African Journal of Business Management Vol.6 (14), pp. 4761-4767, 11 April, 2012
Available online at http://www.academicjournals.org/AJBM
DOI: 10.5897/AJBM11.1747
ISSN 1993-8233 ©2012 Academic Journals

Review

Integrated production systems under the sustainable innovation perspective

TONELLI, Dany Flávio[1]*, NOGUEIRA, Elizete A. Teixeira[2], CALEGÁRIO, Cristina Lélis Leal[1] and DE BENEDICTO, Gideon Carvalho[1]

[1]Federal University of Lavras, Campus UFLA, Brazil.
[2]Federal University of São João del Rey, Campus UFSJ, Brazil.

Accepted 16 February, 2012

The purpose of this paper was to describe the integrated farming system in a perspective of sustainable innovation. For that, the paper initially sought to synthesize two of the current conceptions about the innovation theory: the economic and the sociologic approaches. The first highlighted the contribution of the Schumpeterian approach of evolutionary economy, which importantly reflects on the conduction of the innovation politics in several countries. The second highlighted the dedication of Science and Technology Studies in order to understand how the innovation can be seen as a socio-collective process which stabilizes a heterogenic network of actors. The path shown for exploitation of theoretical and practical models of sustainable innovation was developed through the alliance between the environmental, the economical and the social perspectives. The description of the Integrated Production Systems fell within this perspective of sustainable innovation, since these systems search to conciliate indissoluble needs originated from environmental, social, and economic dimensions. Finally, the conclusion pointed that Integrated Farming Systems are processes developed in a systemic approach, that is, holistic, since they sought a rational use of natural resources and higher productive efficiency, considering the environmental, social and economic aspects.

Key words: Innovation, sustainability, integrated farming system.

INTRODUCTION

The concern with sustainability is one of the most important phenomena of the present time. Thus, the economical growth challenge with the sustainable development considering the load capability of the ecosystem to absorb and maintain the human life favorable balance is a crucial question in the development of the sustainable technologies. There are innumerous initiatives towards the creation of non-aggressive production alternatives to the environment which articulate with the production of economical wealth and with the welfare of the society. In this systematic, the development of the new production technologies which value the sustainability in its environmental, social and economical dimensions, in an indissoluble way reveals itself as a movement of socio technical change of innovation in production processes.

*Corresponding author. E-mail: danytonelli@gmail.com.

The objective of this paper is to describe the Integrated Farming Systems under a perspective of sustainable innovation. The integrated farming is a system which produces food and other products with high quality using natural resources and regulating mechanisms to avoid the use of pollutant inputs and to ensure the sustainable agricultural production. These mechanisms are characterized by a systemic and integrated view, and by a development of alternative technologies, which are created to meet the specific contexts and with optimization of the natural resources, respecting the social and economical aspects.

First, the work synthesizes two of the current conceptions about the innovation, economical, and sociological theories. In the first, the innovation is focused from the instrumental notion of goods and wealth generation and perpetuation of the capitalism dynamics. Schumpeter and his followers consolidated the idea that the technical changes represent the reinvention of the capitalism by means of the introduction of new cycles

of economical growth, which implied the scientific and technological policies of several countries by means of the influence of the National Systems of Innovation.

In the second conception, originating from the social studies of science and technology, the concern is about understanding the social/collective dynamics in which the innovation processes are immerse. In this way of thinking, innovation is a product of the stabilization of controversies around a heterogeneous network of human and non-human elements. The way pointed out as promising for the development of theoretical and practical models of sustainable innovation is in the conciliation between the environmental, social, and economical dimensions. Next, the connection between the sustainable growth and development by means of sustainable technologies is exploited.

Finally, the Integrated Farming Systems is described in a sustainable innovation perspective, once these systems seek the conciliation of the indissoluble necessities originating from the environmental and cultural, social, and economical dimensions.

SUSTAINABLE INNOVATION

The innovation theory was widely marked by the influence of the economy approach. Schumpeter (1961), when seeking evidence to explain the hegemony of the capitalism over the other possible economical organization systems, stated that the secret to its perpetuation was in its power to reinvent through the introduction of new economical growth cycles. The new economical cycles would bring along the necessity of the reorganization of the production by means of the technological innovations. Thus, the innovation would then be considered an essential phenomenon and without which there would be a stagnation of the economy and, consequently, the decline of the importance of the market laws in the sustenance of the capitalist system.

Concerning the importance of Schumpeter, Nelson and Winter state that almost all the general contemporary studies of the capitalist machine are based on Joseph Schumpeter (Nelson and Winter, 2005). After that, many other economists from the heterodox perspective brought their contributions in the same sense started by Schumpeter. In this perspective, the neo-schumpeterians are inserted, within which highlight Nelson, Winter, Lundvall and Freeman together with the approach to the National Innovation Systems (Nelson and Winter, 1977; Lundvall, 1988; Freeman, 1995), which still reflects a lot in the conduction of the scientific and technological policies of several countries (Lundvall, 2010).

The innovation theory which is based on the National Innovation Systems, seeks to understand: (i) the nature of the technical advance (evolutionary, before all); (ii) how the processes acquire a structurally inserted architecture, which involves specific contexts and conditions, and (iii) what are the strategies to, among others, create mechanisms of wealth appropriation (Nelson and Winter, 1977; Lundvall, 1988; Freeman, 1995) and deal with the complexities of the innovation in the so-called economy based on knowledge (Lundvall, 2010).

Another study line more directed towards understanding the innovation processes as socially inserted processes is in the sociology of innovation. This approach counts on a great contribution of the Social Studies of Science and Technology (Bijker et al., 1987; Law and Callon, 1992). In this view, the concern is not about establishing economical impact of the innovation, discovering the obstacles at their diffusion or at the technologies transferences, determining institutional reforms or investigating their effects over the rate of employment or over the competitive capacity in the country. What is intended is to investigate the social or collective production while immerse in relations and interactions which are built by heterogenic actors (Oliveira, 2008).

The economy sets aside the social actors and assigns them a purely instrumental logic, which works as a kind of dehumanization, setting the economical change as a neutral mediation instrument. In the perspective of the science and technology studies, particularly in its way of thinking known as Actor-Network Theory, in opposition to the economy, there is a kind of elevation of the individuals to the condition of actors, humanizing the objects and performing the change of a complex process of translation (Latour, 2000; Law, 2003).

Among many differences of purpose between both approaches, the fact that the first seeks to perpetuate the idea of economical growth based in the development and introduction of innovations is highlighted. The second sets aside the impacts over the economy and seeks to understand the innovation as a socially inserted practice of recruitment, combination and negotiation between the heterogeneous elements, which simultaneously transform the realities and is transformed by them.

In the first view, the sustainability of the ecological systems acquires a minor importance than the concern about the economical growth. In the second view, the question is very inclined to the understanding about how the distinct actors produce influences one over the other and shape the realities. Thus, the innovation is considered as a stabilization of controversies around the technological artifacts. In this case, the sustainable development comes in as another contingency that can produce effect over the reality that is desired to understand.

Considering both the sociological and economical approaches, the proposals that put the problem of environmental sustainability as a *sine qua non* condition are not common. Habitually, when these approaches emerge, they seek to ally the economical and the social aspects. The so called Social Technology movement is

an example of that. It seeks to conciliate the generation of income with the question of the social inclusion. Among the implications of the social technologies, according to the manual of the Social Technology Institute (ITS, 2007), in the item (iv) can be found: socio environmental and economical sustainability.

However, even for the political specificity about social technologies, that does not insert nor purposes to insert, for example, the production in wide scale realized by private companies. As can be seen, the social technologies are a set of techniques and transforming methodologies, developed and/or applied in the interaction with the population and appropriate for them, which represent solutions for the social inclusion and improvement of the life conditions (Social Technology Institute[1] **-** ITS, 2007).

In this sense, it can be stated that there is a lot of work towards the consolidation, both the theory and the practice, of models of sustainable innovation models. Such models could advance assigning importance, not only over the economical result of the innovation or over the understanding of its collective construction, but also in its capacity to promote the environmental, social, and economical sustainability.

Development under a sustainable perspective

The broadest approach to the sustainable development originates from the Brudtland (1987) report, in which: *"the sustainable development is that which provides the needs of the present without compromising the capacity of the future generations to provide their own needs*" (Brundtland, 1987- our translation).

In the ecological economy approach by Daly and Farley (2004), the development in its conceptions of sustainability, it is expected to be understood in the limits of nature and the creation of policies that allow our economy to develop itself within these limits. Allied to those restrictions lies the problematic of the interactions of two complex systems: the human system and the ecological system which sustains it.

To picture this man/nature relation, Gladwin et al. (1995) brings a classification of three paradigms:

Technocentric Paradigm, Ecocentric Paradigm and Sustaincentric Paradigm. The first paradigm is considered as "dominating" and which supports the idea that the land is inert and passive, which can be, therefore, legitimately exploited. In the approach, the ethics is anthropocentric, selfish and utilitarist, because the contemporary human beings are those who care the most, in this approach. Thus, all the problems can be solved by means of technology.

The second paradigm promotes a view of the biosphere and of the society, based on the ecological principles of holism, the balance of nature, the diversity, the finite limits, and the dynamic changes. Nature is addressed as fragile and vulnerable and, thus, in this perspective, there is a view of the limitation of technology; that is, no matter how good nature is, it might not be sufficient to solve ecosystemic problems.

The third way of thinking, Sustaincentric Paradigm, defined by Gladwin et al. (1995) would incorporate a conciliatory and broadened notion to the various dimensions which a part of the notion of sustainability. It is acceptable that the global ecosystem is finite, vulnerable to the human interference and limited to its regenerative capacity. Basically, this perspective seeks to evaluate the ecological, social and economic impact of the new technologies before they are introduced, in the sense of minimizing their adverse effects.

The idea of the sustainable development translates the development in a perspective of qualitative improvement in the capacity to satisfy the lack (needs and desires) without the quantitative increase in the production into beyond the environmental load capacity. The load capacity is the population of humans who can be sustained by a given ecosystem in a given level of consumption using a given technology.

The limits to growth do not necessarily imply limits to the development. The development is the increase in the quality of the goods and services, as defined in their capacity of increasing the human welfare, provided by a determined product. A development which takes into consideration the resilience, that is, the capacity of a system to face disturbances keeping its functions and structure in a bearable ecosystemic view (Gladwin et al., 1995; Daly and Farley, 2004).

Growth, on the other hand, by the conventional approach, is a quantitative growth in dimension, or in an increase in production. Whereas, the production is the flow of raw materials and energy of the global ecosystem, through the economy, which returns to nature as residues. The almost exclusive concern about the efficient attribution is the almost exclusive concern about the efficient attribution. Ecological economy considers the efficient attribution as important, but, secondary, in comparison with the scale and the distribution.

There is a paradigmatic duality in the approach to growth in the technological perspective. On one side, the ecosystem seen as a sector of extraction and leakage of the economy admits that even the services becoming scarce, the growth will be able to continue forever because the technology allows the return of the natural growth through the replacement of natural capital done by man. In this perspective, the only limit to the growth is the technology, and supposing that we can always develop new technologies, there is no limit to the economic growth. This is a weak conception of sustainability. On the other hand, the strong sustainability constructs a supposition that the natural capital is irreplaceable and, therefore, essential. The strong

[1] A Brazilian institute that promotes the social technology approach and disseminates the practices of social inclusion.

sustainability defends the maintenance of the natural capital, independent of the development of the forms of human capital, which does not depend on the developed technology. By definition, there is no sustainable consumption rate for non-renewable resources. The main difficulty in the use of non-renewable resources is not the immediate exhaustion, but the technical, economical, environmental and socio political difficulties, associated with the decline in quality of the resources and transition to the substitutes. Even existing stocks and flows of the renewable resources, generated by nature, they do not mean that the increase in the human requirement in the biophysical environmental happens in a sustainable rate (Holdren, 1991; Wackernagel and Rees, 1995; Daily and Ehrlich, 1992).The sustainable development does not limit the use of technology. New technologies may bring positive or negative effects. Technologies that increase the productivity of the resource can reduce the pressure over the stocks of natural capital. Technologies that increase the productivity of the manufactured capital and of the employment frequently require the processing of a greater flow of resources, and, therefore, tend to reduce the productivity of the resource.

Historically, the technological progress has favored the productivity of capital and of employment at the cost of the resource productivity. The sustainable development leads to an opposite direction of this type of technical progress: a progress which obtains more services per resource unit, instead of one which only uses more resources to operate a system (Daly and Farley, 2004).

In the perspective of the sustainable development the relation between the reserve flows of natural capital and the resources of service funds represents one of the most important concepts of ecological economy.

To summarize, the production needs to contribute to the structure of the ecosystem. The structure of the ecosystem produces the function of the ecosystem which, in turn, provides services. All the economic production has, thus, an impact on the ecosystem services, and, because the impact is inevitable, it is completely inserted in the interior of the economic process (Daly and Farley, 2004).

INTEGRATED PRODUCTION SYSTEMS

With the growing worldwide charging for a safe production, with the minimum of negative impact on the environment, requiring decrease in the use of chemical defensives, protected workers and consumers emerge a general interest in reintegrating an ecological rationality to the agricultural production, and in making more widely raging adjustments in the conventional agriculture, to make it environmentally, socially, and economically viable and compatible; as well as in the technological aspects introduced. But the focus is about the replacement of inputs, that is, replacing costly and degrading agrochemicals to the environment and intensive technologies for lenient technologies, of low cost and eternal inputs. This focus does not reach, however, the ecological causes of the environmental problems in modern agriculture, deeply rooted in the structure of the predominant monoculture in production systems of wide scale (Gliessman, 2001; Altieri, 2009)

For these authors, the view of sustainability only as a technological challenge to production cannot reach the fundamental reasons of the non-sustainability of the agricultural systems. The agro-ecology provides the basic ecological principles for the study and treatment of the ecosystems both productive and preservers of the natural resources and that are culturally sensitive, socially fair, and economically viable. The agro-ecology is a new approach which integrates the agronomical, ecological and socio economical principles to the understanding and evaluation of the effect of the technologies over the agricultural systems and the society as a whole. In this perspective, other alternative systems of production elapse (Altieri, 2009).

The International Organization for Biological and Integrated Control of Noxious Animals and Plants – IOBC/WPRS founded in 1956, has the objective to develop and implement the technologies based on the ecosystems for the protection of plants. The International Organization for Biological and Integrated Control of Noxious Animals and Plants has become a leader in production strategies respectful of the environment and the social aspects. The evolution of the Concepts of Biological Control of Integrated Management of Pests - IPM which presents a holistic systemic approach was a logical response to the progress and the development of concepts of scientific standards.

The Integrated Farming presupposes the employment of technologies that allow the effective control of the productive farming system by means of the monitoring of all the stages, from the acquisition of inputs to the offer to the final consumer, guaranteeing, thus, the safe and traceable food by the interaction of all the productive chain. The definition of the Integrated Production was created in March 6, 1992, in Wadenswill, Switzerland, by means of cooperation between International Organization for Biological and Integrated Control of Noxious Animals and Plants.

“Integrated Production is a farming system that produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming. Emphasis is placed on a holistic systems approach involving the entire farm as a basic unit, on the central role of agro-ecosystems, on balanced nutrient cycles and on the welfare of all species in animal husbandry. The preservation and improvement of soil fertility and of a diversified environment are essential components. Biological, technical and chemical methods are balanced

carefully taking into account the protection of the environment, profitability and social requirements (International Organization for Biological and Integrated Control of Noxious Animals and Plants, 2010)."

In the early 70s, International Organization for Biological and Integrated Control of Noxious Animals and Plants went through a process of restructuring and expansion which resulted in the emergence of its regionals. In 1971, the West Paleartic Regional Section - WPRS, encompassing Europe; the South and East Asian Regional Section - SEARS; and the Western Hemisphere Regional Section - WHRS, including the Americas emerged.

In 1977, the East Paleartic Regional (EPRS) emerged, and also in 1989, the Afro Tropical Regional Section (ATRS). This system preferably meets the requirements of the consumer markets of Europe represented by Euro-Retailer Produce Working Group (EUREPGAP), EUREP for Good Agriculture Pratices (GAP), now known as GLOBALGAP, for safe foods, traceable and of high quality.

Thus, it becomes necessary to employ technologies that allow the effective control of all of the stages in the productive system, that is, that integrate all the productive chain in consonance with the institutionalized international and international laws.

Analyses: Integrated farming systems in a sustainable innovation perspective

Aiming to present the Integrated Farming Systems in a sustainable innovation perspective, first, is based on its conception, the systemic view, initially in the integrated pest management, evolving into the integration of processes in all of the productive chain. Therefore, its implantation should be seen in a holistic form, structured under four pillars of sustenance: productive base organization, system sustenance, monitoring of the processes and information and data bank, components which link and consolidate the remaining processes. It is placed on the apex of the pyramid as the most evolved level in organization, technology, management and other components, in a context in which the sills for innovation and competitiveness are stratified by levels of development and represents the several stages in which the producer will be able to be inserted in an evolutionary of production.

Furthermore, the Integrated Farming Systems meet the international and national market requirements for food or farming products with quality and food safety. To ensure the safe and traceable food, several efforts must be combined in all of the productive chain. The system presupposes the employment of technologies which allow the effective control of the farming system by means of the monitoring of all of the stages, from the acquisition of the inputs until the offering to the consumer.

The sustainable technologies presently in developing behold the Good Farming Practice - GAP which is consubstantiates by means of the elaboration of norms that rule the Integrated Farming. Within the main norms that meet the needs of the consumers, EUROPGAP, US-GAP are highlighted, which encompasses the regulations of Animal and Plant Health Inspection Service (APHIS), and Integrated Farming. For example, in the Integrated Farming, in the Fruit culture, there are the following proved results: (i) increase in the productivity and in the quality of the produce; (ii) reduction in the water and electric energy consumption; (iii) increment in the diversity and population of natural enemies of pests; (iv) decrease in the application of pesticides and the presence of chemical residues in the fruit; (v) rationalization in the use of inputs; and (vi) improvement of the environment, the quality of the consumed product, of the health of the rural worker and of the final consumer.

International Organization for Biological and Integrated Control of Noxious Animals and Plants, European section, centered their activities in the development of general and specific technical norms for each type of culture, in order to allow the application, certification, and expansion of the farming practices defined in the context of Integrated Farming according to internationally standardized norms. The publications are Technical Guidelines I and Technical Guidelines II.

The Normative Instruction number 27 institutes the Legal Mark of the Integrated Farming in Brazil - PI Brazil and validates the Specific Technical Norms to have the official certification seal, on products originating from animals and plants. The system started with the public and private partnerships (MAPA, 2011).

The Normative Instruction number 27 establishes directions for the programs and projects that foster and develop the Integrated Farming - PI-Brazil aiming to support the productive chains to cope with the marketwise requirements and aiming to elevate the quality and competiveness standards of the farming products to the level of excellence. In this sense, it fosters the sustainable farming, the diffusion and transference of technologies, technological innovations, good farming practices and animal welfare, with basic elements of transference of the convention farming into sustainable, certifiable and traceable.

It is a system which stimulates the organization of the farming base, which monitors the system, seeking the sustainability of the farming processes, implantation of data base, systems of prosperity management and economic instruments to ensure the business viability. In the social aspect, it incentives and promotes capacitating programs for the involved with the farming chains (MAPA, 2011).

In this systematization, there is the offer of farming products, safe and with quality, produced according to

parameters and sustainable farming systems, being indispensable to meet the requirements and expectations of the international and national consumer markets.

The development of sustainable technologies into Integrated Farming Systems via the elaboration, proposition, adequacy, review and development of Specifically Technical Norms (NTE) for the implantation of Model of Evaluation of the Process Conformity of Integrated Farming in Brazil - PI Brazil. The process of evaluation of the conformity will be sustained by the models defined in the scope of the National System of Metrology, Standardization and Industrial Quality (SINMETRO, 2011), and will be executed by organisms of third part which follows international methods and which is according to the criteria and requisites established by MAPA and SINMETRO. Before such procedures, the use of the seal of identification will be obligatory on the certified products prescribed by PI-Brazil (MAPA, 2011).

The Integrated Farming, in Brazil, is being implemented in the poles of production using a methodology of pilot-projects installed in rural properties of several productive chains, under coordination of researches/teachers of governmental institutions, counting, for that, with the partnership established between the MAPA, and the National Scientific and Technological Development Council (CNPq), considering that the financial resources are originated from MAPA and are made available to CNPq, which hire the projects together with coordinators, under general supervision of MAPA/CNPq.

In these projects, there are multidisciplinary and support teams involved, constituted by means of a committee which elaborates the technical farming norms, which are tested, validated and applied in selected properties. In this system, better and more adequate farming technologies, seeking the rationalization of farming chemical products, the management of water, of the soil, of the environment, of the culture or species, of the post-harvest and the necessary implantation of records in all of the farming phases to obtain traceability (Andrigueto et al., 2009).

FINAL CONSIDERATIONS

In conclusion, that the theoretical methodological assumptions of the Integrated Farming Systems are inserted in a perspective of sustainable innovations, since they are farming processes developed in a systemic and integrated approach, and which aim to the rationalization of the use of natural resources and a greater efficiency of the processes in the productive chains.

By means of the management of the farming processes the reduction of the external inputs is sought, that is, reductions of the pesticides indexes, and consequently, reductions of water and soil contamination. Greater rationalization of the use of water, greater biological control and of pests by natural means, fertilization of soil with alternative fertilizers, besides the necessity of personal protective equipment (PPE), and training for all rural workers.

The conceptions of the production of food and other products with technologies that aim to reduce the use of natural resources, and that has regulating mechanisms to replace pollutant inputs, as well as seek to preserve and improve the fertility of the soil, of a diverse and integrated environment, besides the observation of ethical, social and welfare criteria are essential components for a sustainable farming.

The Integrated Farming System presupposes the employment of technologies which allow the effective control of the farming productive system by means of the monitoring of all the phases, from the acquisition of the inputs to the offering to the consumer. These sustainable technologies currently being developed behold the Good Farming Practices (GFP) which are consubstantiate by means of the elaboration of norms that rule the Integrated Farming.

Thus, the structural and constitutive principles of PI-Brazil and its instruments should behold the pursuit for quality, security of the farming products, sanity of the products, sustainability, traceability and monitoring of the processes and information records. In this systematization Specific Technical Norms (STN) are sought for the implantation of the Integrated Farming in Brazil - PI Brazil Processes Conformity Evaluation Model and, consequently, the identification seals of the certified products in the Integrated Farming System.

With this work, of theoretical nature, the possibility of growth with sustainable development by means of sustainable technologies recommended in the Integrated Farming Systems which are the Good Farming Practices is concluded.

ACKNOWLWDGEMENT

The authors acknowledge the Minas Gerais Foundation of Support Research.

REFERENCES

Andrigueto JR, Nasser LCB, Teixeira JMA, Simon RF, Martins MVM, Kososki AR (2009). Integrated Production of Fruits and Integrated Agricultural System. MAPA, Brasília, Brazil.

Altieri M (2009). Agroecologia: a dinâmica produtiva da agricultura sustentável. 5ª ed. Ed. da UFRGS, Porto Alegre, RS, Brazil.

Bijker WE (1987). The Social construction of technological systems : new directions in the sociology and history of technology**.** MIT Press, Cambridge, Mass, USA.

Brundtland G (1987). World Commission on Environment and Development. Our Common Future**.** Oxford University Press, Oxford, UK.

Daily GC, Ehrlich PR (1992). Population, Sustainability, and Earth's Carrying Capacity: A Framework for estimating population size and lifestyles that could be sustained without undermining future generations. BioScien., 42: 761-771.

Daly H, Farley J (2004). Ecological Economics: principles and applies. Instituto Piaget, Lisboa, Port.

Freeman C (1995). The National System of Innovation in historical perspective. Cambrid. J. Econ., 19: 5-24.
Gladwin TN, Kennelly JJ, Krause TSS (1995). Paradigms for sustainable development: implications for management theory and research. Acad. Manag. Rev., 20: 874-907.
Gliessman SR (2001). Agroecology: ecological processes in sustainable agriculture. UFRGS, Porto Alegre, Brazil.
Holdren JP. (1991). Population and the energy problem. Pop. Environ., 12: 231-255.
IOBC/WPRS International Organization for Biological Control of Noxious Animals and Plants (2010). Integrated Production in Europe. <http://www.iobc-global.org/>.
ITS Social Technology Institute (2007). Knowledge and Citizenship 1**:** social technology. ITS press. São Paulo, Brazil.
Kososki AR (2009). Integrated Production of Fruits and Integrated
Latour B (2000). Science in Action: how to follow scientists and engeneers throught society**.** Unesp,São Paulo, Brazil.
Law J (2003). Traduction/Trahison: Notes on ANT. Centre for Science Studies, Lancaster, UK.
Law J, Callon M (1992). The life and death of an aircraft: a network analysis of technical change. In: Bijker WE, Law J (Ed.). Shaping technology/building society : studies in sociotechnical change. MIT Press, Cambridge, Mass,USA, p. 21-52.
Lundvall BÅ (1988). Innovation as an interactive process: from user-producer interaction to the national system of innovation. In: Dosi G *et al* (Ed.). Technical Change and Economic Theory**.** Pinter Publishers, London, UK, p. 349-369.
LundvalL BÅ (2010). National Systems of Innovation: toward a theory of innovation and interative learning**.** Anthem Press, London, UK.
MAPA – Ministry of Agricultural, Livestock and Supply (2011). Normative Instruction Number 27. Integrated Production. MAPA, Brasília, Brazil.
Nelson RR, Winter SG (1977). In search of useful theory of innovation. Res. Pol., 6: 36-76.
Nelson RR, Winter SG (2005). An evolutionary theory of the Economic Change. Unicamp, Campinas, Brazil.
Oliveira L (2008). Sociology of Innovation: a social construction of techniques and markets. Celta Press, Lisboa, Portugal.
Schumpeter JA (1961). Capitalism, Socialism and Democracy. Fundo de Cultura Press, Rio de Janeiro, Brazil.
SINMETRO National System of metrology, standardization and industrial quality (2011). Disponible in: www.inmetro.gov.br/qualidade/pif.asp. Acess 07 mar. 2011.
Wackernagel M, Rees W (1996). Our ecological footprint: reducing human impact on the earth. New Society Publishers, Canada.