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ENVIRONMENTAL IMPACTS OF TRANSITION FROM CONVENTIONAL MILK PRODUCTION TO ORGANIC PRODUCTION

IMPACTOS AMBIENTAIS DA TRANSIÇÃO ENTRE A PRODUÇÃO DE LEITE CONVENCIONAL PARA ORGÂNICO

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ABSTRACT: The objective of this study is to evaluate the environmental impacts of the transition to organic milk production practices. Seven family farms were evaluated in the Federal District and surrounding Integrated Development Region, based on Embrapa’s Ambitec-Agro indicators system. Data were obtained in family farms during field assessments carried out in 2012 and 2013, along with family members in charge of production. Average environmental performance indices were -2.13 and 3.37 respectively, for conventional and organic production systems. "Soil quality" (19.1), "waste disposal" (16.4)," Property value" (15.1), and "income generation" (13.9) were the indicators that contributed most to the organic performance indices. The percentage of increase in technology performance was 18.35%.

KEY WORDS: Organic milk, Agroecological Conversion, Family agriculture

RESUMO: O objetivo deste estudo é avaliar os impactos ambientais da transição para as práticas de produção de leite orgânico. Sete propriedades familiares foram avaliadas no Distrito Federal e no entorno da Região de Desenvolvimento Integrado, com base no sistema de indicadores Ambitec-Agro da Embrapa. Os dados foram obtidos na agricultura familiar durante avaliações de campo realizadas em 2012 e 2013, junto aos familiares responsáveis pela produção. Os índices médios de desempenho ambiental foram -2,13 e 3,37 respectivamente, para os sistemas de produção convencional e orgânico. "Qualidade do solo" (19,1), "destinação de resíduos" (16,4), "Valor da propriedade" (15,1) e "geração de renda" (13,9) foram os indicadores que mais contribuíram para os índices de desempenho orgânico. O percentual de aumento no desempenho da tecnologia foi de 18,35%.

PALAVRAS-CHAVE: Leite orgânico, Conversão Agroecológica, Agricultura familiar

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INTRODUCTION

Low technical indices currently observed in the Brazilian dairy sector show that increases in productivity are required to meet consumption needs. Milk production in the country is based on 11,5 million milked cows (Census, 2017), with millions of hectares occupied, for example, in the Cerrado biome (Alvim, 2003). These indices suggest that intensification of milk production is necessary (SOARES et al., 2011). Organic milk production can be an option to increase milk production without degrading natural reserves. According to FAO (1998), IFOAM (2008), and BRASIL (2003), organic agriculture is defined as a management system that promotes and encourages the health of the agro-system, including biodiversity, biological cycles and soil biological activity.

As in any animal production system, in organic milk production it is recommended that nutrition and animal feed are balanced. Supplements must be free of antibiotics, hormones, chemical worm medicines, growth promoters, appetite stimulants, urea and other additives, being prohibited the application of feed or supplements derived or obtained from genetically modified organisms, or even vaccines manufactured with transgenic technology (FIGUEIREDO, SOARES , 2012; BRAZIL, 2011). Soares et al (2011) recommend intercropping of grasses and legumes for nitrogen management in the system, requiring diversification of plant species for management and fertilization of pastures. Agroforestry practices, such as implementation of silvopastoral systems are proposed, in which nitrogen-fixing trees and shrubs (legumes) can be associated with agricultural crops and pasture.

As for the organic sanitary management, veterinary treatment is considered a complement and never a substitute for good practices, however, if necessary the use of herbal medicines and homeopathy are recommended SOARES et al., (2011). All vaccines established by law are mandatory, and vaccinations and tests are recommended for the most common diseases in each region. As a preventive measure against ecto and endoparasites, pasture rotation, homeopathic and phytotherapic compounds are recommended.

Although data on the production of organic milk in Brazil are still scarce, according to Neiva (2000) organic production of milk and its derivatives has been timidly emerging. The Southern Region produces about 10,000 liters of organic milk per day; the Southeast 1,800 liters, and the Northeast 500 liters. In more recent estimates, production of organic milk in the Federal District (DF) represents approximately 182.5 thousand liters/year (SOARES et al., 2011). These values are higher than the Brazilian reality for this activity, and in 2005 the production of organic milk was 0.01% (AROEIRA et al., 2005) and grew to ~0.02% (6.8 million liters in 2010) of the total milk produced (28 billion liters in 2010) according to preliminary data from surveys carried out by the organic systems for animal production project in 2011, with producers and cooperatives in different states. This meager production contrasts with society's current demand for organic milk, making an increase in production indispensable. The consumer wants a quality product, at a fair price, healthy from the food safety viewpoint, free from biological hazards, and with care in relation to animal welfare (NICHOLAS ET AL., 2014; BAINBRIDGE ET AL., 2017; REY, 2015).

With regard to the sale of organic milk, it is mainly focused on dairy products, normally carried out on a small scale (bakeries, mini-markets, open-air stores, and home baskets) in view of the requirements of sanitary legislation to be placed in large retail channels. Even though state and municipal legislation has facilitated the action of small farmers and small agribusinesses (FONSECA, 2000), there are still limitations, especially in the diffusion and transfer of technologies, with extension training being necessary to bring technologies to farmers who may be facing difficulties or may not apply the best production practices due to lack of knowledge (FONSECA, 2000). Even submitted to marketing difficulties and technical constraints, it is possible to profit from the activity, as market figures indicate. Currently Brazil presents the fifth largest area under organic production in the world (1.77 million hectares by 2007, IFOAM 2011). According to Willer and Lernoud (2019) in the survey carried out by the Research Institute of Organic Agriculture (FIBL), in partnership with IFOAM, organic agriculture is at its highest stage of development since the FIBL research began 20 years ago, counting with 70 million hectares and showing market growth around the world, which reached 97 billion dollars, the highest levels ever recorded.

Among the organic products of animal origin, organic milk stands out for being present in all European countries, showing high growth rates, reaching double its production since 2008, in order to meet the great demand for organic dairy products in those countries. The production of organic milk in the European Union registered for the year 2017 was 4.4 million tons, which constitutes about 3% of the total production (WILLER; LERNOUD, 2019).

It is estimated that the annual trade is R$ 500 million, being 30% for the internal market, and 70% for export. According to MIDIC, (2007) US$ 5.5 million in organics were exported, with the main items sold to foreign markets: sugar, coffee, cocoa, and fresh and dried fruits. The main buyers of these products are the USA (41.2%) and the Netherlands (29.5%), followed by Canada, Japan, and the United Kingdom. The sector grows between 20 and 30% a year. Based on these data, we can see that organic milk production does not only serve a niche market, but shows production volumes, profitability, and sustainability, being a market waiting for satisfaction (SOARES et al., 2011). Thus, the present work has for objective the comparative analysis of the transition from conventional to organic milk production, contrasting the use of technologies before and after adoption, with milk producers who adopted organic milk production practices in the Integrated Development Region of the Federal District and Surroundings.

MATERIAL AND METHODS

Given the objective of assessing the environmental impacts of the production practices adopted in the conventional to organic milk production, the Ambitec-Agro method (Animal Production module) was applied, as described by IRIAS et al. (2004) and ÁVILA et al. (2008). In this method, the indicators focus socioeconomic and environmental changes ensuing from technology adoption, identifying the aspects that increase or decrease the level of impact. Environmental impact assessments (EIA) were designed to foster reductions in negative impacts, defined as "any change in the physical, chemical or biological characteristics of the environment, caused by any form of matter or energy derived from human activities, and that can directly or indirectly affect the health, safety or well-being of the population, the economic and social activities; the biota; the aesthetic and sanitary conditions; and the quality of natural resources" (RODRIGUES et al., 2003a).

Among the applications of EIAs, there are studies of changes observed in productive activities as a result of the adoption of new management practices and technologies, particularly when directed to rural activities (RODRIGUES et al., 2003b). The impact assessment of agricultural technological innovations has been carried out in the institutional context of research and development at Embrapa, through the application of a multi-criteria approach method (Ambitec-Agro; RODRIGUES et al., 2010), with the results being consolidated annually in the institutional Social Balance report (see https://www.embrapa.br/balanco-social).

The Ambitec-Agro indicator system allows a clear and concise measurement of the main factors related to the development of agricultural production units and is a tool applicable to environmental certification processes, contributing to sustainable rural development (MONTEIRO; RODRIGUES, 2006; AVILA et al. al., 2008).

TECHNOLOGIES FOR ORGANIC PRODUCTION

In a comparative approach, studies were carried out with seven milk producers in the Integrated Development Region of the Federal District and Surroundings, where a set of technologies provided in Normative Instruction IN 46 (Brazil, 2011) was evaluated, describing practices and processes allowed in organic production systems for dairy cattle.

FARMERS ORGANIZATIONS AND CHARACTERIZATION

Tabatinga lote 134, Tabatinga-DF, with 66 hectares started in dairy production in 1991. He lives alone on the farm and hires 2 employees. He left vegetable production, keeping only the dairy production, which became the main activity on the property. The current main difficulties faced in dairy production are the lack of labor help, credit for investments, equipment and technical assistance. The farmer's milk production averages 6.3 liters/cow/day.

Due to its area of only 2 ha dedicated to dairy, there is need for other food sources to maintain a total herd of 90 animals. The positive point is registration with the Directorate of Inspection of Products of Vegetal and Animal Origin (DIPOVA), which regularizes the production and sale of cheese in the regular market.

"Farmer 2" is located on Capim Jasmim farm, Br 251 Km 21,PAD-DF. Agricultural activity started in 2004 in a total area of 78 ha, with 16 ha of pastures and 3 ha of roughage for herd feeding during dry periods. The herd comprises 60 animals, which produce 150 liters of milk per day, with a monthly income of R$ 3,231.47. The lack of labor help, the low price of milk on the market and the control of parasites in the herd are the main difficulties. There is an agroforestry system in the farm, certified in 2013, which is the main source of income, focused in the sale of banana and citrus.

"Farmer 3" is a land reform settler at Chácara 40.B, rural nucleus Três Conquistas, DF-130 Km 20, Tabatinga-DF. In 9.7 ha, with 3 ha of pasture, 1.5 ha for forage production and 2 ha of vegetable production, the farm has fruits, vegetables and greens as main income sources. There is also poultry and swine breeding, in addition to milk production, with organic certification of the vegetal part. The property's activities are carried out exclusively by the family (wife and three children), having started their dairy activity in 2009. Their biggest difficulties in milk production are the cost of feed, electricity, and the low sale price of milk.

"Farmer 4" is a land reform settler at Thawini site, Colony 1, Padre Bernardo-GO. In 12 hectares, there is production of milk and vegetables, sold at the Association of Ecological Agriculture-DF-AGE Fair at CEASA-DF. Having no family and counting with the help of an assistant, started his agricultural activity in 2007, currently producing 40 liters of milk/day with five cows. The farm presents appropriate zootechnical level, as monitored by Emater – DF, reflecting a financial return of R$ 3041.67/month. Produces cheese in a small agroindustry on the property, which is certified organic in its entirety, enabling direct sale of all animal and vegetable products.

"Farmer 5" is a land reform settler in 17.5 ha, with 4 ha of pastures, 1.5 ha of forage production used to feed the herd in dry periods and 3 ha for vegetable production. He has been in the business since 1995, lives with his wife and three children, all of whom work on the property. The main difficulties declared regard the certification of the animal production system, the acquisition of inputs, the insufficient productive structure of the property which, despite constant improvements still needs adjustments, as well as the logistics for reaching the market. Even with the need to improve the management of the herd, the producer has a monthly net profit from milk of 1.3 minimum wages, about R$ 1,144.00 considering the salary at the field survey time.

"Farmer 6" is a land reform settler, lives with his wife, 2 children and mother in 17 ha of total area, being 1 ha of pasture, 3ha for the production of forages such as sugarcane and capiaçu intended for feeding the herd in the dry periods. The main declared difficulties are low water volumes for irrigation and supply, soil erosion and the price paid for milk. This farmer delivers the produced milk to São Sebastião Agricultural Cooperative (COPAS), and participates in the Balde Cheio program, technically advised by the cooperative. Production includes organic vegetables and fruits, having started dairy activity in 2012.

"Farmer 7" is a land reform settler in 17 ha of total area, being 1 ha of pasture and 2 ha of forage production, such as sugar cane used to feed the herd in dry periods. Activities are shared with his wife and 2 daughters. Produces organic vegetables and milk. The farmer was subscribed into the Balde Cheio program, leaving it due to high costs, one of the reasons that led him to transition to organic production. Income generation and soil quality, that were limiting before the transition, now represent positive aspects. Milk production reaches R$ 1,639.46 monthly.

ASSESSMENT OF THE PERCENT IMPACT OF THE TECHNOLOGY – PIT

Aiming to extend the impact assessment approach, to provide a comparative analysis between the conditions before and after technology adoption, data surveys were carried out to check how farmers developed their activities before and after transition to organic dairy, in order to highlight the differences in terms of technical coefficients comparatively to conventional production.

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To calculate the technology impact indices in this proposed method, values are assigned on an interval scale from -15 to +15. These scores represent the technology impact index, allowing the estimation, from two moments, of the percent impact of the technology (PIT) adoption, for each individual or for a given production system. This measure can take positive or negative values, indicating the direction, if the impact index measured between the two moments (before and after the introduction of the technology) was increasing or decreasing, respectively (SOARES E RODRIGUES, 2013). This same measure can also indicate the magnitude of observed changes, related to these impact indices in contrasting moments.

The expression for percent impact of technology (PIT) calculation is as follows:

$$\mathrm{PIT_i} = \left(\frac{\mu_{2i} - \mu_{1i}}{AM}\right) x\ 100$$

Being:

$\mathrm{PIT_i}$: Percent Impact of Technology for individual i, i=1..n;

μ_{2i}: Impact index after technology adoption, referring to individual i;

μ_{1i}: Impact index before technology adoption, referring to individual i;

AM: Maximum possible amplitude of the Ambitec-Agro scale (= 30).

To obtain the percentage of overall impact of the technology of the production group with n individuals participating in the sample, the following expression was applied:

$$\mathrm{PIT} = \left(\frac{\sum_{i=1}^{n} \mu_{2i} - \sum_{i=1}^{n} \mu_{1i}}{n\,.\,AM}\right) x\ 100$$

Being:

PIT: Overall Percent Impact of Technology;

n: Total number of farmers;

$\sum_{i=1}^{n} \mu_{2i}$: Sum of impact indices for the moment after technology adoption, for n individuals;

$\sum_{i=1}^{n} \mu_{1i}$: Sum of impact indices for the moment before technology adoption, for n individuals;

AM: Maximum possible amplitude of the Ambitec-Agro scale (= 30).

STATISTICAL ANALYSIS

For statistical analysis, the grouping of producers was performed using the 'Cluster' analysis technique, using the results of the environmental impact indicators expressed by the Ambitec-Agro indices. The similarity measure adopted was the "Quadratic Euclidean Distance" and the agglomerative method used was the hierarchical "Ward" binding method. To assess the possible existence of significant differences between the 2012 and 2013 moments, for each variable that composed the ecological and the socioenvironmental indicators, the non-parametric Wilcoxon test was performed, for paired samples at a significance level of 5%. Due to the elements of the sample not having behavior compatible with the normal distribution, the non-parametric test was adopted. The statistical treatment program SPSS (Statistical Package for the Social Sciences) for Windows, version 19.0 and free software R version 2.14 was used to analyze the obtained data.

RESULTS AND DISCUSSION

A significant difference ($p<0.05$) was observed when comparing the Impact Indices calculated for the production systems for the years 2012 and 2013, as shown by the non-parametric Wilcoxon test. For a better understanding and analysis of the set of evaluated technologies, it was necessary to study in particular each indicator, which were discussed in the groups for evaluating indicators of ecological and socioenvironmental impacts.

Comparing conventional dairy and the transition to organic farming, the index that showed the greatest variation within the group of ecological impacts was soil quality, with a variation of $\mu=19.11$ (Table 4), from the comparison of soil management of pastures in conventional milk production ($\mu=-8.39$) in relation to milk production under organic management ($\mu=10.71$), being the greatest contribution to the formation of the index overview of ecological impacts for organic production (Tables 2 and 3). The increase in soil quality index

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is related to the non-use of chemically synthesized fertilizers, prohibited in organic production systems (SOARES et al., 2011; SOARES et al., 2012).

The use of agricultural inputs and resources was the second index showing the greatest variation, being in the production of conventional milk μ=-5.07, changing to μ=5.32 in organic management (Tables 2 and 3), with an improvement for the index of inputs of 10.39, which can be explained by the non-use of chemicals, and greater reuse of materials from within the property, thus increasing the quantity and diversity of inputs used. In the other indices of this group there were no statistical differences (Table 4).

For both soil quality and use of agricultural inputs indices, impact enhancements resulted from the organic management practices, whereas in conventional systems hardly any inputs were used, due to costs and availability restraints. The agroecological transition of milk production systems in the region also provided improvements in the socioeconomic and environmental conditions of farmers, evidenced by increases in the indices of most indicators in this dimension, especially factors related to the well-being and quality of life improvements of involved families, demonstrating the possibility of functioning as a promising alternative to guarantee social benefits (Tables 2 and 3), thus corroborating the statement of MULLER (2007), who described family farming as multifunctional.

Table 2. Change coefficients, criteria, and ecological and socioenvironmental impact indices for conventional management in milk production units in the Federal District Integrated Region and Surrounding, estimated by the Ambitec-Agro System, 2012.

Impact indices (2012)								
Farmer	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Average overall impact index				**-2,13**				
Ecological Impact Indicators								**Mean**
Use of Agricultural Inputs and Resources	-10,00	-1,50	-3,00	-8,00	-6,50	-4,75	-1,75	-5,07
Use of Veterinary Inputs and Raw Materials	-5,00	-2,50	-7,00	-4,00	-7,00	-3,50	-2,00	-4,43
Energy consumption	-12,00	-4,00	-9,00	0,00	3,50	-4,50	-4,00	-4,29
Atmospheric Emissions	-6,20	0,80	-1,00	-7,00	0,10	-2,70	0,30	-2,24
Soil Quality	-5,00	-5,00	-12,50	-10,00	-15,00	1,25	-12,50	-8,39
Water quality	0,00	-3,00	-0,75	-2,00	1,75	-1,75	-0,75	-0,93
Biodiversity Conservation	-1,50	-1,00	-0,90	0,00	-3,00	10,50	6,00	1,44

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Environmental Recovery	2,40	2,40	2,40	1,60	3,00	0,60	0,60	1,86
Social and Environmental Impact Indicators								
Product quality	6,25	-7,50	1,25	1,25	-2,50	-1,25	-7,50	-1,43
Social capital	0,85	-1,10	-0,10	0,30	-0,40	0,10	0,35	0,00
Animal health and well-being	4,50	-5,00	-2,50	1,75	-10,00	-6,75	-8,50	-3,79
Training	5,00	-5,75	2,75	8,25	-1,25	-1,25	-1,50	0,89
Employment offer and qualification	1,86	0,27	1,03	0,02	-0,22	0,42	3,51	0,98
Quality of employment	2,50	1,00	1,00	0,00	-1,00	0,00	0,00	0,50
Income generation	7,50	-10,00	3,75	-15,00	-15,00	-2,50	1,25	-4,29
Income sources diversity	11,00	-3,25	0,75	-3,00	-4,75	3,75	3,50	1,14
Property value	-0,50	-8,25	-3,00	-6,75	-8,75	-5,00	-12,75	-6,43
Environmental and personal health	-2,20	-3,00	-1,20	-0,60	-2,40	-9,00	0,00	-2,63
Occupational health and safety	-13,00	-1,00	-8,50	-3,50	-6,50	-8,50	-3,75	-6,39
Food security	-3,00	-2,40	-1,20	-2,20	-5,10	1,20	-6,00	-2,67
Farmer profile and dedication	-2,25	-13,00	1,00	5,25	-8,50	0,75	-4,75	-3,07
Commercialization	2,25	-6,00	2,00	-3,00	-0,75	1,50	4,50	0,07
Waste disposal	-6,00	-15,00	-6,00	-8,00	6,00	-3,00	-11,00	-6,14
Management of chemical inputs	8,75	0,50	5,25	5,00	0,00	0,00	0,00	2,79
Institutional relationships	6,00	-2,00	0,75	2,00	2,75	-0,75	-6,75	0,29
Mean Impact Indices	**-0,52**	**-4,01**	**-1,44**	**-1,93**	**-3,43**	**-1,06**	**-2,55**	-2,13

Initially, most indicators changed positively. In the dimension of socioenvironmental indicators, the indices that showed statistic differences ($p<0.05$) were “Animal health and wellbeing”, “Employment offer and qualification”, “Income generation”, “Property value”, “Environmental and personal health”, "Occupational health and safety", “Food security”, “Farmer profile and dedication”, “Waste disposal”, and “Management of chemical inputs” (Table 4). It can be inferred that organic transition contributed to the improvement of the production systems in all these indices, in an integrated way.

The individual contribution of each of the positive social and environmental impact indicators may be associated with greater income generation in the organic farms, as reported by the farmers themselves, which is directly related to the increase in the added value of the organic products, even whether still in the transition phase. The appropriation and experimentation of agroecological principles allowed farmers to add value to their products, as well as receive appreciation from society for the services provided by them, especially for the producer-consumer interaction that occurs, especially with those with direct sales.

In this sense, due to the diversity of aspects, those linked to socioeconomic principles will be primarily addressed. The income generation index, the third most important in this dimension, showed great variation between conventional and organic livestock, with μ=13.93 between conventional (μ=-4.29) and organic (μ=9.64). In the case of the Property value index, the variation between the two forms of production was μ=15.07 between conventional livestock (μ=-6.43) and transition to organic (μ=8.64), being the second index of greatest variation within the dimension of socioenvironmental impacts.

Analyzing the income generation of establishments, it can be observed that the increase in income is associated with greater stability, better security and its distribution throughout the year, being influenced by the diversification of the sources that generate income, obtained from organic practices. In addition to milk, other products of vegetable origin produced, which are necessarily required by law, also undergo the transition process. In this sense, the improvement in food safety for families from the introduction of adopted ecological practices, which reduced the risks of food contamination, and the regularity of supply, factors considered by BELIK (2003) as essential to reach food security.

Table 3. Change coefficients, criteria, and ecological and socioenvironmental impact indices for transition management to organic milk production units in the Federal District Integrated Region and Surrounding, estimated by the Ambitec-Agro System, 2013.

Impact indices (2013)								
Farmer	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Average overall impact index				**3,37**				
Ecological Impact Indicators								**Mean**
Use of Agricultural Inputs and Resources	13,00	-0,25	9,50	7,25	7,50	5,50	-5,25	5,32
Use of Veterinary Inputs and Raw Materials	-1,00	-2,00	6,00	-6,00	6,00	3,50	-7,50	-0,14
Energy consumption	12,00	2,00	-2,00	-4,40	-6,00	2,00	-12,00	-1,20
Atmospheric Emissions	5,40	-0,80	-2,20	-3,00	-0,90	1,10	-0,10	-0,07
Soil Quality	7,50	7,50	15,00	15,00	7,50	7,50	15,00	10,71

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Water quality	0,75	5,25	0,75	-1,75	-2,00	2,75	0,75	0,93
Biodiversity Conservation	2,10	2,20	1,30	0,00	5,10	-7,50	8,30	1,64
Environmental Recovery	2,80	0,00	0,40	2,40	6,00	-0,20	3,00	2,06
Social and Environmental Impact Indicators								
Product quality	5,00	-5,00	0,00	1,25	7,50	3,75	5,00	2,50
Social capital	-0,35	1,50	0,00	1,25	1,75	2,20	3,00	1,34
Animal health and well-being	10,50	11,00	3,25	3,75	10,00	5,25	8,50	7,46
Training	-2,50	6,75	0,00	8,25	3,75	5,00	8,25	4,21
Employment offer and qualification	-1,76	0,27	-0,90	0,00	0,34	0,12	-1,44	-0,48
Quality of employment	0,75	1,00	-3,25	3,50	1,00	0,00	0,00	0,43
Income generation	5,00	15,00	-3,75	15,00	15,00	6,25	15,00	9,64
Income sources diversity	-4,00	0,75	-3,25	7,50	4,25	2,50	10,75	2,64
Property value	5,25	5,75	8,75	10,25	12,25	4,75	13,50	8,64
Environmental and personal health	1,00	-0,40	0,40	-2,40	-0,40	9,00	0,20	1,06
Occupational health and safety	13,50	-1,50	5,00	-0,50	-1,50	6,50	1,25	3,25
Food security	3,00	3,00	1,50	2,20	5,10	0,90	6,00	3,10
Farmer profile and dedication	7,50	10,00	2,00	0,00	7,00	2,25	9,75	5,50
Commercialization	3,75	6,00	-0,75	9,00	2,50	1,00	0,00	3,07
Waste disposal	12,00	15,00	9,00	7,00	3,00	11,00	15,00	10,29
Management of chemical inputs	-12,75	4,00	-5,25	-3,50	0,00	0,00	0,00	-2,50
Institutional relationships	-3,25	3,75	1,75	3,00	8,25	3,00	8,25	3,54
Mean Impact Indices	**3,82**	**4,07**	**1,82**	**2,92**	**4,23**	**2,90**	**3,83**	3,37

These improvements are also related to the increase in herds, made possible by the greater availability of feed, and with the diversification of activities, achieved due to the integration of agricultural production. With regard to social aspects, the indicator "Farmer profile and dedication " had positive influence from organic technical transition, from several training courses directed at the activity, seeking better understanding of agroecological issues of organic management and principles, as well as the requirement that the farmers remain in their establishment, due to the practices and the increase in agricultural activities.

According to GAZOLLA (2004), the greater dedication can also be explained by the greater demand for consumption by the family in search for food security. In this indicator, in conventional production the obtained index was μ=-3.07, changing to μ=5.77 in the

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production of organic milk. Comparing conventional production and organic production, the variation was μ=8.57.

In the analysis of the indicators "Environmental and personal health", "Occupational health and safety" and "Food security" all showed variation from the conventional management to organic, with this variation for the first indicator of μ=3.69 between conventional production (μ=-2.63) and organic production (μ=1.06). In the case of the Occupational health and safety index, the variation between the two forms of production was μ=9.64 between conventional production (μ=-6.43) and that of the transition to organic (μ=3.25). The food security index, on the other hand, presented variation between the two forms of management of μ=5.77.

It was observed that the lower emission of air and water pollutants, soil contaminants and residues in food is closely related to the practices of agroecological principles and directly influenced these indicators. Regarding the waste disposal indicators, higher differentiation index was obtained (μ=16.43) and in the Management of chemical inputs lower differentiation index was observed (μ=-5.29) which were positively and negatively evaluated, also showed influence on environmental and personal health and occupational health and safety indicators (Table 4).

Table 4. Differentiation values for Ecological and Socioenvironmental impact indices between conventional and organic management in milk production units in the Federal District Integrated Region and Surrounding, estimated by the Ambitec-Agro System, between 2012 and 2013.

Impact indices (Diferenciação)								
Farmer	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Average overall impact index				**5,50 ***				
Ecological Impact Indicators								Mean
Use of agricultural inputs and resources *	**23,0**	**1,25**	**12,5**	**15,25**	**14,0**	**10,25**	**-3,50**	**10,39**
Use of Veterinary Inputs and Raw Materials	4,0	0,50	13,0	-2,0	13,0	7,0	-5,5	4,29
Energy consumption	24,0	6,0	7,0	-4,4	-9,5	6,5	-8,0	3,09
Atmospheric Emissions	11,6	-1,6	-1,2	4,0	-1,0	3,8	-0,4	2,17

Soil Quality *	**12,5**	**12,5**	**27,5**	**25,0**	**22,5**	**6,25**	**27,5**	**19,11**
Water quality	0,75	8,25	1,5	0,25	-3,75	4,5	1,5	1,86
Biodiversity Conservation	3,6	3,2	2,2	0,0	8,1	-18,0	2,3	0,20
Environmental Recovery	0,40	-2,4	-2,0	0,8	3,0	-0,8	2,4	0,20
Social and Environmental Impact Indicators								
Product quality	-1,25	2,5	-1,25	0,0	10,0	5,0	12,5	3,93
Social capital	-1,2	2,6	0,1	0,95	2,15	2,1	2,65	1,34
Animal health and well-being *	**6,0**	**16,0**	**5,75**	**2,0**	**20,0**	**12,0**	**17,0**	**11,25**
Training	-7,5	12,5	-2,75	0,0	5,0	6,25	9,75	3,32
Employment offer and qualification *	**-3,62**	**0,0**	**-1,93**	**-0,02**	**0,56**	**-0,3**	**-4,95**	**-1,47**
Quality of employment	-1,75	0,0	-4,25	3,5	2,0	0,0	0,0	-0,07
Income generation *	**-2,5**	**25,0**	**-7,5**	**30,0**	**30,0**	**8,75**	**13,75**	**13,93**
Income sources diversity	-15,0	4,0	-4,0	10,5	9,0	-1,25	7,25	1,5
Property value *	**5,75**	**14,0**	**11,75**	**17,0**	**21,0**	**9,75**	**26,25**	**15,07**
Environmental and personal health *	**3,2**	**2,6**	**1,6**	**-1,8**	**2,0**	**18,0**	**0,2**	**3,69**
Occupational health & safety *	**26,5**	**-0,5**	**13,5**	**3,0**	**5,0**	**15,0**	**5,0**	**9,64**
Food security *	**6,0**	**5,4**	**2,7**	**4,4**	**10,2**	**-0,3**	**12,0**	**5,77**
Farmer profile & dedication *	**9,75**	**23,0**	**1,0**	**-5,25**	**15,5**	**1,5**	**14,5**	**8,57**
Commercialization	1,5	12,0	-2,75	12,0	3,25	-0,5	-4,5	3,0
Waste disposal *	**18,0**	**30,0**	**15,0**	**15,0**	**-3,0**	**14,0**	**26,0**	**16,43**
Management of chemical inputs *	**-21,5**	**3,5**	**-10,5**	**-8,5**	**0,0**	**0,0**	**0,0**	**-5,29**
Institutional relationships	**-9,25**	**5,75**	**1,0**	**1,0**	**5,5**	**3,75**	**15,0**	3,25
Mean Impact Indices	4,34	8,08	3,26	4,85	7,66	3,96	6,38	5,50

(*) Indicators with a statistically significant difference at the 5% probability level in the Wilcoxon test.

The technologies used for organic management of milk production had a low influence on the indicator "Employment offer and qualification" due to the need for labor observed in livestock husbandry activities, which were mostly supplied by family work relationships. This reflected negatively, as it was the second lowest significant index observed (μ=-1.47), which together with the Management of chemical inputs contributed to the reduction in the overall average impact index of organic management technology in milk production.

Finally, the animal health and wellbeing indicator was also considered, which encompasses the ways of rearing under grazing and under confinement, the latter being not practiced by any of the producers, as only semi-confinement is allowed in the legislation on organic animal production (BRASIL, 2011). The animal health and wellbeing index did not show great variation between conventional and organic livestock, with 2.73 between conventional (μ=-0.24) and organic (μ=2.48) production, the fourth greatest variation in the socioenvironmental indicators (Tables 3 and 4), however its assessment is of paramount importance as addressed by HURNIK (1992) and MIRANDA (2011). The indicator "Product quality" did not show significant differences ($p>0.05$), which was not expected since one of the main advantages in organic production is the added value to the products, especially in relation to quality, being considered a food free of chemical residues. The small variation was consequently due to the Federal Inspection and the Legislation (IN 46) which is strict, especially due to chemical contaminants (FIGUEIREDO, SOARES, 2012).

In the general evaluation, based on the conventional production of milk, that is, in the period prior to the organic conversion (2012), the average general impact index of the activity was μ=-2.13. With the transition to organic milk (2013), the overall average impact index rose to μ=3.37, with the difference between the two forms of production being μ=5.50 (Tables 2, 3 and 4). This result confirms that the adoption of organic production practices tends to be beneficial to the environment (FIGUEIREDO and SOARES, 2012), since it promoted an increase of 18.35% in the average impact index over the two years (Table 5).

For a better explanation of the results obtained from the groups of producers, a comparison was carried out between the seven milk farmers in transition to organic production, being formed groups ('clusters') between the farmers who obtained greater increments in the indicators of ecological and environmental aspects in the assessment of organic management technology (Table 5 and Figure 3).

The first 'cluster' analyzed grouped the farmers who obtained the best indices of

PIT - PRODUTORES				
Farmer	**Conventional**	**Transition**	**Difference**	**PIT**
1	-0,52	3,82	4,34	14,47%
2	-4,01	4,07	8,08	26,93%
3	-1,44	1,82	3,26	10,87%
4	-1,93	2,92	4,85	16,17%
5	-3,43	4,23	7,66	25,53%
6	-1,06	2,90	3,96	13,20%
7	-2,55	3,83	6,38	21,27%
Mean	**-2,13**	**3,37**	**5,50**	18,35%

ecological impact indicators, with farmers 1, 2, 6 and 7, (Figure 3) that presented the differentiation values of impact index of organic management in milk production between μ=4.34 and μ=6.38, demonstrating greater concern with the ecological aspects of production (Table 5). These farmers, on average, showed increase of 18.9% in the environmental impact index.

In the second 'cluster' analyzed are the socioenvironmental indicators, wich grouped farmers 2, 4, 5 and 7 as can be seen in Figure 3, whose values of differentiation of the impact index of organic management in milk production are between μ=4.85 and μ=6.38, presenting the percentage of average technology increment of 22.5%. In this 'clusters' the farmers stood out for their environmental concerns, since they presented the highest values of the differentiation indexes before and after during data collection, they already used good environmental practices, with only adjustments being necessary with the change to organic production, as required by legislation (BRASIL, 2011).

Table 5. Impact indices for the criteria of the Ambitec-Agro indicator system and percent impact of technology (PIT) as a function of technology effect.

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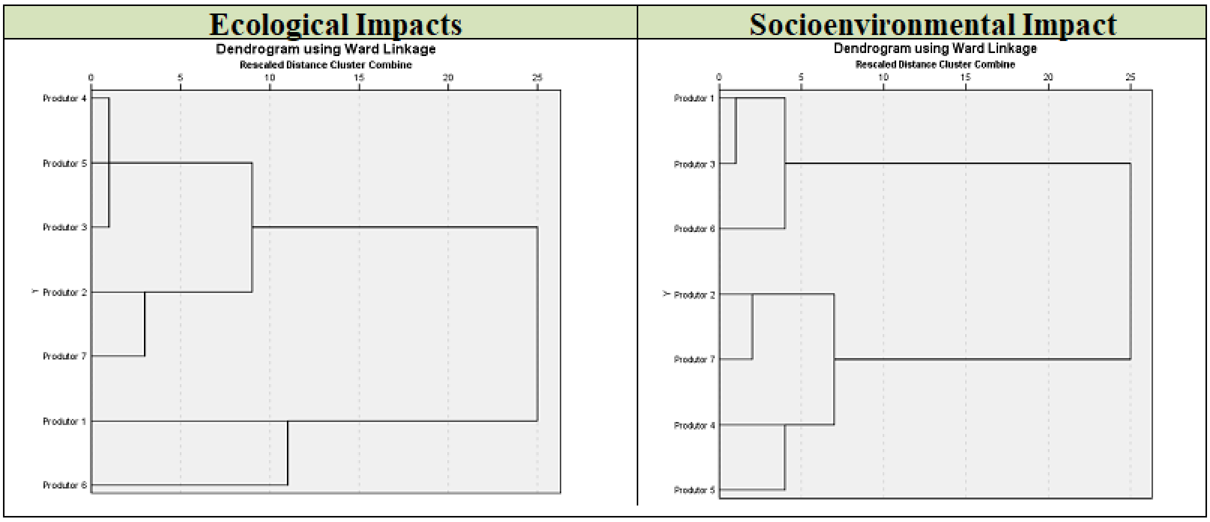

Figure 3. 'Cluster' analysis for classification of ecological and socioenvironmental impact índices, as well as integrated indices observed among the seven milk farmers in transition process to organic milk production selected in this study.

CONCLUSION

There was an 18.35% increase in ecological and socioenvironmental performance indices, with improvements related to practices and technologies used in the transition from conventional to organic milk production, demonstrating the activity's capacity to generate better financial and environmental results. The proposed analysis made it possible to point out which criteria and indicators most evolved over the two years period of implementation of Normative Instruction IN 46 (BRASIL, 2011). Among them, pasture management in rotating systems with intercropping of grasses and legumes in silvipastoral systems, associated with use of alternative inputs for soil fertility management stood up.

The grouping of farmers who presented the best ecological and socioenvironmental impact indexes was the one that included producers 1, 2, 6 and 7, those that obtained highest general impact indices. This can be explained by the fact that they were already more advanced in the agroecological transition process since the beginning of the study. There is also the fact that these producers have already participated in other agroecological initiatives, such as the Balde Cheio program, which ends up providing greater technical capacity for production than the other study participants.

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