Assessment for Developing Countries*. London: Tycooly International, pp.3-64.

Bockstaller, C.; Girardin, P.; Van der Werf, H.M.G., 1997. Use of agro-ecological indicators for the evaluation of farming systems. *European Journal of Agronomy*, 7, pp.261-270.

Bosshard, A., 2000. A methodology and terminology of sustainability assessment and its perspectives for rural planing. *Agriculture, Ecosystems and Environment*, 77, pp.29-41.

Canter, L.W.; Hill, G.L., 1979. *Handbook of Variables for Environmental Impact Assessment*. Ann Arbor (MI): Ann Arbor Science Publishers Inc.

Dee, N.; Baker, J.; Drobny, N.; Duke, K.; Whitman, I.; Fahringer, D., 1973. An environmental evaluation system for water resource planning. *Water Resources Research*, 9 (3), pp.523-535.

Girardin, P.; Bockstaller, C.; Van der Werf, H., 1999. Indicators: tools to evaluate the environmental impacts of farming systems. *Journal of Sustainable Agriculture*. 13 (4), pp.5-21.

McDonald, G.T.; Smith, C.S., 1998. Assessing the sustainability of agriculture at the planning stage. *Journal of Environmental Management*, 52, pp.15-37.

Monteiro, R.C.; Rodrigues, G.S., 2006. A system of integrated indicators for socio-environmental assessment and eco-certification in agriculture – Ambitec-Agro. *Journal of Technology Management and Innovation.* 1 (3), pp.47-59.

Neher, D., 1992. Ecological sustainability in agricultural systems: definition and measurement. *Journal of Sustainable Agriculture*, 2 (3), pp.51-61.

Odum, H.T., 1996. *Environmental Accounting*: *Emergy and Environmental Decision Making*. New York: John Wiley & Sons, Inc.

Proyecto Manejo Integrado de los Recursos Naturales y la Diversidad Biológica (MGAP / BM / GEF). Available at http://eltorodepicasso.com/ministerio/index.php, access on March 12th 2007.

Rodrigues, G.S., 1998. *Avaliação de Impactos Ambientais em Projetos de Pesquisas - Fundamentos, Princípios e Introdução à Metodologia*. Jaguariúna (SP): Embrapa Meio Ambiente (*Documentos 14*).

Rodrigues, G.S.; Buschinelli, C.C. de A.; Irias, L.J.M.; Ligo, M.A.V., 2000. *Avaliação de Impactos Ambientais em Projetos de Pesquisa II: Avaliação da Formulação de Projetos - Versão I*. Jaguariúna (SP): Embrapa Meio Ambiente, Boletim de Pesquisa 10.

Rodrigues, G.S.; Campanhola, C., 2003. Sistema integrado de avaliação de impacto ambiental aplicado a atividades do Novo Rural. *Pesquisa Agropecuária Brasileira*, 38 (4), pp.445-451.

Rodrigues, G.S., 2005. Gestão ambiental e desenvolvimento rural sustentável. *In*: Pântano Filho, R. & Rosa, D dos S. (Eds.) *Meio Ambiente: múltiplos olhares*. Campinas, SP: Companhia da Escola.

Rodrigues, G.S., Campanhola, C., Rodrigues, I.A., 2006. Gestão ambiental de atividades rurais: estudo de caso em agroturismo e agricultura orgânica. *Agricultura em São Paulo*. 53 (1), pp.17-31.

Rossi, R.; Nota, D., 2000. Nature and landscape production potentials of organic types of agriculture: a check of evaluation criteria and parameters in two Tuscan farm-landscapes. *Agriculture, Ecosystems and Environment*, 77, pp.53-64.