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A SYSTEM OF INTEGRATED INDICATORS FOR SOCIO-ENVIRONMENTAL ASSESSMENT AND ECO-CERTIFICATION IN AGRICULTURE – AMBITEC-AGRO

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Abstract

The Brazilian Agricultural Research Agency (Embrapa) has proposed a “System for Environmental Impact Assessment of Agricultural Technology Innovations” (Ambitec-Agro) for the appraisal of research projects and technology innovations in the institutional context of R&D. A derived system, directed at eco-certification of rural activities (Eco-cert.Rural), has been proposed in order to extend the environmental assessment practice to rural activities. The Ambitec-Agro System comprises a set of weighing matrices organized for the integrated assessment of socio-environmental indicators, including modules focused on the environmental impact assessment of Agricultural, Livestock production, and Agro-industrial activities and a specific module for Social Impact Assessment. The calculated impact indices facilitate socio-environmentally sound decision making and allow the delineation of *ad hoc* recommendations for performance improvements, as well as selection of best cases for benchmarking purposes. The paper presents the Ambitec-Agro System and its applications as a project appraisal and technology management methodology.

Key words: socio-environmental impact assessment, technology appraisal, environmental certification, eco-labeling, sustainable development

1. Introduction

While environmental conservation and social responsibility issues gain increasing importance in the development agendas at all institutional levels, it becomes necessary to select, adapt, transfer, and assess Sustainable Environmental Management and Best Production Practices (Barnthouse et al., 1998). Especial reference to this managerial movement is warranted when rural activities are regarded, because of the spatial scale and bulk of natural and human resources encompassed worldwide by agriculture (Pimentel et al., 1992).

In order to bring a practical reach to this sustainable development objective, society should value and recompense farmers and producers who adequately manage their environment and resources, both as an incentive towards sustainability and as repayment for environmental and social services rendered (Viglizzo et al., 2001). Among the possible alternatives to carry out assessments of socio-environmental performance of rural activities, the use of ecological and social indicators of sustainability has been a method of choice (Girardin et al., 1999). Ideally, the indicators are organized in Impact Assessment Systems that may span increasing levels of complexity and goal requirements for environmental management (Rodrigues et al., 2003; Payraudeau et al., 2004).

Aiming at motivating farmers to wittingly promote technology conversion and adoption of sustainable management practices for rural activities, as well as facilitating technology development project appraisal at the institutional R&D level, a system for impact assessment is sought, based on objective indicators constructed on a flexible platform, acceptable for application on the large diversity of rural activities, environmental situations, and their combinations.

Pursuing this objective, the Brazilian Agricultural Research Agency (Embrapa) has proposed a “System for Environmental Impact Assessment of Agricultural Technology Innovations” (Ambitec-Agro) for the institutional context of R&D (Rodrigues et al., 2003). The system has been installed as a corporate impact assessment platform employed yearly by all Embrapa Units (38 throughout the country) to evaluate their technological contributions (Lima et al., 2001; Avila et al., 2005), besides being widely applied to support research project appraisals and technology innovation impact assessments (Irias, 2004a; Lanna et al., 2004). The files containing the Ambitec-Agro System (and its modules) are available for download via internet access through the Embrapa Environment homepage at http://www.cnpma.embrapa.br/forms/ambitec.html.

An Impact Assessment System derived from the Ambitec-Agro platform has been proposed recently, integrating all environmental and social indicators, organized toward eco- certification of rural activities (Rodrigues et al., 2006a), in attendance to a demand of the “Inter-American Institute for Cooperation on Agriculture – Cooperative Program for the Agricultural Technological Development of the South Cone” (IICA - PROCISUR). The present paper revises these impact assessment systems and discusses their application for the appraisal of research projects, technology innovation management, and agricultural activity participatory certification.

2. A System for Environmental Impact Assessment of Agricultural Technology Innovations – Ambitec-Agro

The aim of the Ambitec-Agro System is to provide a practical, expedite, reliable, and reproducible socio-environmental impact assessment platform for a wide range of agricultural technologies and rural activities. The system’s hierarchical structure rely on series of technology and rural activity *Principles*, composed by *criteria* of social and environmental performance, constructed by selected *indicators*, which were validated by prior experience and field trials (Irias et al., 2004a; Lanna et al., 2004; Rodrigues et al., 2006b). The indicators are scored in a field survey / interview with the farmer / administrator who expresses a *change coefficient* for each indicator, according to his / her knowledge about the technology or rural activity effects. The change coefficients are weighed by factors related to each indicator’s *relevance* toward effecting socio-environmental impacts and its *scale of occurrence* (Rodrigues et al., 2003). Finally, Impact indexes are calculated for each indicator, criterion and technology innovation studied.

The Ambitec-Agro System consists of a platform of indicator weighing matrices (Figure 1) integrated in electronic spreadsheets (MS-Excel®). The indicators are combined meaningfully to compose the modules of the system, according with the productive sector (agriculture, livestock, agro-industry) and assessment dimension (environmental or social) (Table 1). Once the change coefficients resulting from the field survey / interview are introduced in the weighing matrices, the impact indices for each criteria are expressed graphically in the assessment spreadsheets.

Table of change coefficients for variable		Water quality variable				
Water Quality		Biochemical Oxygen Demand	Turbidity	Floating materials / Oil / Scum	Siltation	weighing factor check
Weighing factors k		-0,25	-0,25	-0,25	-0,25	**-1**
Scale of occurence = No-effect	Mark with an X					
Near	1				-1	
Proximate	2	-1	-3			
Surrounding	5			-3		
Impact Coefficient = (change coefficients * weighing factors)		**0,5**	**1,5**	**3,75**	**0,25**	**6,0**

Fig. 1. Typical Ambitec-Agro indicator weighing matrix for environmental impact assessment. The given example expresses the field observation of a moderate reduction in BOD at the proximate environment scale, a major decrease in turbidity also at the proximate environment, a major reduction in the presence of floating materials / oil / scum in the surrounding environment; and a moderate reduction in siltation at the near environment scale.

Ecological performance principle		**Socio-environmental performance principle**				
Use of Inputs and Resources Criterion and Indicators:	**Environmental quality criterion and indicators:**	**Costumer Respect Criterion and Indicators:**	**Employment Criterion and Indicators:**	**Income Criterion and Indicators:**	**Health Criterion and Indicators:**	**Management & Administration Criterion and Indicators:**
1. Use of Agricultural Inputs and Resources 1.1. Use of Agrochemicals - Pesticides - Fertilizers - Soil amendments 1.2. Use of Natural Resources- Consumptive use of water- Water for processing- Land area	4. Atmosphere - Greenhouse Gases - Particulate material / Smoke - Foul smells - Noise	9. Product Quality - Chemical residues reduction - Biological contaminants reduction - Inputs suppliers availability - Input suppliers reliability	11. Training 11.1. Training Type - Local short course - Specialization short course - Regular education 11.2. Training Level - Basic - Technical - Superior	15. Net Income generation - Security - Stability - Distribution - Amount	18. Personal and Environmental Health - Endemic diseases sources - Atmospheric pollutant emissions - Water pollutant emissions - Soil contaminants generation - Restriction to sport and leisure practices	21. Farmer Capability and Dedication - Specialized training - Dedicated working time - Family engagement - Use of accountancy system - Formal planning - Certification / Labeling
2. Use of Veterinarian Inputs and Raw Materials 2.1. Use of Inputs- Veterinarian products- Hay / Fodder	5. Soil Quality - Erosion - Organic matter - Nutrient leaching - Compaction	10. Production Ethics 10.1. Animal Welfare & Health - Animal welfare - Access to water sources and forage supplementation - Sanitation and health conditions - Livestock density - Ethical handling, transportation and slaughtering	12. Opportunity and Qualification for Local Employment 12.1. Worker Origin - Farm - Local - Municipality - Region	16. Income Sources Diversity - Agriculture and livestock - Other rural activities - External jobs - Business branching - Financial investments	19. Occupational Safety & Health - Risk exposure - Noise - Vibration - Heat / Cold - Moisture - Chemical agents - Biological agents	
2.2. Use of Raw Materials - Basic raw materials - Raw materials for processing - Agroindustrial additives Feed / Supplements	6. Water Quality - Biological Oxygen Demand - Turbidity - Floating materials / Oil / Scum - Siltation		12.2. Worker Qualification - Untrained - Trained - Specialized - Technical	17. Land Value - Facilities improvement investments - Natural resources conservation - Products / services prices - Compliance to legal aspects - Public services / Tax policies etc.	20. Food Safety & Security - Production guarantee - Food quantity - Food nutritional quality	
3. Use of Energy - Fossil fuels - Biofuels - Biomass - Electricity	7. Biodiversity - Natural vegetation loss - Fauna corridors loss - Species / Varieties losses	10.2. Social Capital - Attention to local social needs - Rural technical assistance projects	13. Job Generation and Engagement - Temporary - Permanent - Partner - Family			

8. Environmental Restoration - Degraded soils - Degraded ecosystems - Legally-defined Preservation Areas - Mandatory Protection Areas	14. Employment Quality 14.1. Work Legislation - Underage work prevention - Workweek < 44 hs. - Formal contract - Social Security 14.2. Fringe Benefits - Housing assistance - Food assistance - Transportation assistance - Health care assistance

Table 1. Integrated Principles, Criteria and Indicators of the several modules of Ambitec-Agro (whole indicators set, presented as organized in the Eco-cert.Rural System)

The change coefficients of the System are standardized as varying from –3, meaning a major decrease in the indicator, to +3, meaning a major increase in the indicator (Table 2), reflecting the effects of the studied technology or rural activity, contingent to each particular assessment. The indicators are then weighed according with their *relevance* to conform the assessment criteria and their *scale of occurrence*.

Table 2. Effects caused by the agricultural technology in the studied situation and *indicator change coefficients* to be inserted into the cells of the Ambitec-Agro weighing matrices

Effect of the technology innovation on the agricultural activity under the management conditions studied	**Component change coefficient**
Major increase in the component	+3
Moderate increase in the component	+1
Component unaffected	0
Moderate decrease in the component	-1
Major decrease in the component	-3

The *weighing factors* related to the *relevance* of each indicator (k in Figure 1) are defined on an *ad hoc* basis according to user criteria in order to better reflect specific situations and add up to ±1 (according with the indicator impact direction, either positive or negative). Hence, the relevance weighing factors consist of a normalization step to equalize the different number of indicators that make up each assessment criteria. The *factors for scale of occurrence* (Table 3) are related to the geographic scale in which the indicator change coefficient occurred in the studied case, as follows:

i. *near environment* when the technology / rural activity effect on the indicator is restricted to the crop area, productive field or facility where the studied activity is being conducted;

ii. *proximate environment* when the technology / rural activity effect on the indicator extends beyond the productive unit, but within the limits of the property or farmstead;

iii. *surrounding environment* when the technology / rural activity affects the indicator in an area or environment beyond the limits of the property or farmstead.

Table 3. Weighing factors included in the Ambitec-Agro System, relative to the scale of occurrence of an indicator change coefficient, contingent to the field survey / interview on the effects of an agricultural technology innovation or activity.

Scale of occurrence	**Weighing factor**
Near environment	1
Proximate environment	2
Surrounding environment	5

After the insertion of the indicator change coefficients into the assessment matrices the system automatically calculates the *impact coefficient* for each indicator (Figure 2), and for all indicators in each criterion (Figure 3), expressing graphically the obtained results. Lastly, a *Technological Innovation Impact Index* (Figure 4) is calculated for the specific conditions studied, by averaging all the normalized impact coefficients.

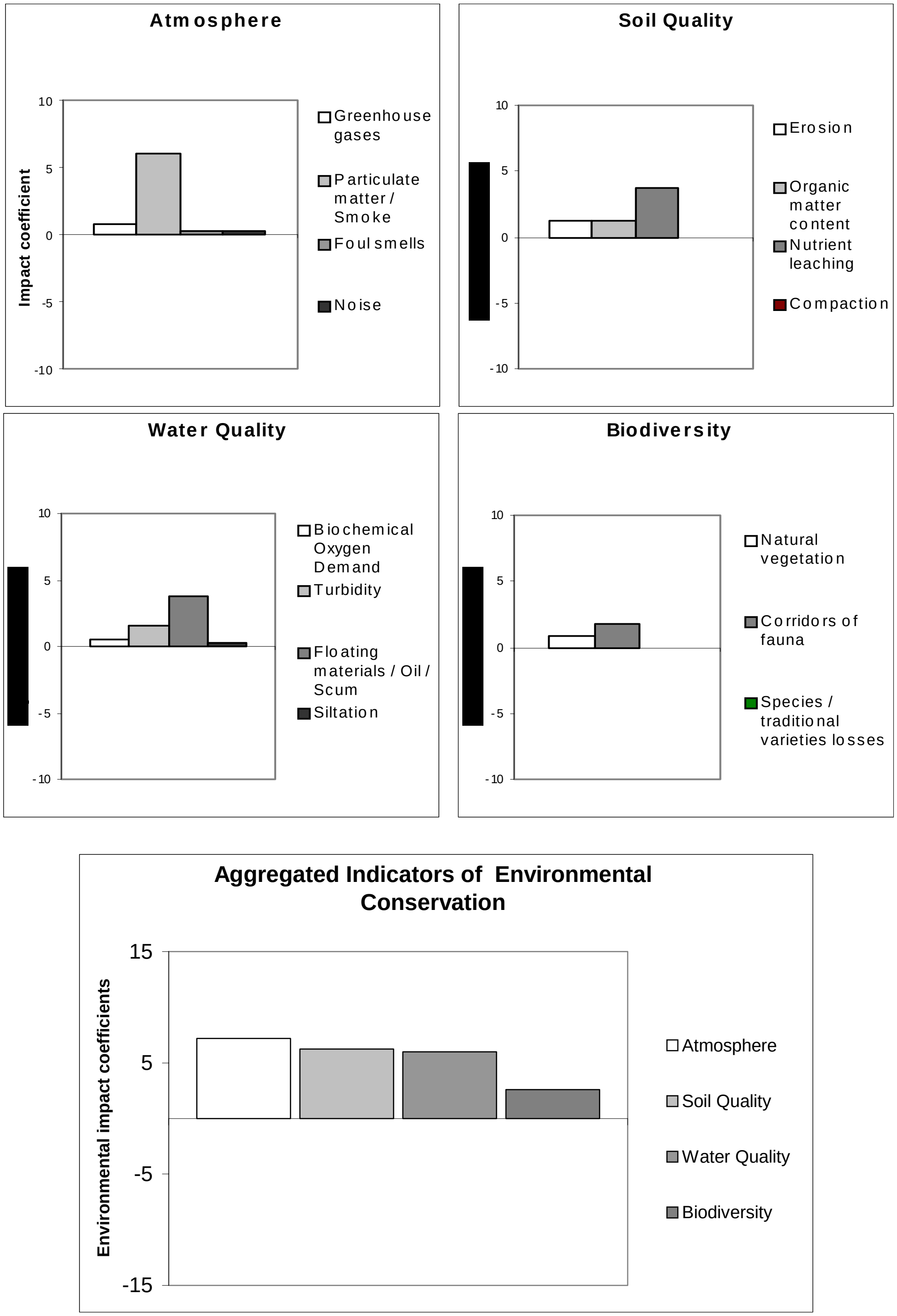

Fig. 2. Typical Ambitec-Agro graphic display showing criteria results. The example presents the aggregated impact assessment indices for environmental conservation indicators

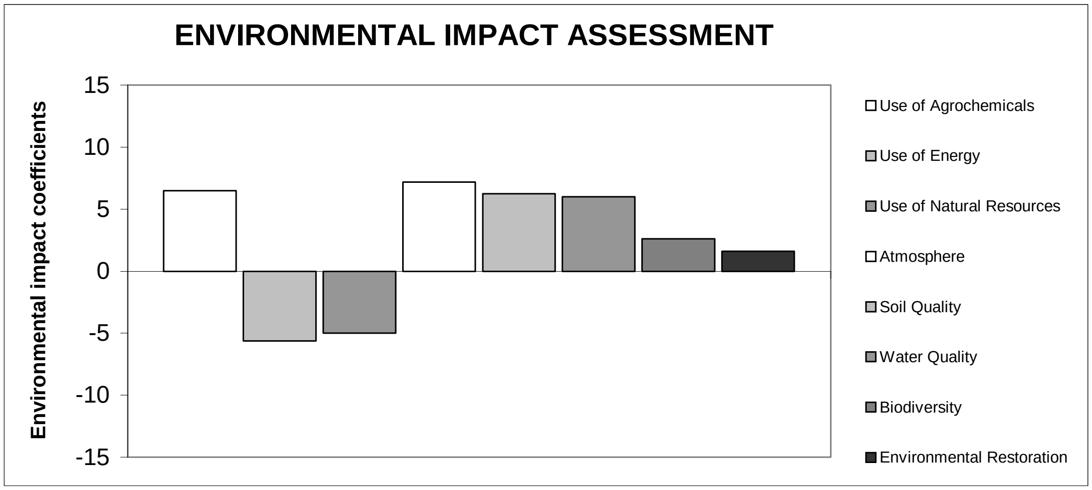

Fig. 3. Typical Ambitec-Agro graphic display for aggregated criteria results. The example presents the aggregated impact assessment indices for the Ambitec-Agriculture module.

Environmental Impact Indicators	Importance weighing factor	Indicator impact coefficient
Use of Agrochemicals	0,125	6,50
Use of Energy	0,125	-5,63
Use of Natural Resources	0,125	-5,00
Atmosphere	0,125	7,20
Soil Quality	0,125	6,25
Water Quality	0,125	6,00
Biodiversity	0,125	2,60
Environmental Restoration	0,125	1,60
Weighing factor check **1**	**Agricultural Technology Innovation Environmental Impact Index**	**2,44**

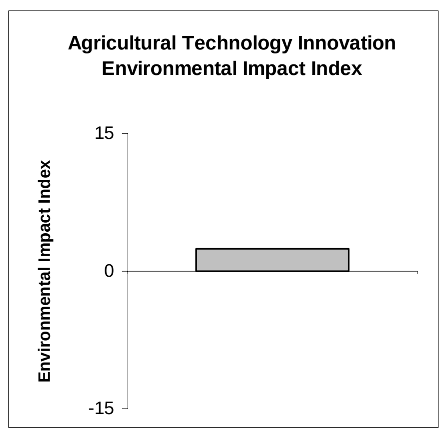

Fig. 4. Final environmental impact assessment graphic display of Ambitec-Agro (agriculture module). The indices Table shows the Importance weighing factors for each criteria and the final Technology Innovation Impact Index.

2.1. Ambitec-Agro Assessment Modules

The Ambitec-Agro System is composed by four modules, designed to application focused on the productive sectors of Agriculture, Livestock, and Agro-industry environmental impact assessment (Irias et al., 2004b) and a specific module for Social impact assessment (Rodrigues et al., 2005). The evaluation process is developed in three steps: 1. data surveying about the technology use magnitude, geographical area delimitation and users; 2. field survey / interview applied to the establishment manager, and system filling out; and 3. indexes analysis, interpretation, and proposal of alternative management practices and technologies, focused on minimizing the negative impacts and stimulating the positive ones, contributing for local sustainable development.

2.1.1. Ambitec-Agriculture assessment principles, criteria and indicators

The Ambitec-Agriculture consists of four principles of agricultural activity impacts resulting from technology innovation adoption: (i.) its magnitude, (ii) efficiency, and contribution towards environmental (iii) conservation and (iv) restoration. These principles are organized in eight criteria of technology environmental performance, constructed by a total of 37 indicators. This module is specially designed for technological innovations which impacts are measured in area, such as crop, forestry and pasture management. For details about Ambitec-Agriculture Principles, Criteria and Indicators, as well as its applicability to field evaluations, refer to http://www.cnpma.embrapa.br/forms/index.php3?func=softwma (access on 8.18.2006).

2.1.2. Ambitec-Livestock assessment principles, criteria and indicators

Composed by 11 criteria and 52 indicators, this module addresses impacts from technology innovation in livestock-husbandry activities and consists of six assessment principles: (i.) magnitude, (ii) efficiency, and contribution towards (iii) environmental conservation and (iv) restoration, (v) animal welfare and health, and (vi) product quality. This module is specifically designed for technological innovations and activities for which the impacts are measured according with alterations in the demand for products and resources, as well as management practices, applied to animal units. For details about Ambitec-Agriculture Principles, Criteria and Indicators, as well as its applicability to field evaluations, refer to http://www.cnpma.embrapa.br/forms/index.php3?func=softwma (access on 8.18.2006).

2.1.3. Ambitec-Agroindustry assessment principles, criteria and indicators

The Ambitec-Agroindustry module is composed by five assessment principles, constructed in eight criteria and 36 indicators of agro-industrial activity impacts caused by technology innovation adoption. This module is designed to assess technological innovation impacts which are measured according with indicator alterations imposed at the whole establishment or productive unit scale. For details about Ambitec-Agriculture Principles, Criteria and Indicators, as well as its applicability to field evaluations, refer to http://www.cnpma.embrapa.br/forms/index.php3?func=softwma (access on 8.18.2006).

2.1.4. Ambitec-Social assessment principles, criteria and indicators

The Ambitec-Social System consists of four assessment principles, constructed in 14 criteria and a total of 79 indicators related to the social impacts of technology innovation adoption. These indicators are also evaluated according with alterations effected by technology adoption at the rural establishment scale. The System thus is composed by four spreadsheets for data insertion that include 14 indicator-weighing matrices, presented as follows.

Employment Aspect

The Employment aspect is based in the assessment of four indicators, namely (1) Training, (2) Opportunity and Qualification for Local Employment, (3) Job Generation and Engagement and (4) Employment Quality.

The indicator (1) Training comprises three types of events possibly offered to the establishment residents under influence of the technology innovation: (i) Local short courses, (ii) Specialization short course, and (iii) Regular education. Additionally, the indicator weighs the level in which the training occurs, be this (i) Basic, (ii) Technical or (iii) Superior. The establishment residents considered in this indicator are the farmer / administrator, the partners and the permanent employees, as well as their family members.

The indicator (2) Opportunity and Qualification for Local Employment weighs the worker origin (be it the region, the locality or municipality, or the establishment proper). The weighing factors consider the percentage of personnel occupied in the rural activity onto which the technological innovation is applied. The indicator weighs also the qualification needed by the activity, as untrained, trained, specialized, or technical.

The indicator (3) Job Generation and Engagement focus on the quantitative generation of employment positions due to adoption of the technological innovation, according with the type of enrollment, which include temporary, permanent, partnership or familial, with a weighing scale that favors the latter two, given their larger contribution to local sustainable development.

The indicator (4) Employment Quality refers to all workers engaged as a consequence of the technological innovation adoption. The employment is qualified according the compliance with the main legal parameters, namely prevention of underage worker enrollment, maximum daily working hours, formal contract and social security assignment, besides the main fringe benefits (assistance in housing, meals, transportation and health care) claimed under Brazilian legislation.

Income Aspect

The Income aspect consists of three indicators, namely Net Income Generation, Income Sources Diversity and Land Value.

The indicator (5) Net Income Generation is conditioned by the tendency of the income attributes (security, stability, distribution and amount), as affected by the technology innovation adoption. The attribute security refers to the warranty of attaining the expected income, compared against the situation before technology adoption; the stability refers to the temporal or seasonal distribution of the perceived income; the distribution refers to the partition of the perceived income as paid wages, and the amount refers to the total income perceived in the establishment, as affected by the technological innovation.

The indicator (6) Income Sources Diversity assesses the family income origin for the farmer / administrator and the permanent employees, including the partners, under the situation before and after technology adoption. The diversification of income sources considers the agricultural and non-agricultural activities performed in the rural establishment, the opportunity of employment outside the establishment, the entrepreneurial branching and eventual financial applications resulting from the adoption of the agricultural technological innovation. The several income origins are weighed differently, favoring those income sources resulting from technology adoption at the establishment level.

The indicator (7) Land Value checks whether an increase or decrease may have occurred in the value of the affected rural establishment, under effect of technology adoption, according with local or external causes. The local causes are represented by investments in facility improvements, quality and conservation of natural resources, prices variations in products and services, compliance with the legislation and changes in public services, policies, and taxation.

Health Aspect

The Health aspect brings three indicators into consideration: Personal and Environmental Health, Occupational Safety & Health and Food Safety & Security.

The indicator (8) Personal and Environmental Health considers changes caused by the adoption of the technology innovation on the existence of endemic diseases sources, pollutant emissions (to the atmosphere, water and soil), and (restriction to) access to sports and leisure, components that imply a negative direction to the social impacts (negative weighing factors).

The indicator (9) Occupational Safety & Health checks workers exposure to risks due to the technology innovation adoption. The risk factors considered are those listed in the Brazilian legislation (noise, vibration, heat / cold, moisture, chemical and biological agents), and any exposure is weighed as a negative social impact.

The indicator (10) Food Security regards impacts of the technology innovation on the access to quality foods, considering the people associated with the productive processes (employees and family members), as well as the general public, represented by the consumers. The components of this indicator include the Production guarantee and the Food quantity, which represent security in daily access (regularity of food provision) in adequate quantities (sufficiency of food provision), as well as the Nutritional quality of food.

Management and Administration Aspect

Four indicators, namely Farmer Capability and Dedication, Trade Arrangements, Waste Disposal, and Institutional Relationship, comprise the Management and Administration aspect.

The indicator (11) Farmer Capability and Dedication includes variables related with the establishment management, such as specialized training towards the activity to which the technological innovation is applied, weekly hours of dedication, family engagement in the establishment business, use of accountability system and formal planning model, and certification and labeling systems. All these attributes are considered positive regarding the managerial capacity of the establishment administrator.

The indicator (12) Trade Arrangements include the descriptors of market insertion of the products obtained in the activity to which the studied technology innovation is applied. It considers the carrying out of direct, anticipated, or cooperated sales, local processing and storage, transportation, advertising and trade mark creation, linkage to other previous products, services, and activities, besides commercial cooperation with other local farmers.

The indicator (13) Waste Disposal checks for practices for abating the generation of residues in the establishment, as associated with the adoption of the innovation. Note that both the production and domestic residues are considered, regarding selective collection, reuse and composting, and measures for adequate disposal and treatment.

The indicator (14) Institutional Relationship deals with the complexity of the establishment's chain of interactions, and with the professional capacity of the manager and managerial employees. The indicator includes access to technical assistance, association / cooperation with members of the interest group, and nominal technological affiliation, legal consultation and inspection. All these components are considered favorable to the adequate management and administration of the establishment.

For details about Ambitec-Agriculture Principles, Criteria and Indicators, as well as its applicability to field evaluations, refer to http://www.cnpma.embrapa.br/forms/index.php3?func=softwma (access on 8.18.2006).

2.2. Eco-cert.Rural

Attending a demand of the IICA-PROCISUR for a system directed towards environmental certification of rural activities, an Ambitec-Agro derived "Base System for Eco-Certification of Rural Activities" (Eco-cert.Rural) has been proposed (Rodrigues et al., 2006a). The purpose is to install the system as a primary tool for environmental certification and eco-labeling in the South Cone Region, under the auspices of PROCISUR (see http://www.procisur.org.uy, access on 8.18.2006).

The Eco-cert.Rural System provides an impact overview for a selected productive activity at the rural establishment scale, considering environmental, social, economical, and institutional assessment principles, criteria and indicators. The output of this basic socio-environmental performance assessment system allows the farmer / manager to inquiry which management practices and productive activities result in major impacts (either positive or negative), favoring the selection of best management practices according with local resources availability and environmental constraints. For decision makers and public managers the system permits the delineation of policies and tools for rural activities performance improvement. Also, the Eco-cert.Rural System serves as a benchmarking scheme to guide eco-certification of agricultural products, considering local sustainability objectives.

2.2.1. Environmental certification alternatives and the Eco-cert.Rural System

The demand for product certification has been driven by market interests, mostly focusing on the improvement of relations with socio-environmental movements, public procurement policies, and, in cases related to agriculture, by pursuits of betterment in production and management practices. The majority of certification processes aim at differentiating institutional capacities, by means of auditing procedures carried-out by external third-party inspectors. These procedures usually do not agree with locally defined sustainable development objectives, because the assessment principles, criteria and indicators tend to be established according with standardized institutional goals, not always in line with local farmers' and communities' needs and ambitions.

Alternatively, *Participatory Certification Procedures* have been proposed (Rodrigues et al., 2006b;c), by which organized farmers are assisted in the formulation of adequate principles, criteria and indicators that agree with the collectively constructed local sustainable development objectives. Participatory Certification can be an intermediate step toward third-party certification, depending on market demands and exportation requirements. The Eco-cert.Rural System has been formulated to promote Participatory Certification as a step for motivating and capacitating organized farmers to initiate an instructed process of sustainability assessment and environmental performance improvement. The system integrates all Ambitec-Agro indicators under two general assessment Principles (Ecological and Socio-environmental performance), encompassing 24 Criteria and 125 Indicators (Rodrigues et al., 2006a; Table 1).

From an agricultural management standpoint, the Eco-cert.Rural System provides an overview of positive and negative impacts of rural activities, highlighting variables that should be modified to promote improvements, even in a simulation or estimated (*ex-ante*) basis. For this purpose, the assessments are constructed in Environmental Management and Eco-certification reports, delivered to the farmers / administrators, pointing out technological alternatives and management practices improvement opportunities, according with the generated impact indices.

Ultimately, the set of Principles, Criteria and Indicators of the Eco-cert.Rural System conforms a basis for the establishment of codes of conduct by organized farmers, providing, on the one hand, a guide for defining agreeable sustainable development objectives, and on the other, the assessment benchmarks and the practical evaluation tool.

3. Ambitec-Agro and Eco-cert.Rural: Applications and contributions for technology management

The Ambitec-Agro System is currently applied at Embrapa's institutional context for performing the socio-environmental impact assessment of technology innovations made annually available through the National Agricultural R&D Program (Avila et al., 2005). After integration with the economical return rate estimates for all technological innovations evaluated, the generated technology appraisal reports constitute the basis for constructing the institutional Annual Social Balance (Embrapa, 2006). These technology evaluations contribute as a feedback for society about the governmental investments in agricultural R&D, as well as provide a tool for researchers to program new research initiatives and to assess the relevance of their research contributions (Irias et al., 2004a).

The latest annual technology appraisal report (Avila et al., 2005; Embrapa, 2006) includes the set of over 30 new technological innovations currently being transferred by Embrapa's Units, which span a broad application spectrum, from rural establishment administration software, to alternative production systems for selected crops, pastures and their integration systems; from integrated pest management, to new seed varieties and animal breeds; and from an agro-industrial support system, to methods for degraded areas reclamation.

With such a diversity of applications, the obtained environmental impact indexes varied broadly, from a minimum of –2,60 for a 'System of cotton production in Cerrado areas', to 5,26 for the technology 'Monitoring of tick resistance to miticides'. The negative result for the former case was due to the important agricultural intensification process associated with the proposed cotton production system, which implicated increases in the demand for energy, inputs and resources, beside a pressure on new production areas, given the economical advantages offered by the technology. On the other hand, the positive impact index obtained for the latter mentioned case results from exceptional capacity to minimize miticide application rendered by the monitoring technology, implicating reduced water contamination risks and improvement in product quality, since miticide residues can be an important contamination problem.

In general, the technological innovations associated with the proposition of intensification in production systems were mostly associated with low amplitude or negative impact indices, whereas technological innovations linked with managerial improvements, such as integrated production systems and resource conservation technologies, reached larger positive impact indices. This conclusion is corroborated by the tendency observed in the data, for the negative partial impact indices to be associated with indicators related to energy use requirements (42%), input requirements (29%), and impacts on biodiversity (26%) (Avila et al., 2005).

When the experience of application of the Eco-cert.Rural System is regarded, emphasis is being placed on organizing codes of socio-environmental conduct for such production sectors as milk production (Rodrigues et al., 2006b), and ostrich husbandry. The latter case involves the participation of producers organized in the Federation of Struthioculture Cooperatives, who are seeking to define the best socio-environmental production practices and establish an eco-label for the sector in the country. Such initiatives set the stage for new market niches and commercialization opportunities.

A critical analysis of the potential contributions of the presented impact assessment systems has been carried-out in a comparison with several available EIA methods (Payeaudeau et a., 2004). It was recognized that the system's main objective is to provide an impact assessment directed at identifying management practices that may cause increased pollutant emissions and input requirements. The critical analysis pointed out the need for the methods to be transparent in order to facilitate farmer participation, simple to allow easy application in the field, and sufficient in number and scope of indicators to avoid gaps in the assessments. All these features were regarded as met by Ambitec-Agro.

4. Conclusion

Ambitec-Agro consists of a practical EIA system of agricultural technology innovation, ready for field application through an interview / survey directed at the farmer / manager responsible for the agricultural activity modified by the adoption of the studied technology. The system relies on a computational platform readily available and easily applicable at low cost, and facilitates the storage and communication of information regarding environmental impacts.

Regarding the computational structure, the system is simple and transparent, unveiling to the user all operations performed with the data. Also, while fairly standardized relative to measurements, the system is malleable, allowing the user to adapt for specific use situations, by changing the weighing factors of indicators and components when appropriate.

The acceptance of simpler systems such as Ambitec-Agro is an important step toward more complex methods that require a stronger analytical basis and involve a more complex theoretical foundation. In effect, a multi-attribute EIA system for agricultural activities' environmental management, integrating dimensions related to Landscape ecology, Environmental quality, Sociocultural values, Economic values, and Management values has been formulated and is currently under extensive field application (Campanhola and Rodrigues, 2003). In this sense, Ambitec-Agro is a contribution to the stepwise process of sustainable agricultural technology development and appraisal.

The Ambitec-Agro System's main contributions are (i) to improve the understanding of farmers and researchers alike, about the social and environmental implications of agricultural technology innovation adoption, and (ii) to introduce socio-environmental impact assessments at an operational level, facilitating the grasp of interactions between technology adoption and the sustainable development of agriculture.

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