AMBIENTE & SOCIEDADE

Quality of life of organic and conventional soybean farmers

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Abstract: This paper examines the quality of life of organic and conventional soybean farmers in Brazil. We analyzed self-reported symptoms associated with exposure to pesticides and measured life satisfaction levels of the farmers. We applied three models to analyze the data according to the dependent variable distribution - dichotomy, Poisson, and ordinal. Questionnaires were applied to 62 and 139 organic and conventional soybean farmers, respectively. We found that the probability of organic farmers to report symptoms related to pesticides exposure was 59% lower than conventional farmers; and organic farmers had a 68% higher odds ratio for life satisfaction compared to conventional farmers. We conclude that organic soybean production has improved the quality of life for agricultural workers, while also enhancing the sustainability of rural areas.

Keywords: Organic production, health, life satisfaction, soybean, sustainable rural development

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Introduction

The Brazilian southern region is known for its traditional soybean production, which mostly comes from family farmers. In contrast, the Central-West and Northern regions are recent production areas dominated by large farms (STADUTO et al., 2018). Despite their size, these farms rely heavily on modern inputs, such as pesticides and fertilizers, which contribute to health and environmental issues (CARNEIRO, 2015; DHANANJAYAN and RAVICHANDRAN, 2018). The main agricultural supply chains in Brazil, including soybean, corn, cotton, and sugar cane, are responsible for chemical contamination resulting from the overuse of these inputs (PERES, 2009). This conventional agricultural production system generates negative externalities for the environment, as well as for consumers and agricultural workers.

Schreinemachers and Tipraqsa (2012) found that a 1.0% increase in crop output per hectare corresponds to a 1.8% increase in pesticide use per hectare. However, as countries become more economically developed, the growth in pesticide use intensity tends to slow down. Despite this trend, few high-income countries have significantly reduced pesticide use intensity. On the other hand, middle-income countries such as Brazil, Mexico, Uruguay, Cameroon, Malaysia, and Thailand have experienced rapid growth in pesticide use intensity.

In Brazil, agricultural expansion has coincided with increased pesticide sales. Between 2002 and 2012, pesticide consumption rose from 2.7 kg/ha to 6.9 kg/ha (IBGE, 2015). In 2012, Class I (highly dangerous), Class II (very dangerous), Class III (hazardous), and Class IV (low dangerous) pesticides accounted for 0.7%, 64.1%, 27.7%, and 7.5% of total sales, respectively. Pesticides with lower levels of danger were used less frequently (IBGE, 2015).

In contrast to the prevalent technological model, which relies heavily on pesticides and agrochemicals, organic agriculture "relies on ecological processes, biodiversity, and cycles adapted to local conditions, rather than the use of inputs with adverse effects[1]" (IFOAM, 2016). Organic production has been increasing worldwide, as many countries seek to expand their market share of organic products. This demand has been driven by consumers seeking healthier and more environmentally sustainable food options (TANDON, 2020; YU et al., 2022). However, the provision of organic products is complicated by information asymmetry between producers and consumers. As a result, the certification has become increasingly important in the supply-side market to ensure compliance with organic production and commerce requirements (GIANNAKAS, 2002; SANTOS et al., 2017).

Many countries worldwide are working towards meeting the United Nations Sustainable Development Goals (SDGs) by 2030 and converting conventional agricultural systems to organic production is one strategy for achieving goals such as zero hunger, responsible consumption and production, and climate action (EYHORN et al., 2019). Although organic production has great importance, in Brazil it is still relatively small

1 - https://www.ifoam.bio/why-organic/organic-landmarks/definition-organic

compared to the scale of conventional production (MAPA, 2020). However, organic production has the potential to expand significantly, even within the soybean commodity.

Recently, organic agriculture has been defined as a production system that prioritizes not only the health of the soil and ecosystem but also the well-being of consumers and rural workers (BRÜSEKE, 1998; IFOAM, 2008). Surveys have been conducted on the life and health conditions of rural populations, particularly farmers and agricultural workers who are more directly and indirectly exposed to agrochemicals (DHANANJAYAN and RAVICHANDRAN, 2018).

Since the 1970s, soil preservation programs have been adopted in southern Brazil to reduce degraded areas and preserve environmental protection and legal reserve areas (DE FARIAS, 2009). However, despite the apparent health of the rural landscapes, intense pesticide and fertilizer use has contaminated the region and concealed the precarious nature of workers' lives. Organic production can reduce negative pressure on the environment and rural populations while being a profitable and viable option (MAZZOLENI and NOGUEIRA, 2006; HAN, ARBUCKLE, and GRUDENS-SCHUCK, 2021). Moreover, certificated organic production can be more profitable than non-certificated (FROEHLICH and MELO, 2016).

This paper aimed to investigate the quality of life of farmers who produce conventional and organic soybeans in Brazil. To do so, we administered a questionnaire that focused on self-reported symptoms that may be associated with exposure to pesticides and on the level of life satisfaction. Our study aims to fill a gap in understanding the effects of organic production on farmers' quality of life, compared to conventional soybean producers. To provide more accurate results, we surveyed farmers who grow the same crop. We obtained a sample of organic producers from a company located in the state of Paraná that trades organic soybeans with international certification. These producers are mostly from the southern Brazil region. The studies reveal that organic and conventional farmers have different levels of exposure and symptoms (FUHRIMANN, et al., 2019; BENBROOK, et al., 2021). Comparing both groups of producers and applicators for the same commodity can provide more accurate and reliable results.

Methodological Procedures

Sampling of Organic and Conventional farms and producers

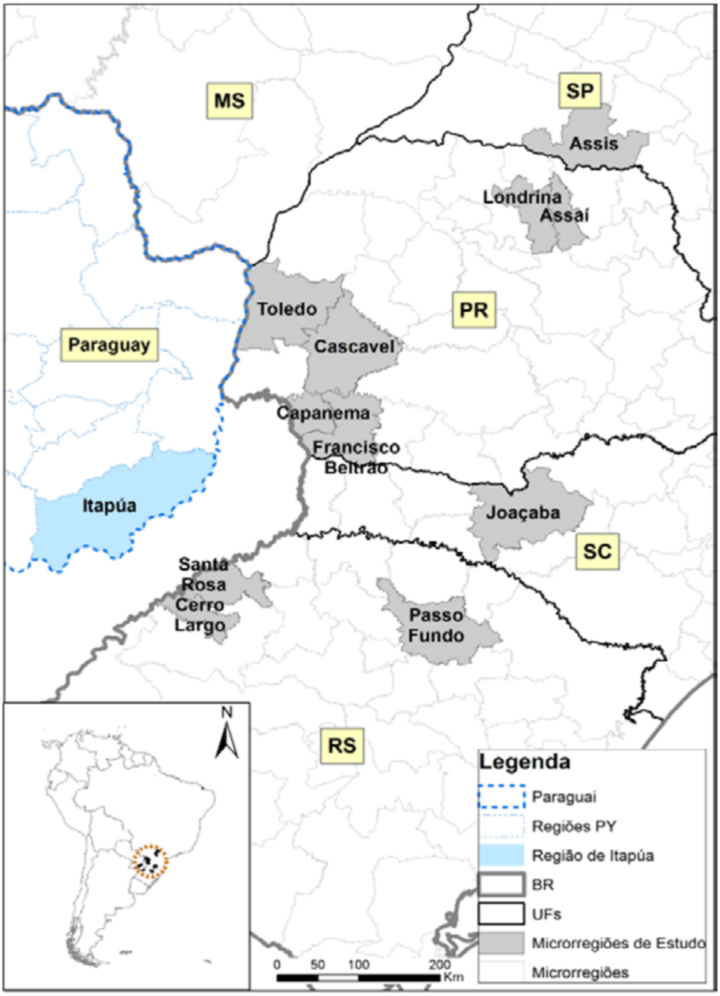
We conducted a field survey through the application of a structured questionnaire to capture data on self-reported health quality and life satisfaction of two samples of soybean producers: conventional and organic with international certification. An interviewer personally collected data by visiting the farmers.

In 2017, Brazil had 236,245 soybean farm holdings, while Paraná state had 84,590, covering 30,722,657 ha and 4,271,463 ha, respectively (IBGE, 2017). Although Parana state is the largest producer of organic soybean in Brazil, it has only 162 certified organic farmers as of 2020 (MAPA, 2020), which represents only 0.19% of the total soybean farmers in the state. The number of organic soybean producers with international certification is even smaller.

Due to the minimal number of organic farms, random sampling would have been challenging. Therefore, we opted for intentional sampling from a list of producers of a company located in Paraná state that trades organic soybean with international certification. This company not only markets the product but also provides technical assistance and input to achieve the required standards and compliance for international certification. All farms own similar production technology levels. From a list of 63 farms, we used data from 62 farms, with one discarded due to a filling problem. Of the sampled farms, 87% were in the southern region of Brazil: 34 in Paraná, 19 in Rio Grande do Sul, one in Santa Catarina, and other municipalities in São Paulo (1) and Paraguay (6), which are close to the border with Brazil (Figure 1). The dispersion of organic farms indicates some difficulty for farmers to adopt organic production with international certification. We interviewed plant protection products (PPP) applicators and owners for 55 farms, while the other 7 applicators were outsourced.

It is important to highlight that organic production does not use chemical products, such as pesticides applied in conventional agricultural production. However, PPP for organic production is applied to control insects, weeds, and phytopathogens that cause significant economic damage (GAHUKAR, 2012). The use of PPP in organic production systems must comply with the rules and regulations set by the Brazilian Ministry of Livestock and Agriculture (MAPA). According to Lemos and Ribeiro (2008), these products are not necessarily safe or non-toxic to humans. Wearing personal protective equipment (PPE) is an obligation for all workers as a way of mitigating occupational risks and illnesses. It is a requirement of the Regulatory Standard for Safety and Health at Work in Agriculture, Livestock, Forestry, and Aquaculture – NR 31, it is adopted as one of the three priorities for eliminating risks to rural workers. Therefore, the use of PPE should not be dispensed with when applying PPP in organic agricultural production (SANTIAGO, 2012).

Figure 1 – Location of the organic producers sampled in 2016.



Font: IBGE, 2007. Elaborated by the authors.

We sampled conventional soybean farmers from the western mesoregion of Paraná for accessibility. We selected farms that were available and within reach of the researchers. This approach corresponds to the selection of elements of the population to which access is possible to enable investigation (Massukado-Nakatani, 2011). Paraná is a leading soybean producer with high productivity and a tendency among farmers to converge on a single intensive technological standard involving agrochemical inputs (ORLANDI et al., 2012). Currently, almost 100% of soy harvested in Paraná is from transgenic seeds, which were permitted for cultivation in the state from the 2003/04 harvest. Farmers of all property sizes have adopted the same simplified technological standard (SILVEIRA and RESENDE, 2010). We interviewed 139 conventional farmers, who also served as pesticides applicators. The field research was conducted between November 2015 and February 2016 and the information about the 2014/2015 harvest.

Similar studies on the health of agricultural workers have been conducted by Ohayo-Mitoko et al. (2000), Lima (2008), and Jensen et al. (2011), who also used questionnaires with self-declared questions. Additionally, the questionnaire included questions about the socioeconomic aspects of the rural family and the use of PPE, which were based on Ehlert et al. (2014).

During the interviews, the respondents were asked about any symptoms they experienced during and after the application of pesticides or PPP on soybean crops during the 2014/2015 harvest season. The symptoms included headache, dizziness, stomach pain, rash, sneezing, blurred vision, eye irritation, and diarrhea. In addition, those responsible for applying the pesticides or PPP were asked how frequently they experienced these symptoms - whether frequently, sometimes, or rarely. Table 1 describes the variables derived from the questionnaire. There are three dependent variables, two related to self-reported symptoms. The first variable is binary, while the other is a weighted symptom, which serves as a proxy to measure cumulative events based on the frequency and is thus a more sensitive variable (see Table 1). The two independent variables are related to symptoms associated with pesticide exposure, despite organic producers applying PPP. The same questionnaire, which included self-reported questions about symptoms associated with pesticide exposure, was applied to conventional and organic producers. Consequently, we could apply the models shown in the section 2.2, and the outcomes were more consistent. The third dependent variable is the farmers' level of life satisfaction, which they were asked to rate during the interviews.

We collected information on economic and financial aspects by asking about farm size and gross profit of all properties. We asked producers to estimate the gross profit of their farms by calculating the total value of their production, subtracting the total cost of goods sold, and expressing the result in terms of equivalent soybean bags. This measurement was easier for many producers, but it can be biased due to incomplete and flawed accountable sheet records. This is a common issue for Brazilian farmers (VESTENA et al., 2011), as well as farmers who consider such information confidential. Therefore, other variables, such as farm area and health care insurance, were used to better understand the economic and financial level. Table 1 describes the questionnaire variables that were used in the statistical models.

We applied statistical tests to evaluate the probability of differences between organic producers and conventional producers for the variables collected in the field research. First, we tested if the ordinal and scalar variables had a normal distribution using the Skewness-Kurtosis test (CAMERON and TRIVEDI, 2022). Otherwise, there is no normal distribution for ordinal and scalar variables, the non-parametric Wilcoxon rank sum test (Mann-Whitney) is applied. The non-parametric Chi-square test is applied to categorical variables (CONROY, 2012).

Table 1 – Description of the variables used to estimate statistic models.

Variable	Description
	Dependent variables
Symptom	declared at least one disease symptom = 1; declared no disease symptom = 0
Symptom_weight	count-data: sum of symptoms in which each one was weighed for 3, 2, and 1, representing frequently, sometimes, or rarely, respectively
Life_satisfaction	self-reported about life satisfaction: 1 to 10 fewest=1 and very good=10
	Independent variable
Organic_farm	organic producer=1; conventional producer=0
	Demographic variables
Gender	male=1; female=0
Age	years old
Schooling	no one= 0; elementary school =1; high school =1; under college = 3
	Financial and economic variables
Health_insurance	private health insurance=1; private health insurance =0
Farm_area	farm size (hectares)
Soybean_area	soybean crop size (hectares)
Gross_profit	number of bags per farm
	Health variables
Self-reported_health	very good/ good=1; regular/ bad/ very bad =0
Smoking	smoking= 1; nonsmoking=0
Doctor go	number of medical appointments in the last 12 months
PPE_time	how many years wearing personal protection equipment (PPE)
Application_number	number of applications of phytosanitary protection products or pesticides per agricultural year*
Highly_toxic	number of times per agricultural year that one handles pesticides of toxicological classes III and IV
Mildly_toxic	number of times per agricultural year that one handles pesticides of toxicological classes I and II
	Satisfaction variables
Life_satisfaction	self-reported about life satisfaction: 1 to 10 fewest=1 and very good=10
Income_satisfaction	self-reported about income satisfaction 1 to 10 fewest=1 and very good=10

Family_satisfaction	self-reported about family condition satisfaction: 1 to 10 fewest=1 and very good=10
Education_satisfac-tion	self-reported about education satisfaction: 1 to 10 fewest = 1 and very good=10
Work_satisfaction	self-reported about work satisfaction: 1 to 10 fewest=1 and very good = 10

Font: Field survey, 2016. Elaborated by the authors.

Statistic Models

This study employed three different types of a probability distribution for the dependent variables. Therefore, three statistical models were used to determine the likelihood of farmers reporting symptoms of diseases associated with pesticides exposure and self-reported life satisfaction in both organic and conventional crops. Table 1 outlines the distribution of variables used in these models, where (a) the symptoms variable has a binary distribution, (b) symptom_weight is a count-variable with a Poisson distribution, and (c) life_satisfaction has an ordinal distribution (Greene, 2003).

To obtain more robust results, the probability of producers self-reporting more symptoms was estimated for two types of dependent variables using a Logit model. The symptoms variable (y) was used, and x represents the set of characteristic variables described in Table 1 and is represented by equation (1):

$$L\ (y) = \ ln\left(\frac{P}{1-P}\right) = \ \beta_0 + \beta' x \qquad (1)$$

The probability of the variable symptom_weight for soybean producers was estimated by Poisson distribution, and its probability density function is represented by equation (2). The output from the Poisson regression model improves the robustness of this estimated dependent variable (GREENE, 2003).

$$P(Y > 0) = \ \frac{exp(-\lambda)(\lambda)^y}{(1 - exp(-\lambda)y)!} \qquad (2)$$

The predicted value (can be converted in terms of probability by equation (3):

$$\lambda = \exp(\beta_0 + \ \beta' x) \qquad (3)$$

The cumulative probability reflects the ordination of categories for the variable life_satisfaction. Thus, the probability of this variable for soybean producers was estimated by ordinal distribution, and its probability density function is represented by equation (4) (AGRESTI, 2007).

$$Logit\left((y \leq j)\right) = log\left(\frac{P(y \leq j)}{1 - P(y \leq j)}\right) = \alpha_j + \beta'_x \quad (4)$$

Where: $j = 2, 3, \dots k$, and k is the number of ordinal categories. The values of the cut-off points α_j are different , considering that the calculated cumulative probabilities are different for each set of x values. This model assumes that the odds of event j are independent of category j, which means that the odds are assumed to be constant for all categories. The limit values (α_j) correspond to the cut-offs where the individual moves from one reported category of self-reported life_satisfaction variable to another.

Results and Discussion

Descriptive Statistics Analysis

Table 2 shows the comparison of variables between organic and conventional producers that were collected in a field survey. These variables were used in the statistical models. Symptom variables associated with pesticide exposure were similar and statistically non-significant between organic and conventional farmers. In fact, the expectation was that the groups would be statistically different.

However, the literature suggests that one of the reasons for conversion to organic production is due to serious cases of poisoning among farmers or agricultural workers who wish to improve their livelihoods (HOSSAIN, 2013). This variable captured whether the pesticide applicator or PPP (if organic production) reported any of the symptoms, but not how frequent they were. However, the symptom_weight variable is more sensitive and was shown to be statistically different between organic and conventional soybeans.

The social and economic status (SES) of the rural population has not contributed to women assuming managerial positions[2] in both organic and conventional soybean productions, with only 3 and 4 women as managers, respectively. This finding reflects the typical gender roles in the rural area of the South region of Brazil, where men typically manage agricultural production activities (STADUTO et al., 2013). As a result, we have limited data for analyzing the impacts of gender on pesticides exposure and self-reported life satisfaction.

The distribution of educational levels of organic and conventional producers was low and similar, on average around 1.4, that is, incomplete secondary education (Table 2). This value is higher than the average education level of the rural population of Brazil

2 - See Estanislau (2021)

and Paraná, according to the 2010 Demographic Census of Brazil and Paraná, of 6.33 and 7.64 years, respectively, and indicates incomplete primary education. Education and training are crucial to increase farmers' knowledge and awareness of the potential health hazards of pesticides exposure to themselves, their community, and the environment (DOMINGUES et al., 2004). Therefore, education and training are vital to promoting farmers' knowledge and awareness of potential health and environmental hazards from pesticides in rural areas and to consumers (DAMALAS and ABDOLLAHZADEH, 2016).

Table 2 – Descriptive statistics for organic and conventional soybean producers.

Variable	Organic farmer	Conventional farmer	Pearson Chi-squared[a]	"t" student[b]	Mann-Whitney[c]
	Mean	Mean	chi^2	t	z
Symptom	0.52	0.62	1.86	---	---
Symptom_weight	1.66	2.23	---	---	1.86***
Gender	0.97	0.97	0.018	---	---
Age	54.03	51.57	---	1.44*	---
Schooling	1.40	1.40	---	---	-0.16
Health_insurance	0,18	0,65	39.07*	---	---
Self_reported_health	0.58	0.63	0.49	---	---
Smoking	0.08	0.03	5.43	---	---
Doctor_go	2.23	2.4	---	---	1.79***
PPE_time	9.19	13.61	---	2.78*	---
Application_number	7.92	12.04	---	7.28*	---
Highly_toxic	2.34	10.13	---	---	8.42*
Mildly_toxic	3.11	6.3	---	---	6.46*
Farm_area	49.87	43.53	---	---	3.57*
Soybean_area	21.81	45.04	---	---	6.16*
Gross_profit	163.09	210.23	---	---	4.42*
Life_satisfaction	8.74	8.53	---	---	1.20
Income_satisfaction	7.76	8.24	---	---	2.07**

Family_ satisfaction	8.82	8.97	---	---	0.51
Education_ satisfaction	9.08	9.31	---	---	1.31
Work_satisfaction	9.15	8.91	---	---	1.991*

Font: Field survey, 2016. Elaborated by the authors.

*, **, ***, significance at 1%, 5%, 10%, respectively.

The average age of both organic and conventional farmers is relatively high, with organic farmers averaging 54.03 years and conventional farmers averaging 51.57 years. Both groups are approaching the elderly category. Consequently, the sample of organic farmers had a higher proportion receiving retirement benefits from the Brazilian Social Security Institute (INSS), with 31.7%, while only 19.4% of conventional producers received the same benefits.

The symptoms weighted by frequency reveal more health problems for conventional producers, but organic producers' samples are not free of symptoms associated with agrochemical exposure. However, the symptom variable records of both groups were statistically similar; organic farmers were expected to have lower symptom rates than conventional farmers. Two factors may have contributed to organic producers reporting symptoms associated with exposure to pesticides: the high age of producers, and in fact, most organic farmers had previously worked as conventional soybean producers and had already been exposed to pesticides for many years.

Additionally, GROSSMAN (1972) explains in his seminal research about the health economy; as individuals age, their health stock, accumulated throughout life, starts to depreciate, which is an inherent process. In other words, after birth, people begin to accumulate health capital that will be spent or depreciated over time (HSIANG, et al., 2019, DERYUGINA and MOLITOR, 2021).

The conversion process to organic production involves complying with many rules and regulations to restore ecosystems, including water and soil quality, and biodiversity. However, there are currently no clear procedures in place to improve the health or quality of life of farmers who were previously exposed to pesticides when they were conventional farmers. It would be very convenient if this conversion process had some compliance for assessing and improving the health and well-being of these organic producers. One of the reasons for the conversion to organic production is due to severe cases of farmer or agricultural worker intoxication (HOSSAIN, 2013).

Self-reported health differences between producers were not statistically significant. Health status is not solely related to the absence of diseases but is a complex phenomenon that reflects the social, economic, political, and cultural context, i.e., it is not the same for everyone. It depends on various factors such as time, place, social class, individual values, and scientific, religious, and philosophical conceptions (SCLIAR, 2007). Nonetheless, the variable doctor_go, which measures the frequency of visits to physicians by farmers from both groups in the past 12 months, was statistically significant and was higher for conventional producers, indicating that these producers may be experiencing additional health issues. As conventional farmers have greater access to the healthcare system, because two-thirds of interviewees had health insurance, compared to less than 20% of organic farmers, it can increase the probability of the producer going to a doctor.

The farms of organic and conventional soybean production were holding an average of 49.9 ha and 43.53 ha, respectively, reflecting the average farm size in the southern region of Brazil of 41.52 ha (IBGE, 2017). However conventional soybean crop areas were higher than organic. Both areas were statistically different. Conventional soybean farmers usually rent land to expand their cultivation area, resulting in crop areas larger than their properties. However, renting land for organic cultivation is less common due to the time and money required to meet the many compliances and rules necessary for organic certification. Organic certification is granted for a farm, not for an area, making it a long-term investment (Table 2). Although the mean area for organic soybean production is smaller than conventional, the organic soybean sample had a farm with a cultivation area of around 240 ha, indicating the availability of technology adapted to organic production at different scales.

Brazilian research centers have developed soybean varieties adapted to low latitudes (RAMALHO et al., 2012). However, conventional production has mainly relied on transgenic varieties over time, with technological standards adapted to meet the scale of both large properties in the Midwest region of Brazil and smaller ones in the Western and Southwestern regions of Paraná (ORLANDI et al., 2012). While conventional farmers generate higher gross profit per year than organic farmers (210.23 bags of 60 kg compared to 163.09 bags of 60 kg soybeans, respectively). Consequently, gross profits were statistically significant. Health insurance access for conventional farmers was higher than for organic farmers. Higher average income and access to information increase interest in health insurance. Although public healthcare is free for all Brazilian citizens, there are access restrictions due to high demand.

The associated with exposure to pesticides (PPE_time, application_number, highly_toxic, and mildly_toxic) were statistically significant, with organic farmers reporting lower levels of exposure than conventional farmers. Farmers and agricultural workers are considered a high-risk group with the greatest exposure to pesticides by transporting, mixing, loading, and applying them (DHANANJAYAN and RAVICHANDRAN, 2018). Thus, the major technological standard involves more exposure and risk for farmworkers and inhabitants of rural and urban areas (BELO et al., 2012; RUTHS, et. al, 2022), as well as a consumer (FROTA and SIQUEIRA, 2021). It is, therefore, essential to improve farmers' awareness of the proper and effective use of PPE, facilitate access to PPE, and comply with pesticides regulatory agencies. Additional measures are necessary to prevent contamination by pesticides, including good agricultural practices and adherence to agronomic prescription procedures.

The self-declared life satisfaction between, the producers was not statistically significant. However, this may not be accurate when considering multidimensional well-being, which encompasses more than just absolute or relative income and consumption level. According to Oswald and Wu (2011), there is no clear correlation between these variables and life satisfaction, and other factors, such as those identified by Stiglitz et al. (2009), can also affect quality of life.

The income_satisfaction variable of conventional farmers was higher than that of organic farmers. In fact, we can see that financial variables like gross_profit and health_insurance were also higher for conventional producers than organic producers, reflecting higher income satisfaction. On the other hand, organic producers showed more satisfaction with their work. The satisfaction that farmers derive from their work is a function of both farming rewards and values (COUGHENOUR and SWANSON, 1992), which are expressed through a range of individual farming goals (PARMINTER and PERKINS, 1997). Although organic producers' income is lower, they feel more satisfied with their work. The variables of family_satisfaction and education_satisfaction were not statistically significant.

Analysis of Estimated Models

The models estimated for self-reported symptoms (Tables 3 and 4) and life satisfaction (Table 5) did not include gender and smoking as independent variables, as these variables had little expressiveness and variability. In rural areas, social contracts have led to men predominantly taking over the management of farms and inheriting rural property (DEERE and LEÓN, 2003). This explains why most farm household heads were men, and why 97% of heads of households in both organic and conventional farms were men. Additionally, 94% of the sample were non-smokers due to the positive impact of Brazilian public policies to reduce smoking in the past three decades (MIRRA and CARVALHO, 2017), particularly in rural areas where it has improved health among the population and elders (SZKLO et al., 2016).

Table 3 presents the maximum likelihood estimates for three logit models for the binary dependent variable, which indicates whether a farmer has self-reported symptoms associated with pesticides exposure or not. The first and second models had a good fit, with likelihood ratios (LR) significant at 5%. However, the third model was not significant with the introduction of other variables, which reduced the quality of fit measures.

Logit models (1) and (2) demonstrate the marginal effects of the variables. An important finding is that the likelihood of conventional farmers reporting symptoms associated with pesticides exposure is 18% and 21% lower, respectively, compared to organic farmers. The age of the farmers was not found to be statistically significant in any of the three models, indicating that this variable does not influence the likelihood of exhibiting symptoms related to pesticides exposure. Similarly, the schooling variable was not statistically significant, suggesting that the level of self-reported symptoms is more closely related to the farming system adopted by organic or conventional farmers rather than their level of education.

The variable health care insurance showed statistical significance and a positive correlation, indicating that greater access to private health care reflects a higher socio-economic status (SES) among farmers. This is noteworthy given the high cost of healthcare insurance in Brazil (MALTA et al., 2017) and the socio-economic disparities associated with private health insurance (PILOTTO and CELESTE, 2018). The percentage of organic and conventional farmers with private healthcare contracts was 18% and 65%, respectively (Table 2), which was higher than the national average. In 2013, only 6% of Brazilians living in rural areas had such contracts, while 31% in urban areas did (MALTA et al., 2017). Thus, both groups of farmers were in a more favorable situation than the average rural population in Brazil. However, there was a significant difference in healthcare access between the two farmer groups, suggesting a potential SES gap. This result is consistent with most of the sample living in southern Brazil, where the rural population tends to have a higher SES.

The variable of self-perception of health showed significant results and was found to be inversely related to self-reported symptoms. This outcome is consistent with the notion that health studies encompass not only the occurrence or absence of a disease but also various subjective and objective factors (GALLAGHER et al., 2016). The concept of health considers the interconnectedness of cultural, social, psychosocial, economic, environmental, and community aspects. Moreover, self-reported health provides an indication that covers several domains beyond the biological realm (COTT et al., 1999). Furthermore, self-reported health reflects a sense of mood and well-being in carrying out day-to-day activities (PIKHART et al., 2001).

The remaining variables, including age, duration of personal protective equipment use, number of operations, and number of times pesticides were handled by major toxicity groups (I and II, and III and IV), were found to be not statistically significant.

Table 3 – Marginal Effects of the Logit Method on Symptoms Associated with pesticide exposure.

Variable	Model 1	Model 2	Model 3
Organic_farm	-0.180**	-0.212**	-0.224**
	(0.090)	(0.096)	(0.101)
Age	-0.003	-0.004	-0.004
	(0.003)	(0.004)	(0.004)
Schooling	0.038	0.040	0.038
	(0.056)	(0.056)	(0.059)
Health_insurance	0.193**	0.181**	0.201**
	(0.084)	(0.088)	(0.093)
Self-reported_health	-0.157**	-0.155**	-0.150**
	(0.074)	(0.075)	(0.076)
Doctor_go	0.010	0.011	0.012

	(0.015)	(0.015)	(0.015)
PPE_time	0.005	0.005	0.005
	(0.004)	(0.004)	(0.004)
Application_number		-0.009	-0.011
		(0.011)	(0.011)
Highly_toxic		-0.007	-0.007
		(0.006)	(0.006)
Mildly_toxic		0.015	0.016
		(0.012)	(0.012)
Farm_area			0.000
			(0.001)
Soybean_area			0.001
			(0.001)
LR chi2	14.35**	16.51***	17.22
Observations	201	201	201

Font: Field survey, 2016. Elaborated by the authors.

Note: robust standard error in brackets; *, **, ***, significance at 1%, 5%, 10%, respectively.

Table 4 displays the maximum likelihood estimates for the distribution of the dependent variable symptom_weight, which represents the weighted sum of self-reported symptoms related to pesticide exposure. Significant likelihood ratios (LR) at 1% showed that all models presented good fits. Poisson models (1), (2), and (3) present the marginal effects of the variables. One of the most important findings for organic farmers was that the probability of a relationship between the symptom_weight variable and pesticide exposure is 76%, 72%, and 59% lower, respectively, than that of conventional farmers.

The age of the farmers was not significant in all three models, indicating that this variable did not affect the probability of symptom_weight. The schooling variable was positive and statistically significant, but a previous study suggested a positive relationship between schooling and pro-environmental behavior (MEYER, 2015), hence a negative relation was expected. Similar observations were made for the logit models for self-reported symptoms (Table 3), and it appears that the level of the symptom_weight variable is more linked to the cultivation system adopted by conventional or organic farmers than to the level of schooling. Furthermore, empirical research in both developed and developing countries, such as the United States of America (ANDERSON et al., 2005) and Pakistan (ULLAH et al., 2015), did not find any influence of the schooling level on farmers' decisions to adopt an organic production system.

Like the findings in Table 3 for the logit models, healthcare insurance was also found to be statistically significant and positively related to the outcome variable in the Poisson models. This variable indicates greater access to private health systems and suggests a higher level of socio-economic status (SES) among farmers, given the high cost of private healthcare in Brazil. The health self-perception variable was also significant and negatively related to the outcome, consistent with the logit models in Table 3. Another health-related variable is doctor_go, which counts the number of times farmers from both groups went to physicians in the past 12 months. As expected, the marginal effect of this variable was significant and positive, as people tend to visit doctors more frequently when they report health problems.

The PPE_time variable was expected to have a negative effect, but it was found to be significant and positive with a low value. Farmers who have used PPE for a long time also reported more time of exposure to pesticides, including organic producers who had initially adopted conventional production or switched to organic due to poisoning events (PIACENTI et al., 2019). Dhananjayan and Ravichandran (2018) have identified farmers, agricultural, and non-agricultural workers as high-risk groups who are exposed to pesticides through transport, mixing, loading, and application. Despite this, Damalas and Abdollahzadeh (2016) found that most farmers do not recognize the need to wear PPE regularly, and there is a lack of accurate information on the quality and proper use of PPE over time.

The remaining variables, including age, number of applications, and number of times pesticides were handled by toxicological classes (I and II, and III and IV), were not found to be statistically significant. Additionally, the farm and soybean production areas were included as proxies for pesticide exposure and economic SES, but only the former was found to be significant and negative. This suggests that larger farms, and thus higher SES, may provide some slight evidence for reducing symptom_weight.

Table 4 – Marginal effects of the Poisson Model Estimated by *logit* for symptom_weight associated with pesticide exposure.

Variable	Model 1	Model 2	Model 3
Organic_farm	-0.757***	-0.719***	-0.581***
	(0.208)	(0.226)	(0.238)
Age	0.003	0.003	0.008
	(0.009)	(0.010)	(0.010)
Schooling	0.452***	0.438***	0.502***
	(0.127)	(0.128)	(0.131)
Health_insurance	0.611***	0.660***	0.475**
	(0.206)	(0.213)	(0.222)
Self-reported_health	-0.487**	-0.461**	-0.480**
	(0.217)	(0.217)	(0.215)
Doctor_go	0.090***	0.095***	0.086***

	(0.033)	(0.034)	(0.034)
PPE_time	0.015*	0.015*	0.014*
	(0.009)	(0.009)	(0.009)
Application_number		0.026	0.036
		(0.028)	(0.028)
Highly_toxic		-0.017	-0.013
		(0.018)	(0.018)
Mildly_toxic		0.029	0.025
		(0.033)	(0.034)
Farm_area			-0.006**
			(0.003)
Soybean_area			0.000
			(0.003)
LRchi2	45.33*	47.16*	54.95*
Observations	201	201	201

Font: Field survey, 2016. Elaborated by the authors.

Note: robust standard error in brackets; *, **, ***, significance at 1%, 5%, 10%, respectively.

Table 5 presents the estimated results of life satisfaction determinants for organic and conventional soybean producers based on ordinal logit models. The LRchi2 test was significant at 1%, indicating that the coefficients are nonzero for both models taken together. The quality adjustment measures of the ordinal logit estimates presented in Table 5 suggest that they are reasonable. Unlike other regression models, the ordinal logit model does not have an intercept but cutoff points. For all the estimated models, the cutoff points were within the 95% confidence interval, indicating that the five-category model fits the data properly. The highest level of satisfaction, i.e., very good, is used as a reference, so positive coefficients mean that an increase in the predictor tends to increase the chances of declaring being very satisfied with life. Since the ordered logistic model assumes that the relationship between each pair of outcomes is the same (for instance, the highest versus all lower categories of the response variable), there is only one set of estimates of regression slopes.

Ordinal logit models (1) and (2) indicated that organic farmers have 64% and 68% higher odds ratios of reporting very good life satisfaction, respectively, compared to conventional farmers. The results also showed that farmers' age was a significant and positive factor, with an increase of one year associated with a 3.2% and 4.2% increase in the odds ratio of self-reported very good life satisfaction in models (1) and (2), respectively. However, the variable schooling was not found to be statistically significant. Previous research by Coughenour and Swanson (1992) revealed both positive and negative associations between life satisfaction and this variable, depending on the state in the United States of America, suggesting that the influence of this variable can be ambiguous and dependent on circumstances.

Gross profits were not particularly important for farmers' life satisfaction. However, according to model (2), increasing one's patrimony is important for achieving greater life satisfaction. Specifically, when using farm area as a proxy for patrimony, the variable was found to be positively and significantly associated with an increased odds ratio of farmers reporting greater life satisfaction, indicating that having more land is associated with greater life satisfaction for farmers.

Table 5 – Ordinal logit models (1) and (2) for life satisfaction of soybean farmers.

Variable	Model 1	Model 2
Organic_farm	1.641*	1.679*
	(0.479)	(0.511)
Age	1.032**	1.042*
	(0.013)	(0.014)
Schooling	1.179	1.147
	(0.230)	(0.228)
Self-reported_health	4.445***	4.333***
	(1.347)	(1.332)
Doctor_go	0.994	0.988
	(0.052)	(0.054)
Farm_area	0.997	0.996*
	(0.002)	(0.002)
Gross_profit	1.000	1.000
	(0.001)	(0.001)
Income_satisfaction	-	1.046
		(0.110)
Family_satisfaction	-	1.048
		(0.162)
Education_satisfaction	-	1.161
		(0.189)
Work_satisfaction	-	1.442***
		(0.190)
cut1	-2.04	3.594

cut2	-0.74	4.911
cut3	0.77	6.445
cut4	2.78	8.542
cut5	4.25	10.128
LRchi2	36.16*	53.24*
Observations	201	201

Font: Field survey, 2016. Elaborated by the authors.

Note: robust standard error in brackets; *, **, ***, significance at 1%, 5%, 10%, respectively.

In the models examined, variables such as income, family, schooling, and work satisfaction were found to have positive associations with farmers' life satisfaction. However, only work satisfaction was found to be statistically significant in model 2. Farmers' concerns led to decisions related to their personal life satisfaction and were influenced not only by the availability of resources but also by the value they placed on agricultural activity and social practices (GASSON, 1973).

The satisfaction of farmers derives from their work, which is a function of both farming rewards and values (COUGHENOUR and SWANSON, 1992; PARMINTER and PERKINS, 1997). In addition, environmental quality and other factors play a crucial role in individuals' well-being (FREY et al., 2010). For example, supplying organic vegetables, clean water, and other ecological services improves farmers' life satisfaction (MA, et al., 2021). In this context, organic farmers have been found to have a more positive self-perception of their farming production and work.

Conclusions

This paper aims to investigate the quality of life of farmers who produce conventional and organic soybeans in Brazil. We analyzed two perspectives: (a) health, based on self-reported symptoms associated with pesticide exposure, and (b) life satisfaction. The data were obtained from a company in Paraná State where organic soybeans with international certification are traded. The producers are mostly from southern Brazil.

Our findings indicate that organic farmers are less likely to report symptoms associated with pesticide exposure compared to conventional farmers. This suggests that the agricultural production system chosen by farmers has a significant impact on the health of rural workers, and merely protecting them from agrochemical exposure may not be sufficient, as it also depends on how farmers use personal protective equipment. Furthermore, the fact that many organic farmers were previously conventional soybean farmers reduces the accuracy of our outcomes.

It appears that the agricultural sector needs new strategies to promote the use of personal protective equipment to reduce risks associated with pesticide exposure. Education and training on the health hazards of pesticides are necessary to raise awareness and improve the health of agricultural workers. Organic farmers tend to have higher levels of awareness, indicating the need for greater efforts to educate conventional farmers.

Our results also show that organic soybean farmers have higher odds of life satisfaction compared to conventional soybean farmers. Self-reported health and work satisfaction were the most influential variables for enhancing farmers' life satisfaction. Farmers' life satisfaction is a complex and broad concept that considers both tangible variables such as farm area, as well as intangible factors related to multidimensional well-being, and it is not limited to an economic approach. Again, the choice of production system plays a crucial role in farmers' well-being.

Organic soybean production can contribute to enhancing sustainability in rural areas by improving the health of agricultural workers and reducing the environmental contamination. Shifting from conventional to organic soybean production in Brazil has the potential to decrease negative impacts on both public health and the environment. Therefore, policies aimed at promoting organic soybean production should be developed to encourage conventional soybean producers to convert to organic. This would potentially benefit numerous farms in various regions of Brazil where conventional soybean production is prevalent. In summary, promoting organic soybean production is one strategy for reducing risks associated with conventional production for both health and the environment.

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Qualidade de Vida dos Produtores de Soja Orgânica e Convencional

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Valdir Antonio Galante

São Paulo. Vol. 27, 2024
Artigo Original

Resumo: Este artigo examina a qualidade de vida de produtores de soja orgânica e convencional no Brasil. Analisamos os sintomas autodeclarados associados à exposição aos agrotóxicos e medimos os níveis de satisfação com a vida dos produtores agropecuários. Nós aplicamos três modelos para analisar os dados de acordo com a distribuição das variáveis dependente: binário, Poisson e ordinal. Os questionários foram aplicados para 62 e 139 produtores de soja orgânica e convencional, respectivamente. Os resultados mostraram que a probabilidade de os agricultores orgânicos relatarem sintomas associados à exposição aos agrotóxicos foi 59% menor em relação aos produtores convencionais; e mostraram que os produtores orgânicos possuíam 68% mais chances de relatarem satisfação com a vida em relação aos produtores de soja convencional. Concluímos que a produção de soja orgânica melhorou a qualidade de vida dos trabalhadores agrícolas, além de aumentar a sustentabilidade das áreas rurais.

***Palavras-chave*:** Produção orgânica, saúde, satisfação de vida, soja, desenvolvimento rural sustentável.

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25 anos años years

Calidad de Vida de los Productores de Soja Orgánica y Convencional

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Ana Cecília Kreter
Valdir Antonio Galante

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Artículo Original

Resumen: Este artículo examina la calidad de vida de los productores de soja orgánica y convencional en Brasil. Analizamos los síntomas auto informados asociados a la exposición a los pesticidas y medimos los niveles de satisfacción. Aplicamos tres modelos para analizar los datos de acuerdo con la distribución de la variable dependiente: dicotomía, Poisson y ordinal. Se aplicaron cuestionarios a 62 y 139 productores de soja orgánica y convencional, respectivamente. Encontramos que la probabilidad de que los agricultores orgánicos reporten los síntomas relacionados con la exposición a los pesticidas fue un 59% menor que la de los agricultores convencionales; y los agricultores orgánicos tenían un 68% más de tasa de probabilidad de satisfacción con la vida en comparación con los agricultores convencionales. Concluimos que la producción de soja orgánica ha mejorado la calidad de vida de los trabajadores agrícolas, al mismo tiempo que mejora la sostenibilidad de las zonas rurales

Palabras-clave: Producción orgánica, salud, satisfacción de vida, soja, desarrollo rural sostenible.