Aquisys – A Computer System to Support Good Practices of Management for Brazilian Tilapiculture

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Abstract: Brazilian psiculture has been increasing about 30% per year, having as main factors its profitability and source of quality protein. Its strong interaction with water resources and its interference on the biodiversity turns it both potentially exposed to, as well as, source of negative environmental impacts, requiring the adoption of less impactant management practices. The producer needs information on these practices and computer tools that allow access to them in a single repository could motivate the fast incorporation of these activities to the property. Despite of African origin, the tilapiculture is nowadays present at a large part of Brazilian territory, under pressure for greater product quality and sustainable practices. Embrapa Environment has identified Good Practices of Management (GPM) for tilapia that can be immediately used by producer, from his observation on the property. Aquisys Computer System was developed in PHP, HTML and MySQL computer languages and made use of Apache server in order to make information available, via dynamic Web access, for the diagnosis of these assessment, as well as, economic, production, management and water quality indicators. The present work presents the Aquisys tools for tilapiculture on Brazilian environment.

***Keywords**:* environment ; aquiculture ; management ; Brazil ; informatics.

1. INTRODUCTION

Brazilian psiculture has been increasing about 30% per year, having as main factors its profitability and source of quality protein [Beerli & Logato, 2009]. The native fish farming has great importance in the context of the national scene, but the tilapia (*Oreochromis sp)* has been the biggest fish of economic importance.

Of African origin, tilapia is the second most produced fish in the world, mainly due to its delicious meat, less fishbone and high fertility, as well as, resistance to diseases, overcrowding, high water fertilization and adverse conditions to the environment. Despite that, the main difficulty for fish farmers remains uniform fish size and standards required by the market, which will only be resolved by useful proposals of feed and environment management [Beerli & Logato, 2009].

Favored by the extensive amount of impounded water, excellent weather and by the availability of the first results provided by research, the tilapiculture is present in the great part of the Brazilian territory, which has been suffering with the pressures for high quality products and for adoption of less impactful environmental practices. Among the negative impacts could be mentioned the use of natural resources, pollution, interferences on different biodiversity levels, as well as, its direct interface with the multiple-use-resource essential for life quality, like the water [Tiago, 2007]. Due to that, the dissemination of good management practices for aquiculture has become an instrument allied to the sustainability of production systems. This is a farming system represented by a pre-specified set of requirements and standard practices, which is also known as code of conduct or protocol, to be carried out by farmers in the management and production system. It has a free membership to the producers and has focused on product and environmental qualities, which are expected to be achieved by the adoption of guidelines for the productive activities toward the environmental sustainability of the production system.

Recently, computer science integrated with communication and information technologies have been applied to environmental science and agriculture, creating a new area of knowledge called Environmatics. Its main purpose is to provide computer systems that enable knowledge and guidance for decision makers to protect the environment.

The fish producers are important decision makers when considered as managers of their properties. The main environmental impacts caused by the activities in the property could be quickly identified, as well as mitigated, if the necessary information could also be available in a single environment of easy access and content in appropriate language. Thus, the fish producers could be favored with applications of environmatics for daily monitoring of their production system.

Brazilian Agricultural Research Corporation - EMBRAPA has as mission to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer. The corporation is linked to the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA) and counts with 40 research centers spread over Brazilian territory. Embrapa Environment is one of its thematic research centers, which has as one of its activities to evaluate, develop, adapt, and manage practices to maintain the aquaculture increasing productivity without environmental degradation. In this sense, the "**Management and Environmental Management of Aquiculture" Project** of Embrapa Environment, which is part of "Aquabrasil" network Project, has been identifying Good Practices of Management (**GPM´s**) for tilapia, which are based on farm observation and could be immediately adopted by producers. This project also proposed to provide a system to turn quickly available for producers a set of tools for assessment and calculation of economic, production, management and water quality indicators which support the GPM´s adoption.

Thus, the present work presents the Aquisys Computer System, an Environmatic system developed to turn available the dynamic access, via Web, for the diagnosis of tilapiculture on Brazilian environment.

2. MATERIAL AND METHODS

Aquisys system was developed taking into account the Brazilian aquiculture producer demands, with emphasis for tilapiculture. Thereby, the main users of the system will be also the Brazilian producers.

The tools available on the Aquisys system were identified from surveys conducted in the referral of questions and technical information requested by Brazilian farmers in field days provided by the project "Management and Environmental Management of Aquaculture" of Embrapa Environment, as well as the support service of Embrapa Environment via the Internet.

From those first identified demands, issues were prioritized. These were related to: good management practices of tilapia on the fish property, such as water quality, feed quantity, fast-checking to the identification of environmental impacts on the property (soil, waste, natural resources conservation, among others), as well as economical indicators. Therefore, also identified were practices that allow producers to carry out assessment and diagnoses by their visual observation, by using water quality kits of low cost, as well as, by

conducting common samples held on the farm. Thus, the information required by the Aquisys tools to perform the assessment depends on the user's choice. Among them, one could choose: development stage of fish, temperature, percentage of gross protein in feed, average weight of fish in the fishpond, behavioral aspects of fish in the fishpond, pH, water transparency, dissolved oxygen content, the diversity of benthic populations, physical property, treatment/destination of waste on the farm, storage/use of chemicals products, fishpond, use of equipment, among others.

The technical information which support the tool's content were provided by aquiculture technical literature, as well as, by field work and experience of Embrapa Environment expert researchers in aquiculture, and from meetings held with producers [Berli & Logato, 2009; Seixas et al, 2009a,b; Nunes, 2007; Tiago, 2007; Pavanelli et al., 202; Casaca & Tomazeli Junior , 2001; Boijink & Brandão, 2001; Kubtza, 2001; Valenti et al, 2000; Ostrenski & Boeger, 1998; Karr, 1991].

Regarding the water quality assessment, it was considered that the need for expeditious water quality testing provided by some widely used kits, as well as, for identification of the presence or absence of benthic populations and their community diversity [Karr, 1991] by photographic images provided by the project.

Water and fish feed management information were organized on Freemind [Kumar, 2005] format and presented by Seixas et al. [2009a]. Freemind is a mind-mapping software, licensed under GNU- GPL General Public License, which was written in Java. The software enables to elaborate a mind map, which is a tool for organize and integrate knowledge used to provide information to one or more users on topics presented in a tree diagram.

For the farm productivity indicators, it made available tools for estimates of biomass gain and feed conversion rate in both samples and on the end of cultivation. It was also used methods of polynomial regression analysis, according to Dorn [1981], in order to enable Aquisys system to provide the fish feed quantity necessary taking into account the average weight of fishes and the local temperature, which was based on technical information provided by Ostrenski & Boeger [1998]. Details of those regressions were presented by Seixas et al [2009b].

The diseases indicators based on the evaluation of changes in the physical behavioral of the fishes (swimming, for example) considered information available on the technical literature [Nunes, 2007; Pavanelli et al., 2002; Boijink & Brandão, 2001; Kubtza, 2001; among others].

The Aquisys system environment makes available for user access all questionnaires. The questionnaires were developed in Hypertext Markup Language - HTML [World Wide Web Consortium (W3C), 1989], which is an open source. HTML provides structural, presentational and hypertext markup elements. This computer language provides the development of hypertext for use in sites of dynamic access via the Internet.

The further processing of information in order to provide assessment or diagnoses focused on good management practices, as well as, calculations were carried out using Hypertext Preprocessor Language – PHP [The PHP Group, 2009]. The PHP is an open source; PHP License v3.01 - BSD-style license which does not have the "copyleft" restrictions associated with GPL. Which makes available calculus, logical operators uses, and other facilities provided by languages as C, Fortran, Pascal and others, and also allows the integration with HTML, making available to web developers to write dynamically generate pages. A more detailed economic evaluation of tilapia cultivation was also considered in the Aquisys system, which was promoted by the inclusion of a database developed using MySQL[2009]. MySQL is a GNU-GPL (General Public License) which provides a database management system (DBMS) that uses the Structured Query Language (SQL). It is of worldwide use due to its easy integration with the PHP language and portability. Thus, to enable the necessary calculation of production costs, Aquisys made use of technical information provided by Casaca & Tomazeli Junior [2001]. This information provided by producers will be also stored in MySQL database with no user identification in order to enable the analysis of production costs average prevailing in the country and identification of gaps for research and policy development for tilapia in the country. The process of environmental licensing for aquaculture is also provided in Aquisys, as well as information about the definitions of environmental licensing, aquaculture licensing, granting of hydric resources and about sustainable aquiculture [Brasil.MPA, 2009;

Brasil.MMA, 2009; Brasil.MD, 2009; MMA.IBAMA, 2009; São Paulo.DAEE, 2009; Valenti et al, 2000, among others].

The incorporation of these latter tools were identified in a technical meeting of the first results of development of Aquisys, which was presented during the evaluation workshop of the Aquabrasil network project held in Jaguariúna municipality, São Paulo State Brazil, in July 2009, where researchers members of the network, as well as, sponsors, technical assessors and representatives of aquiculture productive chain were present.

Apache 2, version 2.2.11, was used as Aquisys system web server. Apache 2 [The Apache Software Foundation, 2009] is open source software, which operates in a wide variety of operating systems like Microsoft windows, Linus, Solaris, Unix, Mac Os X, GNU and others, as well as, serve both static content and dynamic Web pages on the World Wide Web.

3. RESULTS

Aquisys system was developed in PHP, HTML and MySQL languages and runs in Apache server version 2.2.11, which turned available 13 computer tools to evaluate the Good Management Practices for tilapiculture in Brazil.

The software was developed to be accessed via the internet by Brazilian producers, without costs associated, in order to promote the rapid transfer of the best practices of tilapiculture´s management. Making available the best practices and easy-to-use techniques, the producers could rapidly adopt them, promoting the environmental quality of the place where the production is conducted.

The Aquisys framework is presented at **Figure 1**, where the gray colored areas represent the tools still under development.

The system allows dynamic access for expeditious diagnoses of good management practices of tilapia on farm, based on indicators of production, management and quality of natural resources of the property. Information about the environment licensing stages, as well as the respective government institutions responsible for, is also available in the system.

Aquisys promotes identification of best management practices for tilapia from visual observations and use of methods commonly used in property and others with low costs associated. For that, it makes available a **fast-checking diagnoses** making use of visual observation, which demands information about vegetation, predominant soil color, main source of water, fishpond depth, dike slope, fate of wastes generated by activities around the fish-pound, fish pound color water in the most pluvious months, transparence of fish-pound water, aerator uses and chemical product uses and their storage in the property (**Figure 2**).

A quick GPM assessment was also available making use of tilapias development phase, gross protein percentage in the fish-feed, fish-pound transparence, fish-pound temperature, oxygen dissolved and water pH.

The system also allows estimates of the amount of fish feed required depending on the average weight of fishes and the local temperature, as well as, the quantities of chemical fertilizers (urea, calcium nitrate, sodium nitrate, ammonium nitrate, ammonium sulfate, super phosphate, among others), considering their quantities use and the fish-pound area.

The diseases indicators based on the evaluation of changes in the physical behavioral of the fishes considering the fish swimming, changes in the dietary pattern, breath on the surface of the pond, equilibrium, vitality, presence of parasites, among others, which permit indicatives that varies from the correction of the concentration of dissolved oxygen until possible presence of body ectoparasites, bacterial diseases, bleeding, among others.

When considering the water quality assessment based on kits of color indicators and electronic measurer, was demanded information of temperature, pH, Dissolved oxygen, total phosphate, quantities of orthophosphate, turbidity, chloride, iron, among others.

Benthic population for water quality indicators considers the presence of *Mollusca*, *Hirudinea*, *Odonata*, *Chironomidae*, among others (**Figure 3**).

To evaluate production costs it considered price information, cultivation operational costs, implantation costs, fish production costs and overhead costs. This information enables the calculus of technical and economical indicators.

Brazilian government agencies related to the process of environmental licensing for aquaculture are also provided in Aquisys, which also enables their respective sites in case of need for more information or contacts. Aquisys also provided information about the definitions of environmental licensing, aquiculture licensing, granting of hydric resources and about sustainable aquiculture (**Figure 4**).

Aquisys also provides estimation of production costs for producers. Thereby, users need to answer questions about the fish production costs (fertilizer uses, equipments, productivity, feed, manpower, transport, overhead costs, and others) (**Figure 5**). The answers are recorded in a MySQL database in order to present the technical-economical indicators.

The screens of the program and its diagnoses and results are presented in the Portuguese language, due to the fact that the software was developed for Brazilian producers.

Aquisys system is still under validation process by researchers and producers of tilapia.

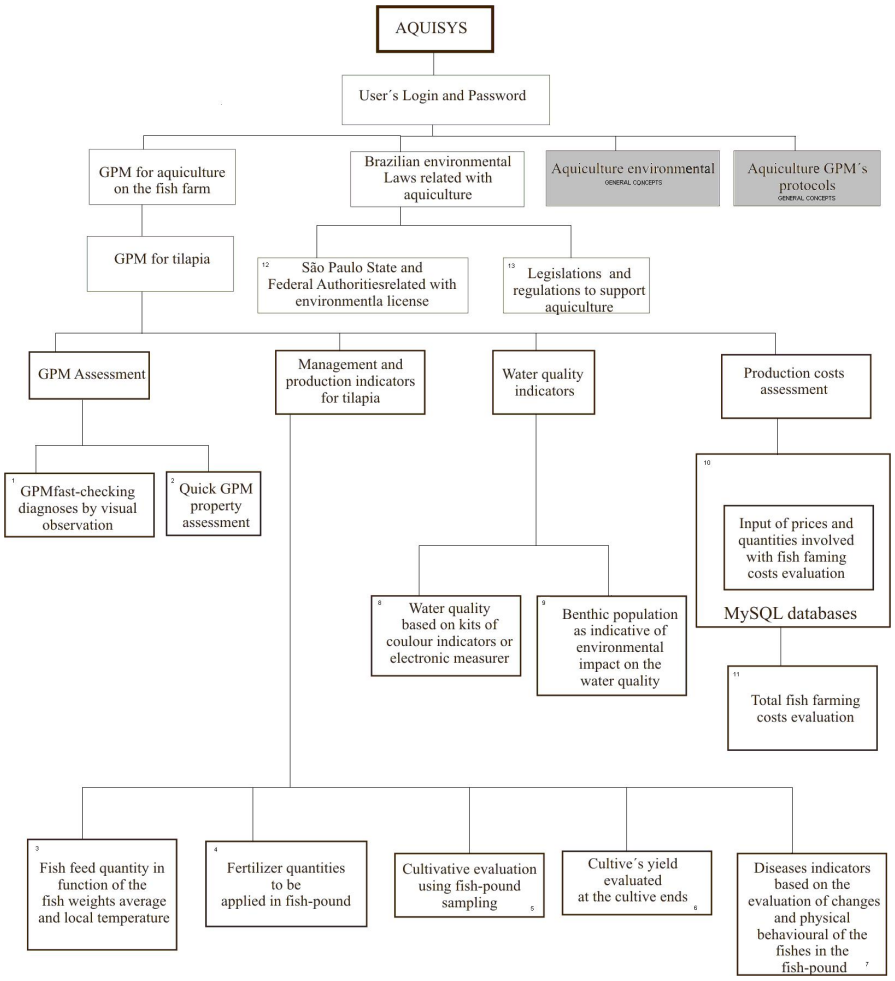

Figure 1. Aquisys system Framework.

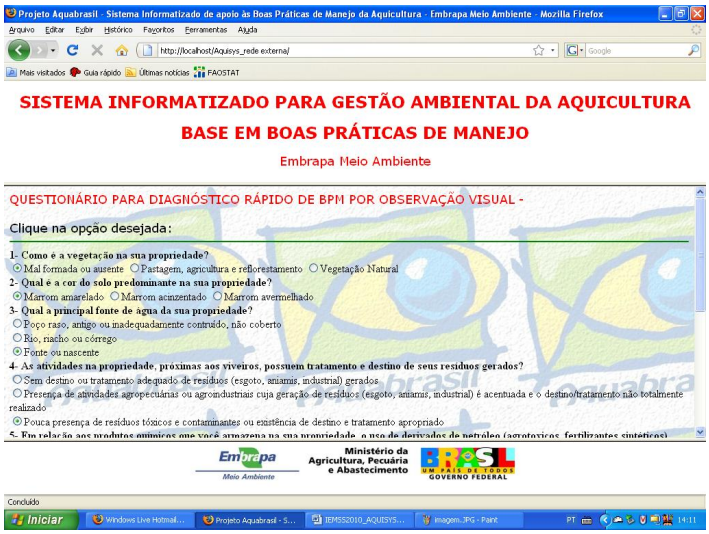

Figure 2. Aquisys´questionnaire available for the fast-diagnosis of Good Practices of Management by user's visual observation.

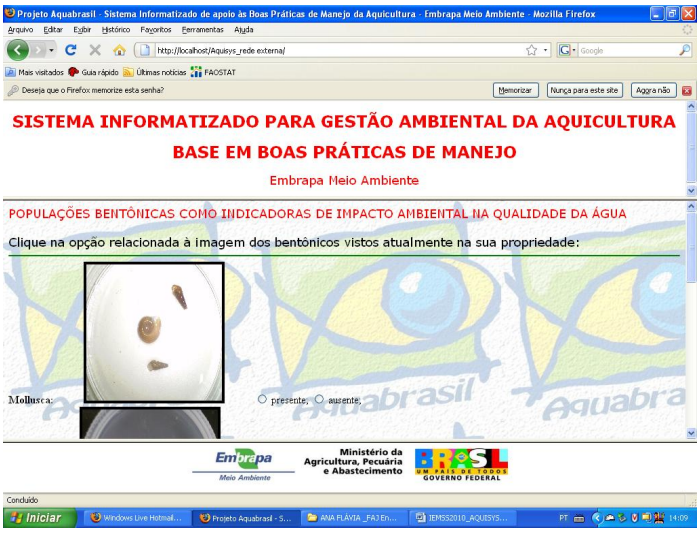

Figure 3. Aquisys´questionnaire available for the user's visual identification of benthonic population, whose the presence, or absence, in the property will be afterward associated with the environmental impact on its water quality.

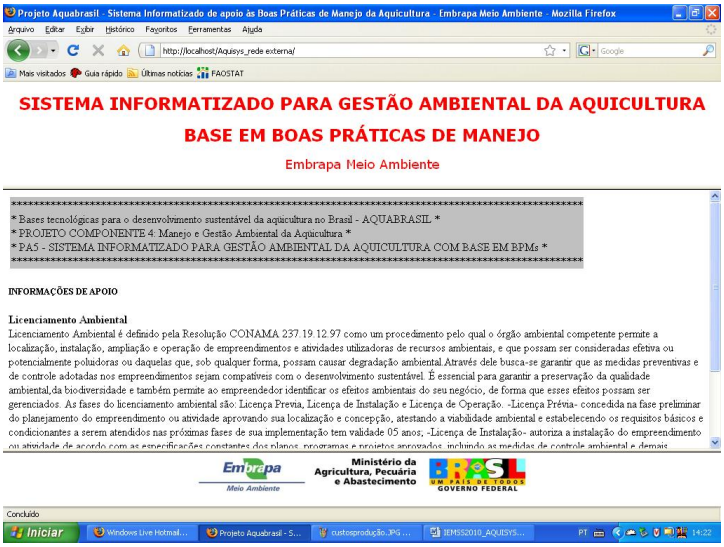

Figure 4. Aquisys´ information resulting from user's demand for environmental licensing process. The system enables information about related law and procedure

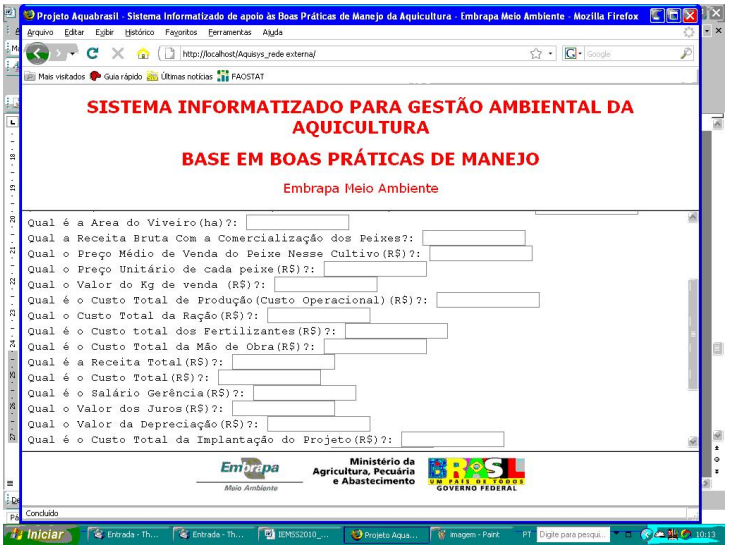

Figure 5. Some questions about fish production (prices, feed costs, fertilization costs, manager salary, and others) in the fish-farming presented to user in order to provide technical-economical indicators .

4. CONCLUSION

Aquisys enables the dynamic access and expeditious diagnoses of good management practices for tilapia, based on indicators of production, management and quality of natural resources of the property. Their use encourages the producer to identify best management practices of tilapia from visual observations and use of methods commonly used in property and other low cost. The development of computational tools provided to organize the existing knowledge available in Brazil to access, but scattered in various sources about the cultivation of tilapia for the needs of good management practices in order to minimize the negative environmental impacts.

5. REFERENCES

MySQL - The World´s most popular open source database, http://www.mysql.com/ . (Accessed on April, 2009).

World Wide Web Consortium (W3C), http://www.w3.org/standards/webdesign/htmlcss 1989. (Accessed on May, 2009)

Beerli, E.L., and P.V.R. Logato, Peixes de Importância para a Piscicultura Brasileira, s.l, s.d,. 36pp., http://www.editora.ufla.br/BolExtensao/pdfBE/bol_65.pdf (Accessed on June 2009).

Boijink, C.L., and D.A. Brandão, Alterações histológicas e comportamentais provocadas pela inoculação de suspensão bacteriana (*Aeromas hyphila*) em juvenis de jundiá (*Rhamdia kelen*), *Ciência Rural*, 31 (4), 234-241, 2001.

Brasil_MD - Ministério da Defesa. Marinha do Brasil, http://www.mar.mil.br/ (Accessed on August, 2009).

Brasil_MMA- Ministério do Meio Ambiente, http://www.mma.gov.br/sitio/en/ (Accessed on August, 2009).

Brasil.MMA_Ibama- Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, http://www.ibama.gov.br/ (Accessed on August, 2009).

Brasil_MPA- Ministério da Pesca e da Aqüicultura, http://www.presidencia.gov.br/estrutura_presidencia/seap/ (Accessed on December, 2009).

Casaca, J.M., and O. Tomazelli Junior, Planilla para Cálculos de Custos de Produção de Peixes. Epagri, 38 pp., Florianópolis, 2001. (Epagri. Documentos, 206).

Dorn, W. S., Cálculo Numérico com Estudos de Casos em Fortran IV, Campus, Ed. da Universidade
de São Paulo, 568pp., 1981.

Karr, J.R., K.D. Fausch, P. L. Angermeier, P.R.Yant, and I. J. Schlosser, Assessing Biological Integrity in Running Waters - A Method and its Rationale. Illinois Natural History Survey, Champaign, 1986. (Special Publication, 5).

Kubtza, M.M.L., Streptococus versus tilápia: é preciso se antecipar aos problemas, *Panorama da Aquicultura*, 11 (66), 33-36, 2001.

Kumar, S., Freemind: Open Source Mind-Mapping Software - User guide (version 8.0). 65p., 2005.

Nunes, B.G. Enfermidades dos Peixes, Universidade Castelo Branco, 39pp., Rio de Janeiro, 2007. (Monografia - Curso de Pós-graduação Lato Sensu do curso Higiene e Inspeção de Produtos de Origem animal).

Ostrenski, A., and W. Boeger. Piscicultura: Fundamentos e Técnicas de Manejo, Guaíba Agropecuária, 211 pp., Porto Alegre, 1998.

Pavanelli, G.C., J.C. Eiras, and R.M. Takemoto, Doenças de Peixes: Profilaxia, Diagnostico e Tratamento, Editora UEM, Maringá, 305pp., 2002.

São Paulo. DAEE. Departamento de Águas e Energia. http://www.daee.sp.gov.br/cgi-bin/principal.exe/index (Accessed on May, 2009).

Seixas, A. F. R., M.C.P.Y. Pessoa, M. E. Losekann, J.F. Queiroz, and D.A.Bosso, Ferramentas computacionais de apoio às boas práticas de manejo de tilápia, paper presented at 3rd Congresso Interinstitucional de Iniciação Científica (CIIC), Campinas Brazil, August 6-7 2009a

Seixas, A. F. R., M.C.P.Y. Pessoa, M. E. Losekann, J.F. Queiroz, and D.A.Bosso, Sistema Especialista como ferramenta de apoio às Boas Práticas de manejo de Tilapia, *Revista Agrogeoambiental*, 1 (3), 130-133, 2009b.

The Apache Software Foundation. Apache. HTTP server Project, http://httpd.apache.org/ABOUT_APACHE.html (Accessed on January, 2009).

The PHP Group, http://www.php.net/ (Accessed on May, 2009).

Tiago, G. G., Aqüicultura, Meio Ambiente e Legislação, Gláucio Gonçalves Tiago (editor), 201pp., São Paulo, 2007.

Valenti, W. C., C.R. Poli, J.A. Pereira, and J.R. Borghetti, Aqüicultura no Brasil: Bases para o Desenvolvimento Sustentável, CNPq e MCT, 399pp., Brasília, 2000.