

Environmental practices of fruit growing companies in Mossoró, Rio Grande do Norte, Brazil

Práticas ambientais das empresas de fruticultura de Mossoró, Rio Grande do Norte, Brasil

Reinaldo Chotten

Universidade Federal Rural do Semi-Árido,
Mossoró, Brasil



Jorge Luís de Oliveira Pinto Filho

Universidade Federal Rural do Semi-Árido,
Pau dos Ferros, Brasil

ABSTRACT

Research Purpose: This research aims to analyze the legal environmental practices of the fruit-growing sector in the municipality of Mossoró, Rio Grande do Norte, Brazil.

Methodology: The study is based on bibliographic, documentary and field research, carried out in 14 companies, through the application of questionnaires on general aspects, environmental legality and environmental practices, and the data are treated in Microsoft Excel software.

Findings: It was found that the profile of the analyzed companies is characterized by medium and large companies. It was evidenced that the companies have environmental licensing. It was also observed that technological innovation in companies' processes contributed to improving efficiency, especially in the consumption of water, energy and waste management.

Originality/Value: The study is original because it highlights corporate environmental management tools for the fruit production sector.

Keywords: Environmental impacts of fruit production; Corporate environmental management; Corporate sustainability.

RESUMO

Objetivo da Investigação: Esta pesquisa tem como objetivo realizar um levantamento da legalidade ambiental e das práticas ambientais do setor de fruticultura no município de Mossoró-RN.

Metodologia: O estudo tem como base pesquisa bibliográfica, documental e de campo, executada em 14 empresas, através da aplicação de questionários sobre os aspectos gerais, legalidade ambiental e práticas ambientais, sendo os dados tratados no software Microsoft Excel.

Resultados: Constatou-se que o perfil das empresas analisadas é caracterizado por média e grandes empresas. Evidenciou-se que as empresas possuem licenciamento ambiental. Observou-se também que a inovação tecnológica nos processos produtivos das empresas contribuiu para melhorar a eficiência, especialmente no consumo de água, de energia e na gestão dos resíduos.

Originalidade/Valor: O estudo apresenta originalidade a partir do apontamento de ferramentas de gestão ambiental empresarial para o setor de fruticultura.

Palavras-chave: Impactos ambientais da fruticultura; Gestão ambiental empresarial; Sustentabilidade empresarial.

1. Introduction

Contemporary environmental issues require companies to adopt a new stance towards the environment, incorporating administrative and technological concepts that contribute to expanding the planet's carrying capacity. In this way, companies should shift from being part of the environmental problems to becoming part of the solutions (Barbieri, 2023). Within this perspective, corporate environmental management emerges, addressing various administrative and operational activities undertaken by companies to tackle environmental issues arising from their operations or to prevent them in the future. This management model became necessary due to the significant increase in industrial activities and the resulting impacts on the environment, creating a competitive scenario in managing the balance between economic development and the environment (Barbieri, 2023).

Overall, companies' environmental concerns are influenced by three major forces that interact reciprocally: government, society, and the market. Consequently, companies address environmental issues resulting from their activities through three different approaches: pollution control, pollution prevention, and the integration of these issues into corporate strategy (Barbieri, 2023).

In the context of the growing demand for food driven by population growth, the fruit production sector is gaining prominence due to increased demand for healthy foods rich in vitamins and minerals, resulting in a global rise in fruit production over the past decades. Brazil has gained worldwide recognition as the third-largest fruit producer, with China leading as the largest market producer, followed by India (National Supply Company – CONAB, 2023). Despite its significance, this economic sector has substantial environmental aspects, necessitating discussions on compliance with environmental laws and sustainable practices.

Therefore, the sustainable practices of the fruit production sector have been studied by Braga and Matushima (2021), Galli, Janones, Batalhão, and Galli (2019), Julio and Bueno (2022), Loiola and Santiago (2021), Martins, Bispo, and Nonnenberg (2023), Masochi, Camargo, Motta, and Silva (2022), Medeiros, Lemos Filho, and Batista (2023), Oliveira, Volff, Bortoluzzi, Queiroz, and Seabra Junior (2019), Ribeiro, Lima and Loiola (2023), and Silva, Brito Filho, Oliveira, Araújo, and Siqueira (2021). However, these studies do not establish a relationship between the profile of fruit production companies, their environmental compliance, and their environmental operational practices.

In the state of Rio Grande do Norte, specifically in Mossoró, there is a significant Irrigated Fruit Production Hub, developed through the interaction of natural (soil, water, and climate) and socioeconomic (medium-sized city, regionalization, trade and services, qualified workforce, and science and technology) characteristics. In this region, the largest production of fruits in irrigated areas in RN occurs, with a focus on melons and papayas cultivated in large, medium, and small properties using modern technologies.

With the consolidation of the Mossoró, Rio Grande do Norte, Irrigated Fruit Production Hub, environmental aspects become increasingly relevant, especially concerning water consumption, energy, inputs, solid waste, and

liquid effluents. Therefore, investigating corporate environmental management on rural properties becomes strategic, allowing for a proactive approach with corrective, preventive, and anticipatory actions, resulting in medium and long-term solutions.

Hence, the aim of this study is to identify the environmental practices of fruit production companies in Mossoró, Rio Grande do Norte, Brazil. To achieve this, the following specific objectives were defined: to provide a socio-economic description, to assess environmental legality, and to determine the environmental actions of the sector under study.

2. Methodology

The development of this research was based on the delimitation of the object of study and deliberation of appropriate methodological procedures.

2.1. Characterization of the Study Area

In the Northeast region of Brazil, in the interior of Rio Grande do Norte, lies Mossoró, situated between the capitals Fortaleza-CE and Natal-RN, at distances of 245 and 278 km, respectively. This municipality shares borders to the north with the state of Ceará and the city of Grossos; to the south with the municipalities of Governador Dix-Sept Rosado and Upanema; to the east with Areia Branca and Serra do Mel; and to the west with Baraúna. It encompasses a total area of 2,099,344 km² and has a population of 264,577 people, making it the first and second in terms of territorial extension and population in the state (IBGE, 2023).

In Mossoró-RN, the predominant economic activities include salt mining, extractive industries, services, and fruit cultivation. This municipality is considered the largest producer of salt in the country and the leading producer of onshore oil, contributing to a GDP of 6,926,042.23 million (PMM, 2023). This economic landscape significantly influences the occupation of individuals, with those aged 18 years or older engaged in various sectors: 5.67% in agriculture; 4.50% in extractive industries; 8.52% in manufacturing; 9.78% in construction; 0.76% in public utilities; 19.72% in commerce; and 43.71% in the services sector (IBGE, 2023).

Considering these natural and economic characteristics, which provide the necessary natural resources (soil, water, and sunlight) for development, along with logistical support and a qualified workforce, the fruit production sector has thrived in Mossoró-RN. Official environmental agencies have recorded approximately 40 fruit exporting companies in Mossoró-RN (COEX, 2023), with this study focusing on 14 producers.

2.2. Research Procedures

The study unfolded through the execution of the following stages: I) Definition of Theoretical Themes; II) Delimitation of Data Collection Instruments; III) Approval by the Research Ethics Committee – “CEP”; IV) Field Data Collection; V) Organization, Processing, and Data Analysis.

Step I – Definition of Theoretical Themes

From the definition of the theme of the research on environmental legality and environmental practices, a theoretical survey was carried out, through a literature review of the articles published in journals on the environmental certification of the fruit growing activity over the past four years.

Step II – Delimitation of Data Collection Instruments

Initially, following the literature review, the data collection instruments were defined, starting with the delineation of documentary investigation on the Fruit Production companies in Mossoró/RN and the description of the municipality itself.

Subsequently, the legal environmental compliance and the survey of environmental practices of the Fruit Production companies in Mossoró/RN were described through a semi-structured interview. The interview aspects such as company size, gross income, property type, enterprise size, time in existence, products explored, export destinations, types of trade, environmental licensing, solid waste and liquid effluent management, environmental inspections, environmental responsibility, environmental training, environmental policy, environmental management systems, environmental auditing, soil management, environmental risks, environmental compliance, and environmental certification

To validate the information obtained through the interview, a field diary was adopted. This method is considered viable as it allows for the writing and reading of the diary, engaging in attention production, reshaping the relationship with the research topic, and activating related memories (Oliveira, 2014).

Step III - Registration with the Research Ethics Committee - “CEP”

To conduct the research, the project was initially registered with the Research Ethics Committee – REC. Contact with the surveyed companies was made via e-mail and/or telephone to determine the collection date for the informed consent letters, which took place until July 17, 2022, resulting in the registration of 14 informed consent letters.

It should be noted that this research adhered to National Health Council Resolutions No. 466/12 and 510/16 (Brasil, 2012, 2016), as well as their complementary guidelines regulating research involving human subjects. These resolutions emphasize "respect for human dignity and the special protection due to participants in scientific research involving human subjects" (Brasil, 2012). Although these ethical guidelines were strictly followed, they do not constitute a procedural step in the research itself.

It should be noted that before registering on the Platform Brazil, a folder was organized to store the necessary files for research submission. These files included the complete project, questionnaire, informed consent letter, and the model for the Free and Informed Consent Term (TCLE), informed consent letters from the surveyed companies, a list of fruit production companies, cover page, institution declaration, and research initiation declaration.

Following this stage, the submission of the research was carried out to meet all the requirements set by the Committee. After filling in the required fields, the cover page was generated, filled out, and signed by the coordinator of the Postgraduate Program to which this research is affiliated.

Finally, the investigation was registered with the REC of the State University of Rio Grande do Norte – UERN, by the researcher, with all required files attached to the platform. The research was approved as per substantiated opinion No. 5,970,401 on March 28, 2023.

Step IV - Field Data Collection

Initially, on-site visits were conducted from July 24 to 28, 2023, employing an exploratory approach to familiarize with the analyzed fruit production companies. During this period, the research was introduced, and appointments were scheduled with each enterprise for the administration of the questionnaires.

Subsequently, the research and its formalization documents, namely the Informed Consent Form (ICF), the Authorization Form for Image Use, and Authorization Form for Audio Use, were submitted.

Following this, 14 interviews were administered to fruit production companies in Mossoró from August 21 to 25, 2023, based on the availability of the interviewees.

Finally, primary data collection was conducted from September 18 to 22, 2023, involving visits to the analyzed companies to create a photographic collection documenting the environmental legality and environmental practices of the researched organizations.

Step V - Organization, Processing, and Analysis of Data

Based on the nature of the obtained data, the appropriate form of organization was determined. Qualitative data were described through a field diary, while quantitative data from the semi-structured interviews were tabulated using the Microsoft Excel program. It is worth noting that photographic records were organized based on the categories of environmental legality and environmental practices.

The data treatment followed the concepts of Marconi and Lakatos (2021), which involve probabilistic and non-probabilistic approaches. Probabilistic treatment involves statistical analysis that corrects errors and gives significance to the research. Non-probabilistic treatment, on the other hand, does not apply statistical formulas. The probabilistic approach was applied to the results obtained from the questionnaires, quantifying percentages using Microsoft Excel, and later presenting them in tables. The study employed a non-probability sampling approach, involving direct observation and photographic documentation of the environmental legality and practices of fruit production companies in Mossoró-RN.

Data analysis is a crucial phase in research, as Gil (2019) suggests that the researcher needs to go beyond reading the data, integrating them into the broader context where they may make sense. In this context, the interpretation of the results was carried out by comparing them with other studies published within the last four years on

environmental certification in fruit cultivation. This comparison aimed to identify similarities and differences and, ultimately, understand the dynamics of this economic sector.

3. Results and Discussion

3.1. General aspects of the Fruit growing companies of Mossoró – RN

The development of the municipality of Mossoró-RN significantly relies on the fruit production sector, characterized by medium and large enterprises. Notably, 89% of these enterprises have more than 100 employees, and they are typically situated on total areas ranging from 500 to 1000 hectares (44%), with exploited areas falling between 100 to 499 hectares (44%). These enterprises report annual revenues exceeding 3.6 billion, and a majority (67%) has been in operation for over a decade. Moreover, all of these enterprises operate on a full-time basis, engage in diverse production (Melon, Papaya, and Watermelon), cater to a diverse market (both national and international), and produce over 10 tons (67%) annually (Table 01).

Table 1

General aspects of the Fruit growing companies of Mossoró - RN

Requirement	Quantitative (%)			
		0 to 9	10 to 49	50 to 99
Employees	00,00%	00,00%	11,00%	89,00%
Revenue (Thousand R\$)	Up to 60	60 to 300	360 to 3.600	Above 3.600
	00,00%	00,00%	11,00%	89,00%
Total Area (Hectares)	0 to 99	100 to 499	500 to 1000	Above 1000
	0,00%	33,00%	44,00%	23,00%
Explored Area (Hectares)	0 to 99	100 to 499	500 to 1000	Above 1000
	00,00%	44,00%	33,00%	23,00%
Existence time	Up to 1 year	From 2 to 5 years	From 6 to 9 years	Above 10 years
	0,00%	11,00%	22,00%	67,00%
Production type	Melon	Papaya	Watermelon	Others
	90,00%	80,00%	70,00%	100,00%
Type of trade	Local	National	International	Others
	0,00%	11,00%	22,00%	67,00%
Average Production	Up to 1 ton	From 2 to 5	From 6 to 9	Above 10
	0,00%	11,00%	22,00%	67,00%
In-House Services	Planting	Processing	Logistics	Commerce
	100%	100%	100%	100%

Source: Prepared by the authors (2023)

In light of the presented data above, similarities can be observed with other enterprises in the same segment and region. Medeiros, Lemos Filho, and Batista (2023) noted that in characterizing rural landowners in the Lower Açu Irrigation District (LIBA), the largest percentage corresponds to large landowners, distributed among 1387.2 hectares of family lots (8.16 hectares), 3331.4 hectares of business lots (75 to 100 hectares), and 163 hectares of technical lots (16.32 hectares). According to these authors, there were also similarities in terms of the activities carried out, as in the DIBA, they are distributed between agriculture and fruit production, with 67% in agriculture and 33% solely in fruit production, with 100% of the producers cultivating bananas, 33% cultivating mangoes and papayas, and 17% cultivating coconuts and watermelons.

Similar results were determined by Barbosa, Lima, and Ferreira (2021) when identifying that producers in the Submédio Vale do São Francisco (Lower-Middle São Francisco Valley) Fruit Production Hub in Pernambuco are represented as small, medium, and large entrepreneurs. The majority of fruit growers work with both permanent

and temporary crops, supplying both the domestic and international markets.

Finally, in the analysis of the destination of exports from the fruit production companies in Mossoró-RN, it was found that the majority are destined for Europe (77%), with Germany (11%) being the main recipient country. The remaining exports are divided between the Middle East (13%) and the Americas (10%). Despite this significance, there is a need for further evolution, as noted by Julio and Bueno (2022), who stated that Brazil faces a disadvantage in the international market due to the absence of an export model for fruits and the lack of export standards that can be processed and exported in the form of by-products, adding value to the production.

Therefore, the contribution of fruit production to the Brazilian economy is evident, especially in terms of job and income generation, property appreciation, food production, local and regional development, and international projection. Nevertheless, the fruit production sector faces significant environmental impacts in its processes, which warrant comprehensive study to inform sustainable management practices.

3.2. Environmental Legality of Fruit Production Companies in Mossoró – RN

The investigation into the environmental legality of companies is fundamental in contemporary society, as highlighted by Assumpção (2015), who emphasizes that legal compliance is one of the requirements for environmental management, seen as a managerial differentiator.

In this context, the environmental legality of fruit production companies in Mossoró-RN is determined by assessing the acquisition of licenses, solid waste management, liquid effluent management, and compliance with inspections.

Upon examining the occurrence of environmental licenses in the investigated companies, it was found that 80.00% have valid licenses, while 20.00% have expired licenses. Regarding solid waste management, 66.67% of the companies store waste in open facilities, and 66.67% use permeable storage facilities. Selective collection was implemented in 66.67% of cases, with 80.00% of waste being donated, and 50.00% of companies adopting recycling as a treatment method. For effluent management, 78.00% of companies direct effluents to septic tanks and employ control techniques to contain pesticide residues, with all establishments having concrete floors and septic tanks. Finally, frequent inspections were observed in 56.00% of establishments, most commonly by the Ministry of Agriculture (32.00%), IDEMA (29.00%), and the Ministry of Labor (25.00%) (Table 2).

Table 2

Environmental Legality of Fruit production companies in Mossoró - RN

Requirement	Quantitative (%)			
	Yes	Yes, but expired	No	Don't know
Has Environmental License?	80,00%	20,00%	00,00%	00,00%
Waste Storage	Open 66,67%	Closed 33,33%	Permeable 66,67%	Impermeable 33,33%
Existence of selective collection	Very frequent 33,33%	Frequent 66,67%	Rarely 00,00%	Never 00,00%
Frequency of waste collection	7 times per week 00,00%	5 times per week 00,00%	Once a week 55,56%	Every 15 days 44,44%
Solid waste treatment	Reduction 00,00%	Recycling 50,00%	Composting 25,00%	Incineration 25,00%
Destination of solid waste	Public collection	Provided	Disposed	Others

	00,00%	80,00%	00,00%	00,00%
Destination of liquid effluents	Public network 0,00%	Septic tank 78,00%	Own station 22,00%	Others 00,00%
Containment structure for pesticide mixtures	Cement floor 100,00%	Containment channels 11,00%	Septic tank 100,00%	Filter 78,00%
Existence of inspection	Very frequent 11,00%	Frequent 56,00%	Regularly 22,00%	Rarely 11,00%
Existence of environmental inspection	Very frequent 22,00%	Frequent 56,00%	Regularly 22,00%	Rarely 00,00%
Existence of inspection by agencies	IBAMA 4,00% Min. Agriculture 32,00%	ICMBIO 4,00% Min. Labor 25,00%	IDEMA 29,00% City Hall 00,00%	IGARN 07,00% Others 00,00%

Source: Prepared by the authors (2023)

Upon investigating the compliance with environmental laws by fruit production companies in Mossoró-RN, it was found that they possess the Environmental Licensing (Figure 1.a) and disclose this procedure as required by the environmental agency, thus adhering to the principle of environmental transparency. It is noted that the companies also fulfill the legal environmental requirements related to the delimitation of the Legal Reserve Area (Figure 1.b). The Legal Reserve Area is situated within a rural property or possession and serves to ensure the sustainable economic use of the property's natural resources, aid in the conservation and rehabilitation of ecological processes, promote biodiversity conservation, as well as provide shelter and protection for wildlife and native flora. Finally, it highlights compliance with the Permanent Protection Area with the environmental function of preserving water resources, landscape, geological stability, and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil, and ensuring the well-being of human populations.

Figure 1

Compliance with environmental laws by fruit growing companies in Mossoró - RN



Source: own collection (2023).

Compliance with applicable environmental legislation allows for the prevention and reduction of environmental impacts from activities using natural resources and potentially polluting. In this regard, the existence of these management instruments was confirmed, as highlighted by Braga and Matushima (2021), who emphasized the need for monitoring, control, and supervision of the use of natural resources, especially water resources, by agriculture.

Emphasizing the importance of legal compliance, Oliveira, Volff, Bortoluzzi, Queiroz, and Seabra Junior (2019) state that certified producers engage in the regeneration of Environmental Protection Areas and dispose of pesticide residues through specialized companies. Thus, it can be inferred that the fruit production sector has been observing

and complying with applicable environmental legislation.

Analyzing the management of solid waste in fruit companies in the municipality of Mossoró-RN, the adoption of sustainable practices related to selective collection (Figure 2.a) was observed, allowing for proper storage (Figure 2.b) and appropriate disposal by third-party service providers (Figure 2.c).

Figure 2

Solid waste management of the Fruit Growing companies of Mossoró - RN



a. Selective collection

b. Correct storage

c. Final destination

Source: own collection (2023)

Upon evaluating the management of liquid effluents, efficient, modern, and appropriate practices were observed. This includes the use of impermeable cement flooring with drainage channels for containment at fueling locations (Figure 3.a), areas where fertilizers are used with drainage channels for containment (Figure 3.b), and the presence of adequate sanitary facilities (Figure 3.c) at various points on rural properties.

Figure 3

Management of liquid effluents from fruit growing companies in Mossoró - RN



a. Cement flooring

b. Syrup containment

c. Cesspool

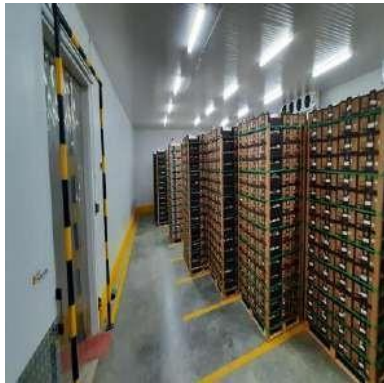
Source: own collection (2023)

In this perspective, waste and effluent-related topics gain prominence in this economic sector. Loiola and Santiago (2021) also affirmed that the main environmental aspects of Irrigated Fruit Production Companies in the Vale do São Francisco in Petrolina, Pernambuco, Brasil, include water consumption, waste generation, atmospheric emissions, effluent discharge, and supplier evaluation. Therefore, the adoption of environmental management actions becomes necessary, as stated by Ribeiro, Lima, and Loiola (2023), which allows for the addition of value to the product.

Finally, the environmental legality of the analyzed companies is achieved through the inspection processes they undergo. Thus, compliance with the requirements of the Ministry of Agriculture regarding fruit refrigeration (Figure 4.a) is evident, adherence to IDEMA guidelines regarding pesticide storage (Figure 4.b), and compliance with the laws of the Ministry of Labor and Employment regarding the Programa de Alimentação do Trabalhador PAT (Worker's Food Program), with the availability of suitable facilities (Figure 4.c).

Figure 4

Inspection of Fruit Growing Companies in Mossoró - RN

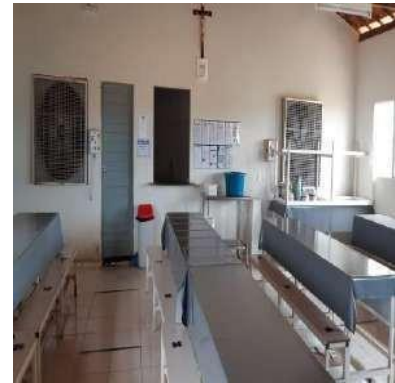


a. Fruit refrigeration

Source: own collection (2023)



b. Pesticide storage



c. Company cafeteria

The issue of inspection is fundamental in the fruit production sector, as highlighted by Braga and Matushima (2021), who pointed out the need for combating the indiscriminate use of chemical compounds in agriculture by authorities and comprehensive inspection by all.

3.3. Environmental practices of the Fruit Growing companies of Mossoró – RN

Essa postura estratégica é caracterizada por enxergar a Gestão Ambiental como uma fonte de vantagem competitiva, considerando toda a cadeia produtiva e o ciclo de vida completo do produto nas estratégias ambientais (Barbieri, 2023). The latter is characterized by viewing Environmental Management as a competitiveness factor, identifying and applying strategic opportunities related to the environment. In this approach, the entire production chain of the companies is taken into account, allowing for the consideration of the entire product life cycle in environmental strategies.

In this context, the environmental practices of fruit companies in Mossoró-RN encompass socio-environmental responsibility projects, environmental training, environmental policies, Environmental Management Systems, environmental audits, soil management and conservation, risk management, regulatory compliance, and international certifications.

When investigating the execution of socio-environmental responsibility projects, regular existence was noted in 55.56% of the companies. Regarding the organization of environmental practices, 77.78% have had an Environmental Management System for a long time, while 22.22% have implemented it recently. All the companies possess a formal environmental policy, and 52.88% disseminate it to their clients via email. Concerning

internal actions, 88.89% conduct environmental training, and 55.56% regularly perform environmental audits in the production process. Notable soil management practices include metal analysis (60.00%), crop rotation (20.00%), and fertility and mulching analysis (18.00%). Regarding the environmental analysis of the production process, there is a presence of environmental risk assessment (100.00%), assessment of environmental compliance for deforestation, Genetically Modified Organisms – GMOs, pesticides, and water (100.00%). Finally, the adoption of these environmental practices is geared towards obtaining certifications, with GLOBAL G.A.P. and S-META (ETI) being the most practiced (100.00%) (Table 3).

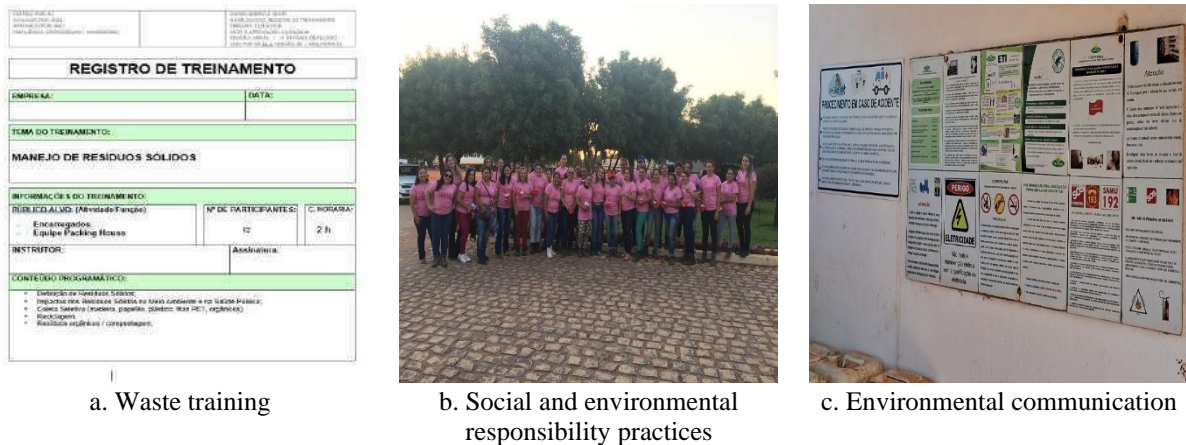
Table 3*Environmental practices of fruit production companies in Mossoró - RN*

Requirement	Quantitative (%)			
	Very frequent	Frequent	Regularly	Rarely
Socioenvironmental responsibility	00,00%	22,22%	55,56%	22,22%
Environmental training	Very frequent 00,00%	Frequent 88,89%	Regularly 11,11%	Rarely 00,00%
Environmental policy	Yes 100,00%	Yes, outdated 00,00%	No 00,00%	Don't know 00,00%
Disclosure of environmental policy	Clients - email 52,88%	Suppliers 21,88%	Employees 28,13%	External - website 6,25%
Environmental management system	Yes, for a long time 77,78%	Yes, recently 22,22%	No 00,00%	Don't know 00,00%
Existence of environmental audit	Very frequent 00,00%	Frequent 22,22%	Regularly 55,56%	Rarely 22,22%
Land use policy	Fertility analysis 18,00% Metal analysis 40,00%	Mulching 18,00% Organic matter 04,00%	Fallow 00,00% Strip planting 00,00%	Crop rotation 20,00% Inter-cropping 00,00%
Knowledge of environmental risks	Risk assessment 100,00% Courses 00,00%	In-house 100,00% Events 00,00%	External consultant 20,00% Internal consultant 00,00%	Laws 20,00% Others 00,00%
Request for environmental compliance	Deforestation 100,00% CO ² emissions 89,00%	OGM 100,00% Packaging 33,00%	Pesticides 100,00% Forests 33,00%	Water use 100,00% Others 00,00%
Existence of international certifications	GLOBAL G.A.P. 100,00% ISO 9001 00,00%	S-META (ETI) 100,00% ISO 14001 00,00%	LEAF MARK 22,00% ISO 18001 00,00%	RAINFOREST 07,00% Others 00,00%

Source: Prepared by the authors (2023)

Environmental issues are becoming increasingly prevalent in organizations, leading to the development of actions to enhance operational processes through waste management training (Figure 5.a). It is important to note that the responsibility of companies extends beyond their organizational boundaries, as evidenced by the existence of socio-environmental responsibility practices (Figure 5.b), with a focus on providing healthcare assistance to the population around the investigated companies. Finally, all actions developed need to be publicized to improve the company's image in society through environmental marketing, involving the creation of environmental communication channels (Figure 5.c).

Figure 5
Environmental practices of fruit growing companies in Mossoró - RN



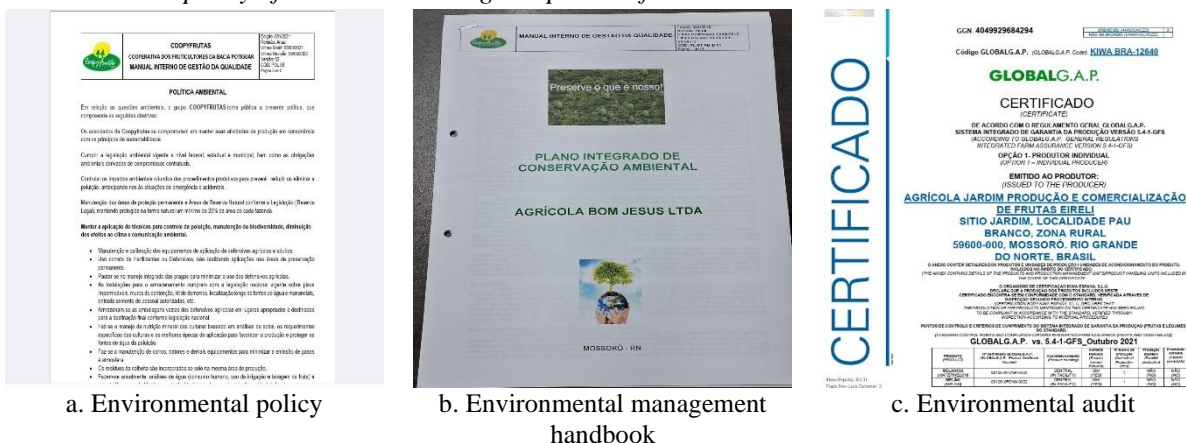
Source: own collection (2023)

Consistent findings were determined by Galli, Janones, Batalhão, and Galli (2019) when they stated that the main motivator for companies to invest in socio-environmental actions is environmental obligation rather than voluntary social actions, revealing a reactive rather than proactive approach. Thus, the authors also emphasized the need for all members of the organization to be aware of the importance of social responsibility and environmental obligations and to manage them correctly and transparently.

Highlighting this context, Silva, Brito Filho, Oliveira, Araújo, and Siqueira (2021) pointed out that identified social responsibility actions include the Mobile Dental Unit program, provision of accommodation, food, transportation, literacy school, and fruit donations. Given the presented information, there is a need for Corporate Socio-Environmental Responsibility (CSR) actions to be correlated with the environmental aspects of organizations.

Regarding the environmental organizational attitudes of the fruit-growing companies in Mossoró-RN, the environmental policy was observed (Figure 6.a), with principles of pollution prevention, continuous improvement of environmental performance, and compliance with legal aspects; the implementation of the Environmental Management System (Figure 6.b), encompassing environmental policy, environmental planning, implementation and operation, monitoring and corrective action, and management review; and the execution of environmental audits (Figure 6.c) to assess compliance with environmental objectives and goals.

Figure 6
Environmental policy of the Fruit Growing companies of Mossoró - RN

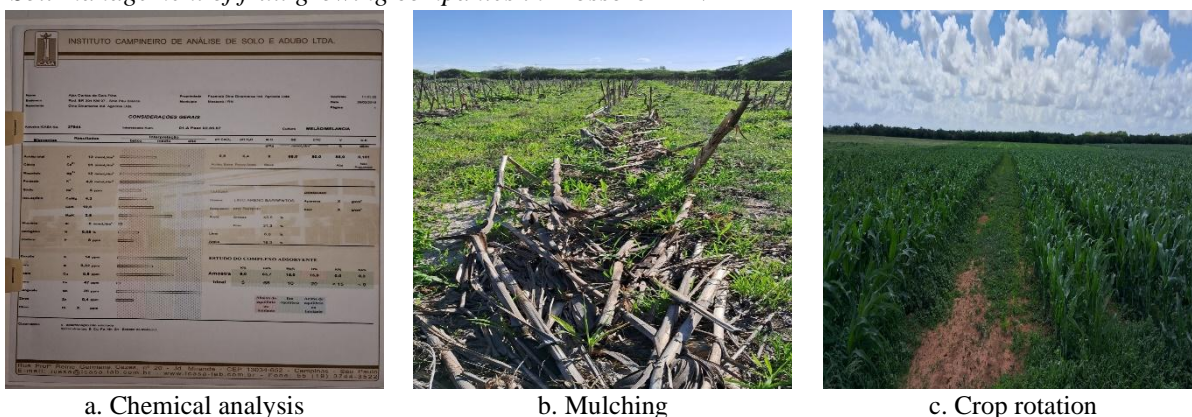


Source: own collection (2023)

Reinforcing the previously described scenario, Ribeiro, Lima, and Loiola (2023) highlight environmental management actions as they allow for added value to the product, enabling the meeting of the demands of an increasingly discerning consumer regarding the product's origin, characteristics, and environmental impact.

Regarding the practices adopted for soil management, there was a constant need for soil chemical analysis (Figure 7.a), especially regarding soil fertility and heavy metals. Actions aimed at improving soil structure were also observed, such as soil cover (Figure 7.b), which aims to protect the soil from high temperatures and prevent excessive soil moisture loss, and crop rotation (Figure 7.c), which is an agricultural conservation technique to reduce soil exhaustion by changing crops with each new planting so that the fertilizer requirements are different for each cycle.

Figure 7
Soil management of fruit growing companies in Mossoró - RN



Source: own collection (2023).

The numerous products of agribusiness are sensitive to various factors, where Martins, Bispo, and Nonnenberg (2023) highlight quality variables, a low level of chemical residues, and impacts on the health of consumers and collaborators. Thus, sustainable soil management becomes increasingly recurrent to ensure that foods comply with

legal requirements.

Finally, the environmental actions of the fruit farming companies in Mossoró-RN are related to meeting normative requirements, providing proactivity. This includes preventing environmental risks in the use of fossil fuels, such as installing small gasoline and diesel oil refueling stations (Figure 8.a); complying with environmental standards for fertilizer storage (Figure 8.b), following safety regulations such as enclosed space, impermeable floor, isolated, with ventilation and natural lighting, and organized according to risk prevention guidelines; and obtaining environmental certification (Figure 8.c) such as GLOBAL G.A.P., which is a certification program transforming consumer requirements into good agricultural practices.

Figure 8

Proactive environmental actions of the Fruit Growing companies of Mossoró - RN



Source: own collection (2023).

Certification allows understanding proactive production strategies. As such, Masochi, Camargo, Motta, and Silva (2022) emphasize that, like traceability, it is possible to record information from the origin to the destination of waste and products, enabling the determination of the environmental risk of the investigated sector.

Regarding environmental compliance, Oliveira, Volff, Bortoluzzi, Queiroz, and Seabra Junior (2019) praised certified producers for meeting environmental aspects, such as practices like regenerating Environmental Protection Areas, correct storage of inputs, and proper disposal of pesticide residues to specialized companies.

Similar results regarding environmental certification were determined by Martins, Bispo, and Nonnenberg (2023) when they identified that the criteria established by certifiers can be grouped into four pillars: environmental, social, management and ethics, and quality, varying their adoption according to the certifier. There are numerous Brazilian certifiers, but the main ones for fruit farming are Fairtrade, SMETA, Global G.A.P., Rainforest, and Organic.

Considering the discussion on environmental practices in the fruit farming sector in Mossoró-RN, a favorable context was identified for integrating environmental management tools aimed at prevention, control, and proactive environmental approaches.

4. Final Considerations

Over the years, the city of Mossoró-RN has been consolidating itself as a significant center for fruit production in Brazil, owing to the natural and socio-economic characteristics of the region. In this context, the fruit industry plays a leading role in generating employment, income, taxes, innovation, and the city's prominence, given that a portion of the production is for export. However, this sector also generates significant environmental aspects, especially concerning the consumption of water, energy, and inputs, as well as the generation of waste and effluents.

In this study, the focus is on the fruit companies in Mossoró-RN, characterized as medium and large in terms of size, number of employees, production, and invoicing, presenting a scenario of serving a diverse market with a focus on international markets. When analyzing the environmental legality of the surveyed companies, it is possible to observe that medium and large companies are the ones with more frequent environmental actions, notably in environmental licensing, solid waste and liquid effluent management, and environmental inspections.

The environmental practices of the surveyed rural properties are routinely implemented, as they are formally embedded in the company's policy. Thus, measures aimed at reducing water and energy consumption, storing inputs, soil management, environmental training, environmental risks, socio-environmental responsibility, and certification were observed.

In the course of the study, the viability of applying environmental management tools to the analyzed enterprises was also observed, with a focus on preventive, corrective, and proactive measures that can be organized at the entry and exit of the developed activities.

Thus, in the entry phase of product development, measures related to farm implementation are highlighted: compliance with applicable environmental legislation, especially for deforestation, and the use of recycled materials with a traceable origin in construction; water consumption: improving irrigation systems using technological equipment to determine the viable quantity for crops and using automated machinery for reuse; energy consumption: efficient lighting, low-consumption equipment, renewable energies, intelligent systems, and automated systems; raw material consumption: production processes with less material usage, use of recycled materials, correct storage of inputs, and material reuse.

In the final phase of product development, emphasis is placed on measures related to solid waste management: reduction, reuse, recycling, reuse, treatment, and proper disposal; liquid effluent management: treatment, reuse, and proper disposal; atmospheric emissions management: avoiding the use of burning in vegetation suppression; environmental management: environmental audits, environmental certification, environmental marketing, environmental risk, and environmental management system; social management: environmental training for employees, environmental perception of customers, and integration of the local community; economic management: consumer identity, sustainability disclosure, and eco-efficiency.

To that end, it is suggested for future research to conduct a case study in a fruit-producing company in Mossoró-RN to apply environmental management models, aiming to create viable models to meet the requirements necessary for

exportation.

Supplementary Information

Authors

Reinaldo Chotten – Universidade Federal Rural do Semi-Árido, Mossoró, Brasil.

reichotten@hotmail.com

<https://orcid.org/0000-0003-0086-7862>

Jorge Luís de Oliveira Pinto Filho – Universidade Federal Rural do Semi-Árido, Pau dos Ferros, Brasil.

jorge.filho@ufersa.edu.br

<https://orcid.org/0000-0002-2730-6929>

Note

Text from Reinaldo Chotten's Master's Dissertation under the guidance of Jorge Luís de Oliveira Pinto Filho in the Graduate Program in Environment, Technology, and Society – PPGATS at the Federal Rural University of the Semi-Arid – UFRSA.

Submission Date: 2024-01-16

Acceptance Date: 2025-03-19

Publication Date: 2025-06-30

References

Assumpção, L. F. J. (2015). *Sistema de gestão ambiental: Manual Prático para Implementação de SGA e Certificação ISO 14.001/2015* (5ª Ed.). Juruá.

Barbieri, J. C. (2023). *Gestão ambiental empresarial: conceitos, modelos e instrumentos*. (5ª Ed.). Saraiva Uni.

Brasil (2012). Ministério da Saúde. Conselho Nacional de Saúde. *Resolução Nº 466, de 12 de dezembro de 2012*. Trata de pesquisas em seres humanos e atualiza a resolução 196. Diário Oficial da União.

Brasil. (2016, 7 de abril). *Resolução nº 510, de 7 de abril de 2016*. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. Conselho Nacional de Saúde.

Braga, R. da R., & Matushima, E. R. (2021). Vale do Jaguaribe: um oásis em perigo no Semiárido Brasileiro – Revisão sistemática sobre contaminação ambiental e potenciais danos à bacia e seus usuários. *Revista de Geociências do Nordeste*, 7(2), 24-34. <https://doi.org/10.21680/2447-3359.2021v7n2ID24607>.

COEX - Comitê Executivo de Fruticultura do Rio Grande do Norte (2023). *Dados de associados*. <https://www.coexrn.com.br/coex>.

CONAB - Companhia Nacional de Abastecimento. (2023). *Boletim Hortifrutigranjeiro de 2023*, 9(12). <https://www.conab.gov.br/info-agro/hortifrutigranjeiros-prohort/boletim-hortigranjeiro>.

IBGE - Instituto Brasileiro de Geografia e Estatística. (2023). *Censo 2022*. IBGE.

Galli, L. C. L. A., Janones, A. M., Batalhão, A. C. S. & Galli, R. A. (2019). Responsabilidade social e aspectos ambientais em empresas familiares: um estudo multicase no agronegócio. *Revista de Negócios*, 23(4), 47-69. <http://dx.doi.org/10.7867/1980-4431.2018v23n4p47-69>.

Gil, A. C. (2019). *Métodos e técnicas de pesquisa social* (7ª Ed.) Atlas.

Julio, F. D., & Bueno, A. (2022). Índice de Vantagens Comparativas Reveladas do Abacate Brasileiro no Comércio Internacional. *Interface Tecnológica*, 19(2), 723-733. <https://doi.org/10.31510/infa.v19i2.1502>.

Loiola, M. V. C., & Santiago, A. (2021). Nível de Aderência aos Indicadores Ambientais (GRI) de uma empresa de fruticultura do Vale do São Francisco. *Revista Gestão e Sustentabilidade Ambiental*, 10(3) 197-218. <https://doi.org/10.19177/rgsa.v10e32021197-218>.

Marconi, M. A. & Lakatos, E. M. (2021). *Fundamentos da Metodologia Científica* (7ª Ed.). Atlas.

Martins, M. M. V., Bispo, S. Q. A. & Nonnenberg, M. J. B. (2023). *Normas Voluntárias de Sustentabilidade (NVS) e implicações sobre a exportações de produtos do agronegócio: frutas*. IPEA.

Masochi, P., Camargo, M. E., Motta, M. E. V., & Silva, M. B. (2022). Percepção dos atores da cadeia produtiva da maçã sobre a rastreabilidade e certificação. *Revista Ingi – Indicação Geográfica e Inovação*, 6(1), 1515-1532. <http://dx.doi.org/10.51722/Ingi.v6.i1.150>.

Medeiros, S. R. M., Lemos Filho, L. C. A., & Batista, R. O. (2023). Vulnerabilidade e percepção higiênico sanitária na perspectiva dos trabalhadores rurais em um polo de fruticultura irrigada no Rio Grande do Norte. *Revista Sociedade e Ambiente*, 4(2), 56-70. <https://revistasociedadeambiente.com/index.php/dt/article/view/89>.

Oliveira, R. (2014). Entre linhas de uma pesquisa: O Diário de Campo como dispositivo de informação na abordagem Autobiográfica. *Revista Brasileira de Educação de Jovens e Adultos*, 2(4), 69-87.

Oliveira, J., Volf, C., Bortoluzzi, L., Queiroz, T. & Seabra Junior, S. (2019). Análise socioeconômica, organizacional e ambiental comparativa entre propriedades de diferentes portes. *Revista de Engenharia e Tecnologia*, 11(1), 77-92. <https://revistas.uepg.br/index.php/ret/article/view/12660/209209210812>.

PMM (2023). *Dados oficiais 2022*. PMM - Prefeitura Municipal de Mossoró.

Ribeiro, S. R. P., Lima, F. A. X. & Loiola, M. I. B. (2023). O café sombreado da serra de Baturité, Ceará, Nordeste do Brasil: gestão ambiental, sustentabilidade e impactos eco-socioeconômicos. *Turismo, Visão e Ação*, 25(3), 482-504. <http://dx.doi.org/10.14210/rtva.v25n3.p482-504>.

Silva, R. A., Brito Filho, A. C., & Oliveira, A. B. B., Araújo, R. C. A. & Siqueira, E. S. (2021). Uma análise dos discursos sobre responsabilidade social dos stakeholders de uma organização produtora de melão no agropólio Assú/Mossoró. *Revista Colóquio: Administração e Ciência*, 1(3), <https://periodicos.apps.uern.br/index.php/CLQ/article/view/3891/3043>.