Viability of local productive arrangements for biodiesel in Brazil: field assessment of sustainability in an oil palm farm [1]

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Context of Embrapa's biofuels sustainability study

Socio-environmental impact assessments have been carried out on oleaginous crops production under the context of expanding demand for biofuels in Brazil, under the auspices of Embrapa's Network Project on Oleaginous Crops for Biofuels. The study brought together the main stakeholders of the biofuels production chains in five regions of the country, in Delphi-type workshops (Monteiro & Rodrigues, 2006). Major impacts expected or observed were related to increases in demand for inputs, resources, and energy, with potential risks on water quality and habitat conservation. In some instances, management practices have been improving soil quality, favoring habitats recovery. Crop intensification has been expected to bring important contributions for farmers training, income generation and income sources diversity, as well as improved management and administration capacities. Especially designed local productive arrangements, involving Institutional Integration have been shown to offer the best policy options for fostering sustainable development and avoiding environmental degradation risks, under the current scenario of expanding demand on oleaginous crops for biodiesel production in the studied regions.

Building upon the results of these Regional Workshops and given the aforementioned expected and observed impacts (for more details on this Regional context, refer to Rodrigues et al., 2007), a field assessment was carried out in an oil palm farm in the region of Belém (Pará State, Brazil), corroborating the importance of local productive arrangements, to promote the sustainability of the production chains of biofuels in the country.

Integrated sustainability indicators system

The "System for Weighed Environmental Assessment of New Rural Activities" (APOIA-NovoRural - Rodrigues & Campanhola, 2003) has been proposed as an adequate method for promoting the environmental management of rural establishments. The APOIA-NovoRural System consists of a set of 62 indicators weighing matrices, formulated towards the systemic assessment of a rural activity at the rural establishment scale, according to five sustainability dimensions: i) Landscape Ecology, ii) Environmental Quality (Atmosphere, Water and Soil), iii) Socio-cultural Values, iv) Economic Values, and v) Management and Administration. The sustainability assessment 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 indices, according to appropriate weighing factors (Figure 1). The impact indices are expressed as utility values (0-1, with the baseline sustainability conformity level defined at 0.7 - Bisset, 1987) in graphs for each indicator, the aggregated dimensions and a final sustainability index.

[1] The results shown in this report were partially presented in the VI International PENSA Conference, held at the School of Business and Economics of the University of São Paulo, Ribeirão Preto – Brazil in October, 24-26th, 2007.

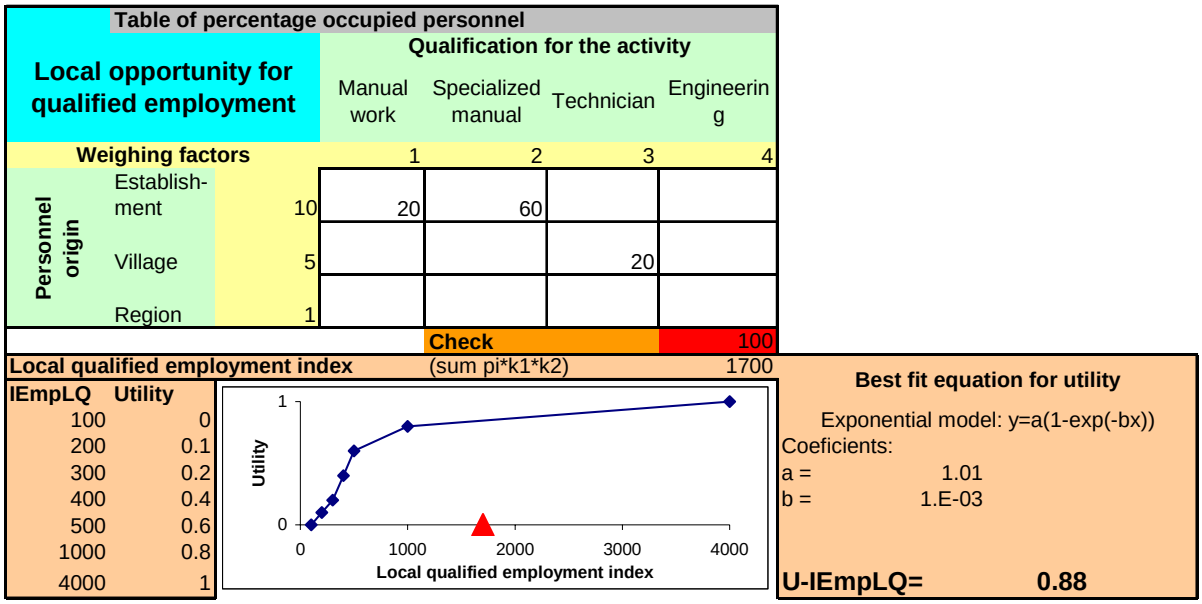

Figure 1. Typical weighing matrix of the "System for Weighed Environmental Impact Assessment of New Rural Activities" (APOIA-NovoRural), showing the 'Local opportunity for qualified employment' indicator.

Information required for filling out the APOIA-NovoRural weighing matrices were obtained in field surveys (aided by GPS, maps and satellite images) and data on the managerial and administrative history of the rural establishment provided by the farmer / manager, according to a structured questionnaire. Other indicators, related to water and soil quality, were obtained in field and laboratory analyses. Some water quality indicators (O_2, pH, Conductivity, Turbidity) were measured in the field with a Multi-parameter Horiba (U-10) probe. Nitrate was analyzed with a Merck RQFlex field colorimeter. Fecal coliform levels were estimated with Tecnobac (AlphaTecnoquímica) culture strips. Water samples were brought to Embrapa Environment laboratory for phosphate and chlorophyll determinations with a HACH spectrophotometer. Soil samples were sent to Embrapa Oriental Amazon laboratory for routine macro-nutrients determinations. For further details on the methodology, the full set of indicators, and access to the APOIA-NovoRural operational system, refer to Rodrigues & Moreira-Viñas (2007).

Field study context

The studied rural establishment dedicated to oil palm production was selected by indication of the Association of Palm Oil Producers Dentauá Ltd. The Ishihara Farm is located in the municipality of Santo Antônio do Tauá, in the Geographical Metropolitan Meso-region of Belém, Castanhal Micro-region (Pará State, Brazil), in the ecological domain of the Amazon Equatorial Rain Forest. At 54m altitude and geographical coordinates 01°06'13" S and 48°07'34" W, the 275 ha farm has oil palm in approximately 192 ha; and a diversified agricultural productive base, including black pepper (28 ha), açaí palm (28 ha), lemon (5 ha), papaya (5 ha), cupuaçu (2 ha), pineapple (2 ha), noni (5 ha), and woods (5 ha distributed among neem, teca, mahogany and Gliricidium). Only 2.5 ha correspond to native forests in the establishment, occupying the Permanent Preservation Areas shoring a small stream.

Sustainability Assessment – indicators and dimensions conformity evaluation

The APOIA-NovoRural System shows the assessment results in a synthesis graph for the sustainability dimensions, and an aggregate index for the establishment, according to the spatial and temporal context defined locally (Figure 2). For the case of Ishihara Farm this Sustainability Index reached 0.70, right in agreement with the conformity baseline defined in the method. Among the sustainability dimensions considered, quite favorable mean indicators results were obtained at Ishihara Farm for Water Quality (0.85) and Economic Values (0.78). With mean indicators values very close to the conformity baseline were Landscape Ecology (0.67) and Socio-cultural Values (0.68). On the other hand, mean indicators results for the dimensions Soil Quality (0.51) and Management & Administration (0.61) were below the conformity baseline defined in the APOIA-NovoRural System.

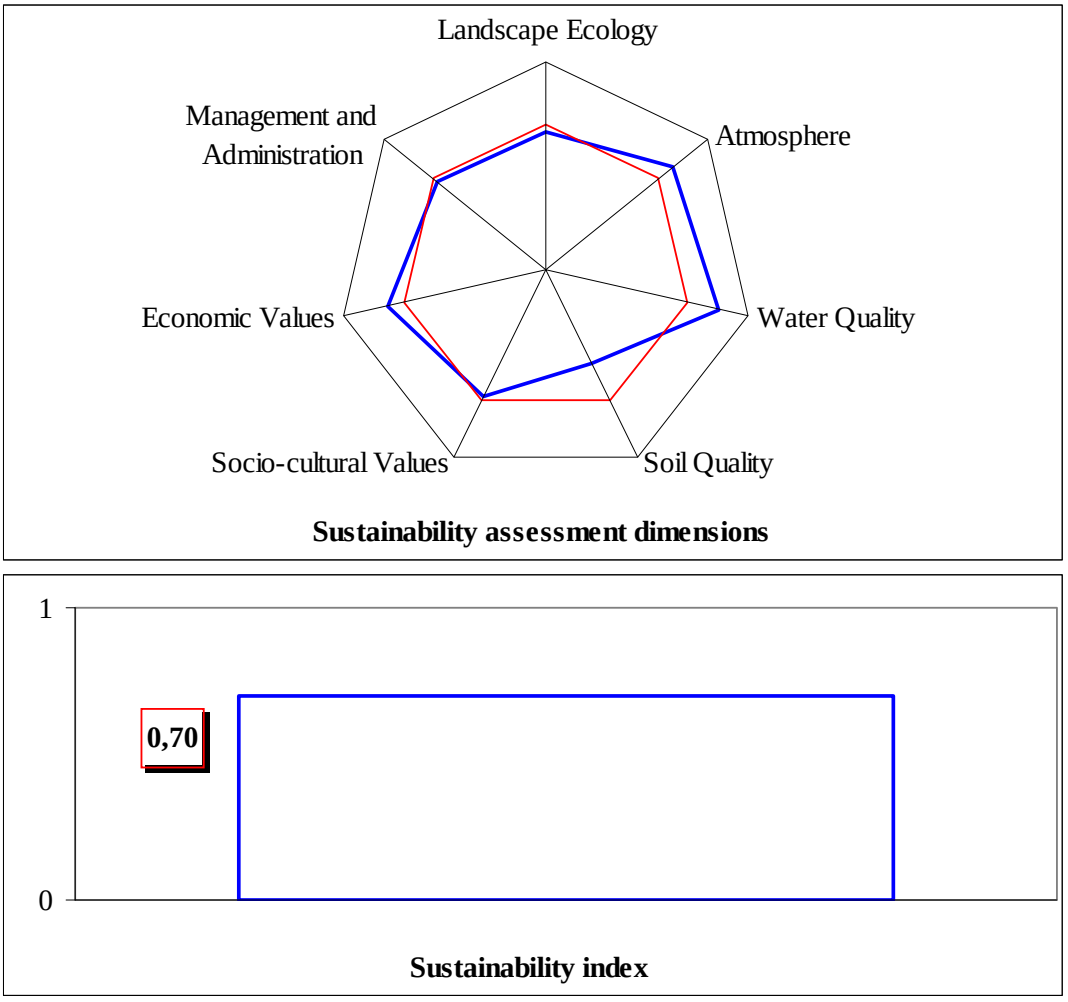

Figure 2. Sustainability assessment for Ishihara Oil Palm Farm, in Santo Antônio do Tauá (PA, Brazil), according to the APOIA-NovoRural System assessment dimensions. March 2007.

The Landscape Ecology dimension (Figure 3) presented the indicators concerned to Natural habitats conservation (0.89), Productive areas management (0.97), and Confined activities/animal husbandry management (0.79) as extremely favorable conditions for the farm's sustainability. The area destined to agricultural production at Ishihara Farm adds to approximately 262 ha, fully taken by perennial crops, mostly oil palm (70%), which is less intensive in terms of inputs and natural resources, comparatively to the other cultures. Natural

habitats make up only 3 ha, comprising a paludal forest in pristine condition, and a tract of recovering secondary rain forest, both very important for conforming the legally mandated Permanent Preservation Area indicator (index = 0.82). On the other hand, the mandated Legal Preserve is nonexistent (indicator = 0.0), a passive from the time of implantation of oil palm in the establishment, when the treelike trait of the culture was amenable for Legal Preserve denomination.

The large number of different crops grown at Ishihara Farm resulted in a relatively high Productive diversity indicator (0.67), a positive factor for the farmer's economic security, against eventual market instabilities. Even though below the baseline level defined in the assessment system, the Landscape diversity indicator was also satisfactory (0.59), owing to the perennial aspect of the crops, which contributed moderately for the conformation of Fauna corridors (0.68), and favored the protection of Endangered species (index = 0.80). The oil palm plantation, however, influenced negatively the Fire hazard indicator (0.55), due to the piling up of flammable organic material remaining from harvest operations and brought back from the industry and left under the trees. As in the eventuality of fire the main culture itself would be affected, causing severe losses, the effect on the sustainability index is quite important. This practice, on the other hand, contributes with the organic matter balance in soils, as shown later on in the text.

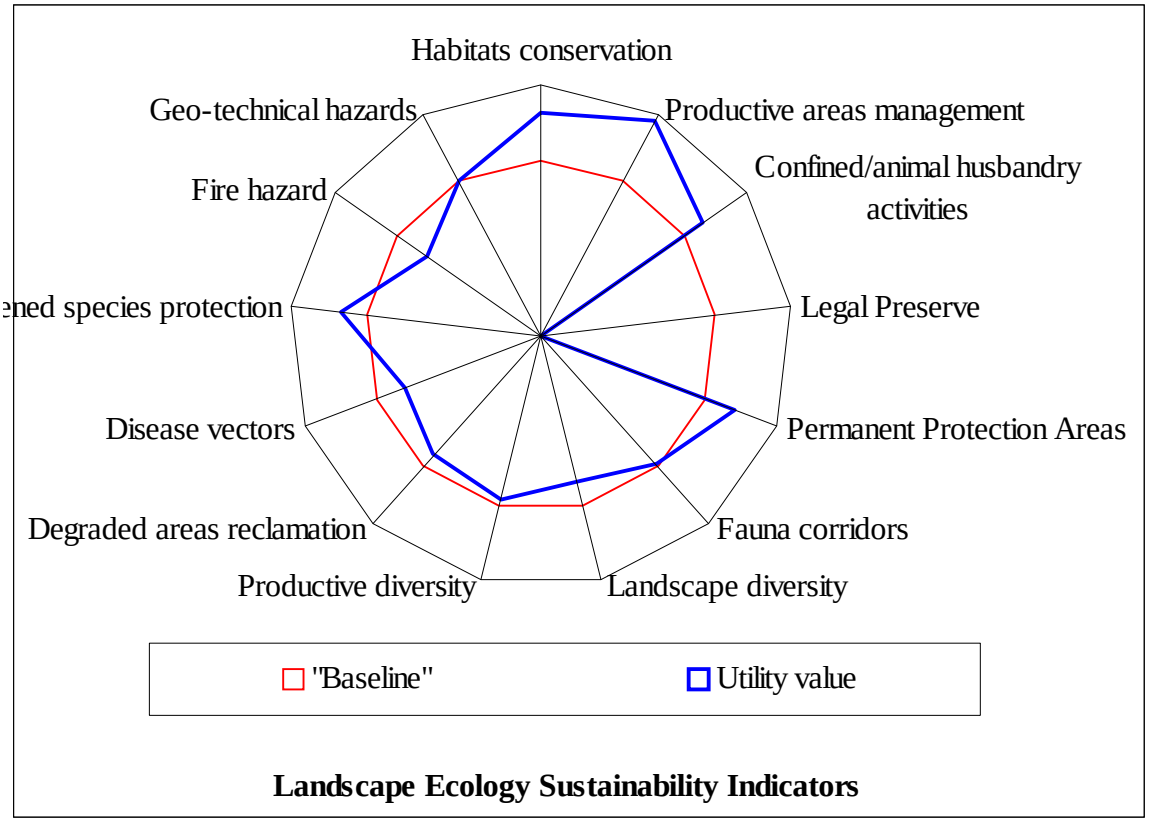

Figure 3. Sustainability indices for the Landscape Ecology indicators, Ishihara Oil Palm Farm, Santo Antônio do Tauá (PA, Brazil), according to the APOIA-NovoRural System. March 2007.

The Environmental Quality dimension resulted well above the baseline conformity level for the indicators of Atmosphere (mean = 0.79) and Water Quality (0.85), whereas the Soil Quality resulted well below that level (mean = 0.51). The Atmosphere indicators pointed

out the absence of particulates and smoke emissions (for no burning is allowed in management, index = 0.89), foul odors (1.0) and reduced period and low intensity of noise generation (0.92). Neither were there important sources of sulfur (0.70) or nitrogen oxides (0.70). On the other hand, the intermittent traffic of tractors for harvesting and management imposes some emission of carbon oxides (0.65) and hydrocarbons (0.65) at the local scale, as compared to other crops produced in the farm.

The Water Quality showed positive indices for most indicators, pointing out the favorable influence of the perennial crops, especially oil palm, for water conservation. Surface waters analyzed showed adequate levels and excellent improvement in oxygen saturation (index = 0.97, up 82%), adequate pH (index = 0.89), nitrate (0.80, under 2.0 mg/L), total solids (index = 1.0), chlorophyll (1.0), conductivity (0.95), visual pollution (1.0), and potential pesticide impacts (1.0). Even though showing adequate conductivity (0.95), groundwater (sampled in the farm's well) showed elevated levels of nitrate (up to 8.0 mg/L, index = 0.21), calling for periodic monitoring. This contamination, however, is most likely linked to domestic effluents, not to agricultural practices, and certainly not to oil palm.

The Soil Quality indicators represent the comparison between oil palm areas and orchards/woods soils, areas to be converted into oil palm when plantations eventually expand in the establishment. The less intensive management and smaller input demand observed in the oil palm areas, which nearly excludes hydro-soluble fertilizers in favor of organic matter amendments, has brought strong decreases in soil nutrients levels. Despite the increased soil organic matter (index = 0.77), drastic decreases in phosphate (0.09), potassium (0.46), and magnesium (0.55) were associated to a high potential acidity (0.50), resulting in very low sum of bases (0.12), and bases saturation (0.20), while important reductions on sheet erosion can be attributed to current oil palm plantation management practices (index = 0.75, Figure 4).

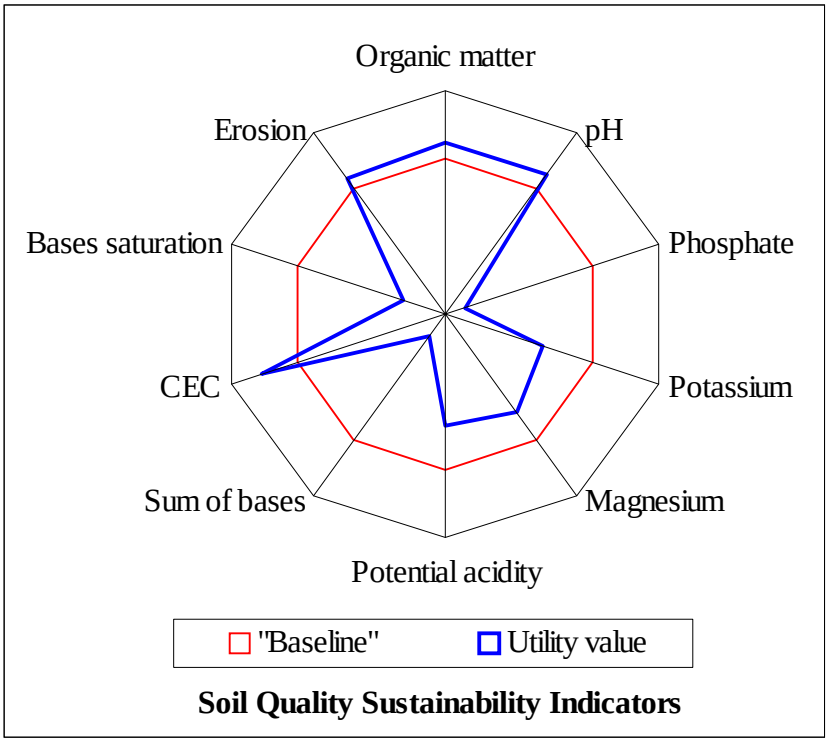

Figure 4. Sustainability indices for the Soil Quality indicators, Ishihara Oil Palm Farm, Santo Antônio do Tauá (PA, Brazil), according to the APOIA-NovoRural System. March 2007.

The mean indicators result for the Socio-cultural Values dimension at the Ishihara Farm (0.68, Figure 5) was very close to the baseline sustainability level of the APOIA-NovoRural System. The establishment houses the manager and eight family members, one temporary and 16 permanent workers. Regarding the Access to education indicator, only the manager receives regular short training courses (offered by Dentauá Ltd.), with no other contribution accountable to the oil palm activity (index = 0.70). The typically modest Consumption standards of the region, especially referring to the employees, resulted in a lower than baseline index for this indicator (0.64), compared to a relatively good availability of Public services (0.69). The activity shows no influential changes on the Access to sports and leisure (0.70) or the Cultural/historic patrimony (0.70) indicators. The occupational safety and health indicator (0.77) pointed out good working conditions, even though the Local opportunity for qualified employment (0.62) shows essentially manual, low specialization, field labor opportunities only. Most importantly, due to the virtual absence of fringe working benefits, and the uncertain contractual regime of the temporary worker, the quality of employment indicator was lower than the baseline sustainability level (0.61).

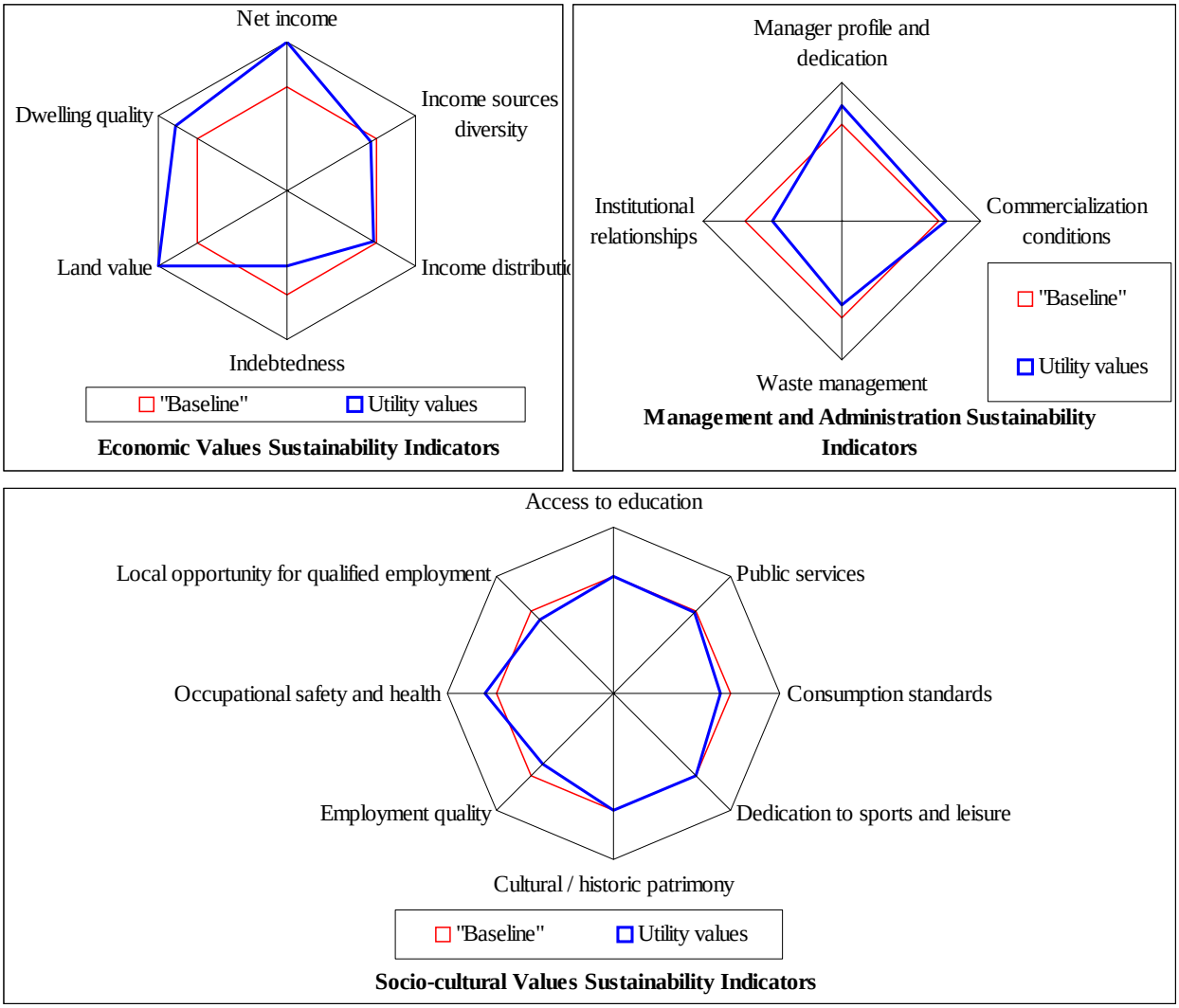

Figure 5. Sustainability index for the Socio-cultural Values, Economic Values and Management and Administration dimensions of the Ishihara Oil Palm Farm, Santo Antônio do Tauá (PA, Brazil), according to the APOIA-NovoRural System. March 2007.

The Economic Values dimension (0.78, Figure 5) showed important indicators with indices well above the baseline sustainability level. Net income improved security, stability and amount (index = 1.0) resulted from the oil palm activity. Reasonably diversified agricultural Income sources (0.65) were associated to a fair pattern of Income distribution (0.67, 1-3 net income / total wages relationship). On the other hand, an increased Level of indebtedness (index = 0.50) was associated to very important Land value improvement (1.0) and good Dwelling conditions (0.86).

The Management & Administration dimension (mean result = 0.67, Figure 5) showed very positive indicators, contrasting with important opportunities for improvement in the sustainability performance of Ishihara Farm, without need for heavy investments. Among the indicators denoting valuable management advantages brought about by the oil palm production activity stand those related to the farmer Profile and dedication (0.83), including local residence, exclusive dedication, specialized training for the activity, family involvement, and formal accountancy system utilization. The only missing component for the indicator was the application of a formal planning system, which may become imperatively valuable for tracking the dynamics presently being imposed onto the agro-energy business. The Commercialization conditions indicator resulted above the baseline level of the APOIA-NovoRural System (0.75), failing to comply only with some components less related to oil palm management, such as Linkage to services/activities and Association to local producers.

Even without regular public service for wastes removal, disposal of domestic residues has been adequately performed, exception to sanitary sewage treatment, that may be impairing groundwater quality with nitrates. Solid domestic residues have been selectively handled, with organic matter being incorporated to soil as amendment. Finally, the Institutional relationship indicator (index = 0,50) denoted availability of Formal technical assistance and Association/Cooperation, both offered by Dentauá Ltd., and also Access to legal consultation, while no Nominal technological affiliation or Continuous training could be referred to.

Conclusion

The sustainability assessment of the Ishihara oil palm farm pointed out important contributions of the main agricultural activity (oil palm plantation) for the socio-environmental performance of the establishment. The Sustainability Index obtained (0.70), which stresses the conformity with the baseline proposed in the APOIA-NovoRural System, figures as a target for continuous improvement and a tool for the farmer's decision making regarding the adoption of technological innovations, managerial practices, and infra-structural and processes investments for improving the establishment's performance.

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References

Bisset, R. **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, 1987. p. 3-64.

Monteiro, R.C. & Rodrigues, G.S. A system of integrated indicators for socio-environmental assessment and eco-certification in agriculture – Ambitec-Agro. **Journal of Technology Management and Innovation**. v. 1, n. 3. 2006. pp. 47-59. http://www.jotmi.org/index.php/GT/article/view/art10;

Rodrigues, G.S.; Campanhola, C. Sistema integrado de avaliação de impacto ambiental aplicado a atividades do novo rural. **Pesquisa Agropecuária Brasileira.** v. 38, n. 4. 2003. pp. 445-451.

Rodrigues, G. S. & Moreira-Viñas, A. An environmental impact assessment system for responsible rural production in Uruguay. **Journal of Technology Management and Innovation.** v. 2. n. 1, 2007. pp. 42-54. http://www.jotmi.org/index.php/GT/article/view/art34.

Rodrigues, G. S.; Rodrigues, I. A.; Buschinelli, C. C. de A.; Ligo, M. A.; Pires, A. M.; Frighetto, R. T., Irias, L. J. M. Socio-environmental impact assessment of oleaginous crops for biodiesel production in Brazil. **Journal of Technology Management and Innovation.** v. 2. n. 2. 2007. pp. 46-66. http://www.jotmi.org/index.php/GT/article/view/art45