ENVIRONMENTAL IMPACTS IN RURAL AREAS: PROPOSAL OF A MODEL OF RURAL SUSTAINABLE PRODUCTION

Antonio Edson Leite, antonio.edson.leite@gmail.com Universidade Estadual Paulista Julio de Mesquita Filho – Bauru - Brasil

Rosane Ap. Gomes Battistelle, Univerdidade Estadual Paulista Julio de Mesquita Filho – Bauru - Brasil

Rosani de Castro, Universidade Estdual Paulista Julio de Mesquita Filho – Bauru - Brasil

Abstract

The pressure from the government, local communities and consumers has changed the way producers address the issue of sustainability. The concept should be applied at all stages and levels of a rural production, ranging from the study of soil, crop choice, fertilizer and herbicides needed, mechanization, irrigation, among others. In the last couple of years the world population has grown exponentially, new technologies also provided similar increase in food supply. However these new technologies have generated significant damage to balance the rural environment. This raims to review the advances brought by new technologies and the main impacts the rural environment has suffered in recent years. The main goal of this study was to discuss and propose a model for more sustainable rural production, with a focus on contributing to a better performance of rural production, both financial and environmental aspects. It is expected that the model will contribute to the decision-making of producers. In conclusion, it should be noted that the conciliation of all items proposed is relatively difficult in the rural environment, but the understanding and quest for meeting these requirements should guide the future activities of agricultural production around the world.

Keywords: sustainability, sustainable rural production

Introduction

Over the last few years much has been discussed about the environmental impacts of human activities on Earth. Several researches have contributed to the disclosure of the problems and possible solutions that can mitigate or at least reduce these impacts.

Bantjes (2011) points out that over the years farmers were more dependent on the market, i.e., less dependent on the things they could provide for themselves, like rustic furniture and tools forged locally.

Formerly, the need used to make the farm more self-sufficient. However, the capitalist dependence of the market could, minimally, affect the incipient sustainable development of rural properties (Matson et al. 1997).

In recent decades the consumption of goods has sporadically increased, and as a result, a greater generation of waste has been discarded. In the rural sector stood out a greater use of pesticide containers.

The ignorance about what is sustainability, and the persistent thought of the farmer to produce without planning can also result in environmental impacts.

In rural areas these impacts can be quite damaging. This is due to the fact that agriculture is an activity in constant interaction with the environment, consuming natural resources such as water and nutrients.

These impacts have increasingly occurred over the decades. According to Matson et al. (1997), the use of high-yielding varieties, irrigation, fertilizers and pesticides has contributed significantly to an increase in the supply of food in the last fifty years.

Pierce (1996) found that the increased consumption and the adoption of mistaken public policies are among the dominant forces that prevent the rural sustainability. In line Arias-Estévez et al. (2008) argue that the use of suitable policies for the use of pesticides could contribute to reducing impacts on soil and water.

According to Lal (1996) another possibility for lowering of environmental impacts, would be the adoption of conservation farming system. Studies by Knowler and Bradshaw (2007) and Castellini and Ventrella (2012) found that the adoption of such a system can be economically and especially environmentally viable, providing reduction of production costs and decreasing emissions of greenhouse gases.

In this context, this study aims to propose a model of sustainable rural production, which contributes both to the effectiveness of rural activity with economic gains and, mainly, to provide the basis for the mitigation of environmental damages within the context of the Brazilian reality.

This study is justified due to the importance of this segment to today's society. In the last decades modern agriculture was able to prevent a collapse in food supplies around the world. However, this was achieved with the use of quite a few technologies, which often were accompanied by various environmental harm.

Literature review

The global agricultural production has undergone great changes over the past decades, more precisely, from the 1950s. At this time comes the global movement called Green Revolution (Chamala, 1990).

According to Matson et al. (1997) the green revolution was based on using high-yielding potential varieties, the application of chemical fertilizers in plantations, increased use of irrigation systems, intensive use of pesticides and high mechanization in rural activities.

This movement towards the modernization was of high relevance to a lot of countries that faced food deficit. These countries managed to increase their production and ensure better quality of life for great part of the population (Costabeber, 1998).

To illustrate the above scenario, Matson et al. (1997) points out that the global agricultural area rocketed to 466% between 1700 and 1980. However, in recent years,

due to geographical restrictions this value decreased significantly. But, even with these restrictions on space, agriculture has shown advances in productivity rates.

Although the growth of the crop area in the country has remained virtually stable within the last few years, there have been improvements in per capita food supply, which can be seen in Table 1.

Table 1 – Indicators of population and development of crop production worldwide between 1975 and 2005.
Fonte: FAO, 2006

Indicators	**1975**	**2005**	**Variation%**
Total population (billions)	3.693	6.4	74,74
Production (million tonnes)	1.225	2.219,4	81,18
Planted area (million hectares)	695	681,7	-1,91
Average productivity (a thousand kg/hectare)	1,76	3,26	84,71
Annual supply *per capita* (kg)	310,00	340,00	9,68

While it is evident the importance of agricultural development shown in Table 1 for the current society, since agricultural modernization has provided improvement in the supply and availability of food for a greater portion of the population, one can not overlook the negative consequences of such advances, such as the environmental and social damage caused by the activity.

As reported by Knickel (1990), the main environmental impacts found in land exploration and use would be: monoculture, soil and rivers erosion, water and soil pollution by pesticides, fertilizers and waste from the animal production and use of fossil fuels and other nonrenewable resources.

Along the same research stream, Singh (2000) cites deforestation as one of the main negative consequences of agricultural expansion. The author highlights the problems faced by developing countries with agricultural modernization, and the Green Revolution brought impressive production increases, however it also brought serious environmental and social damage.

Singh (2000) also states that some developing countries like India have achieved self-sufficiency in food production modernizing the agricultural production. Nevertheless, the negative effects can be noticed in that country's soils and waters.

Methodology

Aiming to achieve a better understanding and improve the knowledge about the environmental impacts in rural areas, there was an exploratory researching, whose methodological framework was based on an extensive literature review, querying the databases, Scopus, Web of Science, SciELO , among others.

Several studies that addresses the environmental impacts generated by rural activity were summarized, besides others which emphasize the importance of developing techniques to mitigate these impacts.

After defining the problem, a theoretical framework was developed and that became the basis for the proposal of a model for a more sustainable rural property.

Results and Discussion

Based on the on the literature review, it is proposed in figure 1 with the basic conditions for a more sustainable farm. This table briefly highlights the characteristics of a sustainable rural property, by way of example, these properties must demonstrate commitment to social, environmental and economic spheres.

MORE SUSTAINABLE RURAL PRODUCTION		
ECONOMICALLY VIABLE	**SOCIALLY FAIR**	**ENVIRONMENTALLY RESPONSIBLE**
- COST REDUCTION - It is possible using organic fertilizers derived from other processes. **- INCREASED PRODUCTIVITY AND PROFITABILITY** - By means of the maintenance of key properties of the soil, which will generate the proper plant nutrition. **- CONTINUITY OF RETURN ON LONG TERM** - Raise in value added products through manufacturing processes in closed cycles.	**- FOOD SUPPLY TO THE COMMUNITY AND SOCIETY** - Development of technologies that ensure food in quantity, quality and affordable for the population grows exponentially. **- RESPECT FOR PHYSICAL INTEGRITY OF EMPLOYEES** - Provision of appropriate equipment for pesticide application. - Monitoring risk activities.	**- RESPONSIBLE CONSUMPTION** - Responsible use of natural resources such as water and energy. **- COMPLIANCE WITH NORMS AND LEGISLATION** - Comply with the protection rules related to pesticide use, avoiding them when it is possible. - Properly dispose of waste pesticides and fertilizers. - not use natural forest areas for production of crops. **- LESS DEGRADING TECHNIQUES TO THE ENVIRONMENT** - Using appropriate management mechanism for the maintenance of fauna and flora. - Use of more efficient cultivation systems.

Figure 1 - Conditions for a more sustainable farm
Source – Developed by the authors

Figure 1 suggested was based on the studies of Hochman et al. 2013. It is proposed that eight requirements for a rural property in Brazil under appropriate local conditions is more sustainable. Following, we discuss each of them briefly.

In the economic sphere, it is proposed primarily a decrease in production costs of the rural property. This cost reduction can occur primarily through two means. First of all through conscious use of pesticides and fertilizers.

Some techniques have been prominently displayed in this regard over the years, among them can be considered as markpoints the agriculture of precision for fertilizer application with floating rates according to the specific need of each location (Kaloxylos et al. 2012; Tan et al. 2012), biological control and integrated pest management (Frank 2010; Díaz et al. 2012). Another way to reduce costs can occur by reusing organic waste for fertilizers composition. These residues may come from livestock, such as poultry, cattle and pigs. Several studies have shown that this craft provides both economic and environmental viability (Barik et al. 1991, Oliveira et al. 2011).

The second point in the economic field refers to greater efficiency in the use of resources in order to increase productivity of crops. It is known that technological advances such as irrigation, chemical fertilizers and pesticides have brought advances in productivity rates (Matson et al. 1997). However, the available resources for the practice of agriculture are limited and increased production and productivity must go first through a review of the techniques currently used. (Pierce, 1996; Perry et al. 2009)

It is still distinguished the maintenance of the activity in the long term basis. For this purpose, it is necessary to adopt production techniques in a closed cycle, with reuse of waste from all processes (Oliveira et al. 2011). This can bring practical and visible gains, besides other intangible benefits by the legitimacy of their activities with the stakeholders (Hart and Milstein, 2004).

Within the social sphere it is highlighted the need and near obligation to produce in quantity and quality sufficient food to feed a population that continues to grow around the world. Add to that improved living conditions of some populations in poor countries that have leveraged the consumption of proteins, especially those derivative from meat, leading to a significant increase in food prices (Giles, 2012).

Harding and Peduzzi (2012) also warn about the diminishing reserves of oil which can cause even more pressure on food prices and producers' profits. Therefore, producing enough food to feed a population of about seven billion people is a challenge for producers and governments.

Still regarding the social field, there is the need to ensure good working conditions, people who participate in the production process within the farms. The supply of personal protective equipment (PPE), use of pesticide application equipment provided with booths including filters to prevent workers contact with chemicals should be a concern increasingly necessary.

Finally, and more widely, there are the environmental variables that must be part of a sustainable farm. Firstly there is a need for responsible consumption of resources. As pointed out by Harding and Peduzzi (2012), cheap fuels are no longer part of the future scenario.

There is also the issue of high water consumption by agriculture that needs to be further studied, with the purpose of a more efficient use of this resource. Some works suggest methods for a more efficient use of water (Perry et al. 2009; Ozerol et al. 2012)

Another point addressed in our research boils down to the need to meet existing laws, using pesticides responsibly, respecting the limits set by law. With special care relatated to pollution of water sources and conservation areas.

In Brazil an example of effective initiative in trying to reduce the damage caused in rural areas is the collection of used pesticide containers for recycling. However, this greater participation of producers regarding this practice is due to drafting the Law 9974 that requires the return of used packaging by producers.

According to data from the National Institute for Empty Packaging Processing (INPEV) the rate of return is increasing annually, and in 2008 were collected approximately nine million packages, and in 2011 this number increased to about fifteen million.

Another issue of relevance is deforestation. Although it has been working to raise producers' awareness about the need to maintain and preserve existing forests much still needs to be done about this. Studies such as Angelsen (1995) and Muller et al. (2013) associated deforestation with agricultural practices currently. However, as highlighted by Saikku (2012), reducing deforestation involves the adoption of an effective climate policy.

Finally, it is pointed out the need for less harmful techniques to environment in rural property. Using more efficient planting systems can ensure the survival of soil biota and maintenance of its essential properties. Some studies have highlighted the possibility of adopting conservation tillage and no-till farming (Knowler and Bradshaw, 2007; Prasuhn, 2012; Homma et al., 2012; Ventrela and Castellini, 2012). According to the authors these techniques could mitigate the impacts produced by the current farming system, reducing the levels of erosion and improving soil fertility.

Concluding remarks

This study aimed to fill a gap in the rural sector, in regard to integration of environmental issues, providing a standard farm considered as reference for a sustainable farm. This model can be applied and used by farmers as a parameter to assist them in decision-making.

Some researchers like Gomes et al. (2009) argue that the major difficulty of implementing sustainability in a rural environment lies in translating the complex and diverse sustainability principles into recommendations for decisions taken by farmers.

However, there is still some resistance in adopting more sustainable practices on the side of producers. This reality can be changed once farmers have the perception of the gains that can be achieved with the adoption of a more sustainable model in its production.

The activity maintenance by legitimizing their actions with stakeholders and the need to add value to products imposed by the prevailing system of global competition leads us to believe that, in the future, agricultural production systems will have to consider the factors proposed in figure 1.

Hockman et al. (2013) proposes a framework similar to the context of Australian agriculture. In his review he concludes that none of the cropping systems used in that country meets sustainable requirements. Corresponding reality can be found in Brazilian properties, where little effort is dedicated towards fulfilling the necessary features for sustainability proposed in figure 1.

As a summary, it can be mentioned that agriculture has foundations for a more sustainable production, with no-tillage techniques, integrated pest management, biological control, the reuse of waste for fertilizer production, among others existing, and that can lessen the damage caused by the producers. However farmers will need a greater amount of information and guidance. The authors believe that the proposed model will help them to make decisions focused on aspects related to the sustainability of their businesses.

References

Angelsen, A. 1995. Shifting cultivation and "deforestation": A study from Indonesia. World Development. **23**(10): 1713-1729

Ariaz-Estevéz, M. et al. 2008. The mobility and degradation of pesticides en soils and the pollution of groundwater resources. Agriculture, Ecosystems and Environment. **123**(4): 247-260

Barik. S. et al. 1991. Bioconversion of Chicken Wastes to Value-Added Products. Bioresource Technology. **36**(3): 229-234.

Bantjes R. 2011. Rural sustainability and the built environment. Journal of Enterprising Communities: People and Places in the Global Economy. **5**(2): 158-178

Castellini, M., Ventrella, D. 2012. Impact of conventional and minimum tillage on soil hydraulic conductivity in typical cropping system in Southern Italy. Soil & Tillage Research. **124** : 47-56

Chamala, S. R. 1990. Social and environment impacts of modernization of agriculture in developing countries. Environmental Impact Assessment Review. **10** (1-2): 219-231

Costabeber, J. A. 1998. Acción colectiva y processos de transación agroecológica en Rio Grande do Sul, Brasil. Thesis (PhD in Agroecology, Peasantry and History) Instituto de Sociologia y Estudios Campesinos.

Díaz, M.F. et al. 2012. Efficiency of different egg parasitoids and increased floral diversity for the biological control of noctuid pests. Bilogical Control **60** (2): 182-191

FAO. 2006. El estado Mundial de la Agricultura y la Alimentación 2005. Roma: Organización de las Naciones Unidas para la Agricultura y la Alimentación

Frank, S. 2010. Biological control of arthropod pests using banker plant systems: Past progress and future directions. Biological Control **52** (1): 8-16

Gomes, E. G. et al. 2009. Estudo da sustentabilidade agrícola em município amazônico com análise envoltória de dados. Pesquisa Operacional **29** (1): 23-42

Gilles, J. 2012. Challenges in the Global Agri-Food Sector: A Consultant's Perspective on 'Big Picture' Issues. The Agricultural Economics Society and the European Association of Agricultural Economists **11** (1): 34-39

Harding, R., Peduzzi, P. J. 2012. The end to cheap oil: A threat to food security and an incentive to reduce fossil fuels in agriculture Article reproduced from United Nations Environment Programme (UNEP) Global Environmental Alert Service (GEAS). Environmental development. **3** : 157-165

Hart, S., Milstein, M.B. 2004. Criando Valor Sustentável. . GV-executivo **3** (2): 65-79

Hochman et al. 2013. Prospects for ecological intensification of Australian agriculture. European Journal of Agronomy. **44** : 109-123

Homma, S. K. et al. 2012. Long-term application of biomass and reduced use of chemicals alleviate soil compaction and improve soil quality. Soil & Tillage Research. **120** : 147-153

INPEV- Instituto nacional de processamento de embalagens vazias. Statistical data 2011. Available at: http://www.inpev.org.br/destino_embalagens/estatisticas/br/ teEstatisticas.asp. (accessed date November 10, 2012).

Lal, R. 1997. Residue management, conservation tillage and soil restoration for mitigating greenhouse effect by CO_2-enrichment. Soil & Tillage Research **43** : 81-107.

Lei 9974 de 6 de junho de 2000. Available at: http://www81.dataprev.gov.br/sislex/ paginas/42/2000/9974.htm. (accessed date November 10, 2012).

Kaloxylos, A. et al. 2012. Farm management systems and the Future Internet era. Computers and Electronics in Agriculture **89** : 130-144

Knickel, K. 1990. Agricultural Structural Change: Impact on the Rural Environment. Journal of Rural Studies **6** (4) : 383-393

Knowler, D., Bradshaw, B. 2007. Farmers' adoption of conservation agriculture: A review and synthesis of recent research. Food Policy **32** (1): 25-48

Matson, P. A. et al. 1997. Agricultural Intensification and Ecosystem Properties. Science. **277** (5325): 504-509

Muller, R. et al. 2013. Policy options to reduce deforestation based on a systematic analysis of drivers and agents in Lowland Bolivia. Land Use Policy **30** (1): 895-907

Oliveira, S. V. W. B. et al. 2011. Generation of bioenergy and Biofertilizer on a sustainable rural property. Biomass and Bioenergy **35** (7): 2608-2618

Özerol, G. et al. 2012. , . Irrigated agriculture and environmental sustainability: an alignment perspective. Environmental Science e Policy **23**: 57-67

Pierce, J. T. 1996. The Conservation Challenge in Sustaining Rural Environments. Journal of Rural Studies **12** (3): 215-229

Prasuhn, V. 2012. On-farm effects of tillage and crops on soil erosion measured over 10 years in Switzerland. Soil & Tillage Research **120**: 137-146

Perry, C. et al. 2009. Increasing productivity in irrigated agriculture: Agronomic constraints and hydrological realities. Agricultural Water management **96**(11): 1516-1524

Singh, R. B. 2000. Environmental consequences of agricultural development: a case study from the Green Revolution state of Haryana, India. Agriculture, Ecosystems and Environment **82**(1-3): 97-103

Saikku, L. et al. 2012. Attributing land-use change carbon emissions to exported biomass. Environmental Impact Assessment Review **37**: 47-54

Tan, L. et al. 2012. An Extensible and Integrated Software Architecture for Data Analysis and Visualization in Precision Agriculture. IEEE IRI **8-10**: 271-278