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Incorporating sustainability in the food supply chain: The development of a private standard of Nature Farming poultry production in Brazil

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ABSTRACT

This article aims to communicate sustainability dimensions and attributes for poultry production throughout a supply chain by developing a Nature Farming (NF) system standard. Poultry production is relevant for food security and job creation, an important economic activity and a significant export item in Brazil. The NF poultry production system was implemented in the 90s as a pioneering initiative, opening space for differentiated products. However, certification of NF poultry products has yet to be established and implemented to reach consumers. The NF products are identified as organic on labels, which does not distinguish the method's sustainability, and communication of specificities needs to be more efficient. We studied the process of establishing a private food standard with a sustainable approach, considering perceptions of the supply chain's agents. The method was a case study of a poultry company that applies NF system. The qualitative research involved interviews with 27 company managers, 23 poultry producers, seven farm assistance technicians, 11 auditors, and 12 commercial managers. The results showed innovation by introducing a Nature Farming poultry standard comprising product attributes and sustainability criteria in the dimensions: environmental, economic, and social in conjunction with two significant dimensions, which are ethical and health. Our findings indicated that Nature Farming is a specific style of agriculture that is diverse from other currents of alternative agriculture. We proposed expressions and claims about the system's quality attributes, aiming at the clarity of communication with consumers. We concluded that the developed standard might be the basis for certification of products. This work contributes to improving food supply chain management with differentiated and sustainable processes.

1. Introduction

Understanding the world's sustainability challenges and transforming agriculture practices is essential for consumers and producers. In this context, private governance through voluntary standards and certifications is a valuable tool (Henson & Humphrey, 2010). Voluntary sustainability standards, such as Rainforest Alliance, Forest Stewardship Council, and GlobalGAP, manage global supply chains' social and environmental impacts by accelerating sustainability-driven public policies (Lambin & Thorlakson, 2018; Rainforest Alliance, 2020).

The activity of poultry production is relevant for food security and job creation. However, it should address several challenges to achieve sustainability goals, such as environmental impacts and climate crisis, efficient use of nature's resources, human and animal health and well-being, and social inequalities (Mottet & Tempio, 2017). Regarding animal production, health issues such as antimicrobial resistance and foodborne diseases are worldwide concerns (Allcock et al., 2017; Graham et al., 2009; Price et al., 2005). The poultry industry may expand on sustainability by realizing which attributes consumers value and adopting signaling, especially regarding credence attributes, which are not objectively measured at purchasing (Ponte & Gibbon, 2005). Claims like "no use of genetically modified grains in diets", "raised without antibiotics", and "raised with animal welfare" appear on labels in the United States (Bowman et al., 2016; Centner, 2016), Australia (Parker et al., 2017; Parker et al., 2018) and Brazil (Demattê Filho et al., 2023) for instance. Private companies focus on product and service attributes

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to communicate these properties and levels to consumers. However, there is difficulty in communicating differentiated attributes, which are not always known or reliable. Informational asymmetry occurs when there is a lack of reliable verifications and certifications, exposing a market failure (Akerlof, 1970; Caswell & Mojduszka, 1996) because producers know more about poultry farming than consumers.

This article aims to communicate sustainable dimensions and attributes for poultry production throughout a supply chain by developing a Nature Farming (NF) system standard. NF principles, preconized by the Japanese thinker Mokichi Okada (1882–1955), applied to poultry production, consist of an original approach to sustainable agriculture. Using the case study method, we examined a poultry production chain in Brazil for its pioneer role due to the practice of NF poultry production without antibiotics, which started in the early 90s[1]. We focused on the process of writing an NF private standard, which is innovative, given the search for sustainability attributes for this supply chain. We studied the system's specific criteria and quality attributes of products in current practices.

The lack of technical standards and certification of poultry products raised in the NF system was a problem, and due to this gap, farmers have used organic agriculture standards as a reference even though they are NF practitioners. Their products are identified as organic in the market, but this fact does not distinguish the NF method. Communicating specificities to consumers needs to be more efficient (Dematteˆ Filho, 2014). According to Brazilian law, the organic system of agricultural and industrial production covers the styles: ecological, biodynamic, natural, regenerative, biological, agroecological, and permaculture (Brasil, 2003). Possibly, given that "organic system" is an umbrella term, it is difficult for some consumers to distinguish NF. In terms of scientific literature, recent papers about NF are scarce. This work addresses these gaps, and the authors expect it to promote the growth of the NF system and other sustainable agricultural productions.

Also, as far as our knowledge, few papers have reported on writing a private standard by collecting the opinions of supply chain agents. We aimed to analyze the process of developing a standard.

This article is organized as follows: Section 2 reviews the NF principles, dimensions, and attributes of sustainable supply chains as the literature that substantiates this study; Section 3 describes the research methodology; Section 4 discusses the results and development of the NF poultry standard, and Section 5 reflects building remarks and suggestions. The research questions we addressed and discussed in Section 4 were: 1) how can a private poultry standard based on NF principles be adequately developed? 2) what would be its acceptance by the supply chain's actors? 3) what requirements and procedures should it include?

2. Review on the Nature Farming system, dimensions, and attributes of sustainable supply chains

Initially, we report the history of currents of agriculture that emerged from the 1920s onwards, opposing chemical fertilization and focusing on biological processes, such as organic agriculture, biodynamic agriculture, and permaculture. Alternative agriculture consolidated from the 1970s onwards, concerned about environmental impacts and chemical residues in food opposing the so-called conventional or "classical" agriculture. Nature Farming is one of the currents that make up alternative agriculture (Ehlers, 1994).

Sir Albert Howard is considered the founder of organic farming, based on his research in India for over 25 years, where he developed the Indore composting process (Howard, 1943). In 1924, the Austrian philosopher and educator Rudolf Steiner gave a series of lectures that laid the foundations for biodynamic agriculture, exposing a new scientific and spiritual perspective that anthroposophical farmers expanded. The method explains that plants and animals are subject to cosmic influences, conceives of the farm as a living organism, is concerned with fertilization, and recommends biodynamic preparations to reactivate the vital forces of nature, among other concepts (Ehlers, 1994; Ponzio; Gangatharan, & Neri, 2013). Naturalist Bill Mollison and designer David Holmgren created Permaculture in Australia in the mid-1970s as an integrated system combining animal species and perennial plants that were helpful to humans. It became an international movement and an ecological design system (Ferguson & Lovell, 2014). In the 1970s, the term agroecology came into use, although its practice relates to the origins of agriculture. Agroecology incorporates an environmentally and socially sensitive approach to agriculture, which aims not only at production but also at the ecological sustainability of the production system (Hecht, 2018).

Private organizations built market regulation at the beginning of the alternative agriculture movement. Since 1928, manuals of biodynamic farming were adopted in Germany; Demeter was one of the first organic standards. Many contemporary organic standards feature conformity assessment by an independent certifying body, which is, in turn, accredited by an external authority (Fouilleux & Loconto, 2017; Squatrito et al., 2020). In the 1970s, the negative impacts of the Green Revolution became more visible, and the organic movement gained engagement from consumers in North America, Europe, and Japan. With distance from the origin and higher prices of products, the demand for standards grew to prevent fraud (Schwindenhammer, 2017), and the establishment of national legislation increased the international trade of organic products (Lockeretz, 2007).

In Japan, Mokichi Okada (1882–1955) advocated a method of agriculture in 1935 when he taught about foundations for attaining health. Okada produced extensive work about culture, arts, religion, and health. In 1950, the method's name was defined as "Nature Farming", and it was introduced in Brazil by Japanese adepts. To this day, researchers and producers conduct activities to expand the NF practice worldwide (Xu, 2001, 2006). The characteristics of NF are the recovery of soil quality, sound food production, and improvement of human health. It is essential to recover the "true nature" or the "natural state" of the soil; natural composts are used, and plowing is done minimally so as not to harm the organisms that inhabit it (Fundação Mokiti Okada, 1984).

Okada emphasized in Nature Farming: an agricultural system that aims to construct a healthy, peaceful, and prosperous society; it should conform to the laws of Nature; the role of a living soil; the spirituality that exists in all beings; and the fundamental mission of farmers to produce healthy food, among other concepts. What distinguishes the proposals of Nature Farming from those of organic and other alternative agriculture currents are its specific aspects (historical, geographical, ethical, cultural), philosophical concepts, and objectives. We propose a conceptual map for the NF system, interrelating the main concepts in a sustainable approach (Fig. 1). It summarizes some distinctive and ethical characteristics of the system.

Dimensions and attributes of sustainable supply chains

According to Kirwan et al. (2017a, 2017b), ethics is a key driver of change in food chain performance. The reflexive governance in which multiple stakeholders participate and share legitimate perspectives can potentially change the performance in the transition to sustainability within the food supply chains. They analyzed corporate sustainability discourses in 12 countries and identified common attributes that portray characteristics of performance arranged in a multi-criteria matrix. They found five dimensions of corporate sustainability across four spheres of action (public, scientific, market, and political), emphasizing the ethics that drive responsiveness to societal needs and concerns. Instead of including indicators in the evaluation model, they arrived at 24 common attributes that reflect performance in dimensions: **economic:**

[1] Years later, some big players in Brazilian agribusiness have also launched their organic or antibiotic-free chicken meat and egg brands, currently constituting a dynamic segment in food stores.

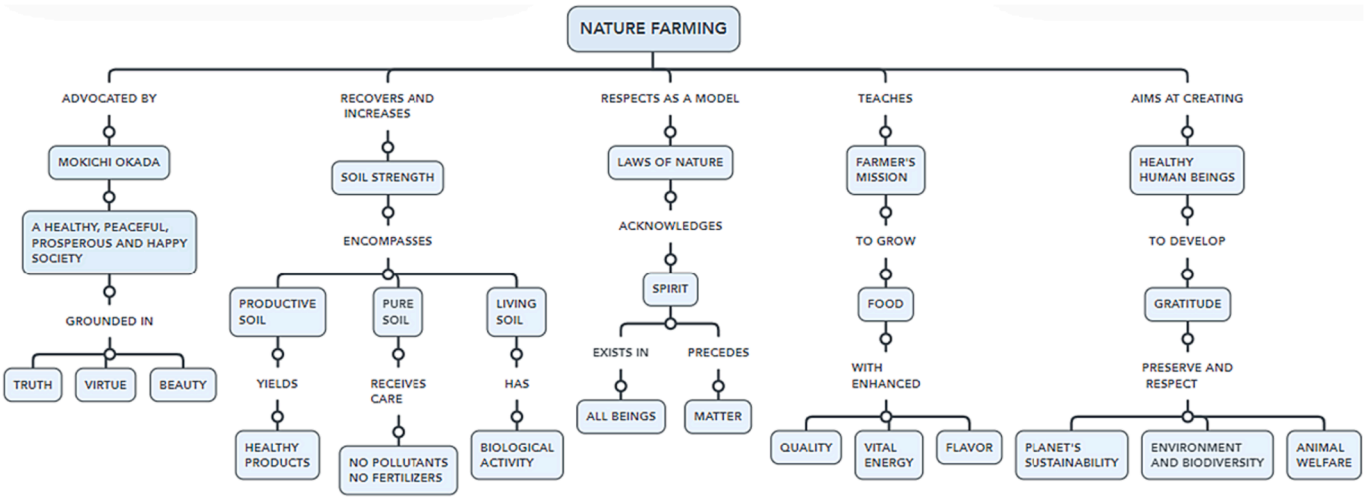

Fig. 1. Conceptual map proposed for Nature Farming. Source: Own author.

accessibility, creation and distribution of added value, contribution to economic development, technological innovation, governance, efficiency, profit/competitiveness, connection, resilience, food waste; **social:** information and communication, food safety, consumer behavior, territoriality, connection, labor relations; **environmental:** resource use, pollution, biodiversity, efficiency, technological innovation, food waste; **health:** nutrition, food safety, traceability; **ethical:** animal welfare, responsibility, labor relations, fair trade, territoriality, food security, governance. Those findings enable more detailed planning of operations.

Supply chain management (SCM) is the management of the interconnection of related organizations through upstream and downstream linkages between the processes that produce value for the ultimate consumer of products and services (Slack et al., 2007). Ahi and Searcy (2013) define a sustainable supply chain as "the creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems". These manage the material, information, and capital flows related to the procurement, production, and distribution of products or services to meet stakeholder requirements, and improve the organization's profitability, competitiveness, and resilience.

The concept of "sustainable development" rapidly propagated since the late 80s (Diazabakana et al., 2014). The Brundtland report introduced the concept as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). The pioneering "Our Common Future" report warned about two key concepts embedded in this definition: the needs, especially the essential ones of the poor population, and the limitations to the environment's ability to meet present and future needs imposed by technology and social organization. Elkington[2] (1997 *apud* Geissdoerfer et al., 2017) expanded the field of sustainability in 1994 by introducing the term "triple bottom line", known as the three pillars of sustainability, comprising people, profit, and environment. The role of businesses in driving a transition to sustainable capitalism became clear. Corporate Social Responsibility has expanded, and currently, the initiatives are reported by companies based on international standards such as the Global Reporting Initiative (GRI), demonstrating responsibility and transparency (Camilleri, 2015).

Diazabakana et al. (2014) reviewed sustainability indicators for agriculture, focusing mainly on the farm level because, at this scale, management decisions can be directly implemented to affect farm sustainability. Farms contribute to sustainable agriculture in economic, ecological, and social functions and may receive payment for externalities. Indicators are usually selected according to the sustainability pillars, and assessment deals with these dimensions divided into objectives, attributes, or themes. Environmental indicators are explored (e.g., greenhouse gas emissions, biodiversity, water quality, resource efficiency, and soil conservation), while economic indicators usually refer to a few themes such as profitability, productivity, autonomy, and resilience. Social indicators relate to the farm community (well-being and health) or the society (quality of life in rural areas). Recent literature on sustainability assessment of poultry production suggested tools using theories of Life Cycle Assessment (Rocchi et al., 2019) and Emergy synthesis (Nacimento et al., 2022).

The Sustainability Assessment of Food and Agriculture Systems (SAFA) is a system of indicators developed by FAO. SAFA comprehends a holistic global framework for assessing food and agriculture value chains, serving as a reference for small-scale producers to companies involved in producing, processing, distributing, and marketing goods. It unfolds four dimensions of sustainability (good governance, environmental integrity, economic resilience, and social well-being) in themes, sub-themes, and measurable indicators (FAO, 2014).

NGOs, governments, and companies have developed standards for animal welfare (Humane Farm Animal Care, 2022; RSPCA Assured, 2022; Souza and Molento, 2015) and fair trade (Fairtrade International, 2019). Private standards, certification, and accreditation schemes were established by entities such as the Sustainable Forestry Council (SFC), Marine Stewardship Council, Friend of the Sea, and Friend of the Earth, which comprise sustainable farming, extractive or aquaculture systems, filling a range of certifications with attributes of socio-environmental responsibility, ethics, and animal welfare, increasingly valued by consumers (Friend Of The Sea, 2016; Van Loo et al., 2014).

3. Methodology

3.1. Scope and region of study

From a global perspective, buyers and consumers have been concerned about the impacts of food production. Several studies explored animal production chains and consumer attitudes related to poultry products, considering ethics (including health and welfare), reproduction techniques, and loss of biodiversity (Schäfer, 2019); sustainability (Van Loo et al., 2014) and animal welfare (Bessei, 2018; Clark et al., 2016; Spain et al., 2018). The "sustainable living" style draws consumer attention to ethics, moral values, environmental and social issues, and a desire to positively impact communities and people (Sossidou, Dal

[2] ELKINGTON, J. Cannibals with Forks: The Triple Bottom Line of 21st Century. Capstone, Oxford, 1997.

Bosco, Elson, & Fontes, 2011; Yunes, Von Keyserlingk, & Hötzel, 2017; Euromonitor, 2021).

In Brazil, poultry production is a highly dynamic socio-economic segment. The country is the second-largest producer and the leading exporter of poultry meat, with revenues of US$ 9.762 billion in 2022 (Brazilian Association of Animal Protein – ABPA, 2023). Brazilian producers have searched for sustainable practices and poultry welfare improvements to fulfill customer expectations.

This research studied the case of the Korin Group, which leads sustainable food production chains based on Nature Farming in the Brazilian market of chicken and eggs produced without antibiotics, growth promoters, coccidiostats, and other chemical therapies. Korin is a focal company for 47 broiler and egg farmers in an integration system around Ipeúna, in São Paulo State (Fig. 2). The agents include agricultural input suppliers, smallholder farmers, processing industries, and marketers interconnected in a supply network (Fig. 3). The processes of nutrition, broiler rearing, and commercial egg production begin with planning and continue with the purchasing of chicks, pre-lay hens, grains, and feed additives. Those are followed by quality control of ingredients, feed manufacturing, broiler and layer rearing, poultry slaughter, and egg processing. Supporting processes such as research and development, technical assistance, quality management, regulatory affairs, and certifications complement the core operations. A Project Management Office integrates product portfolio management, making it possible to incorporate sustainable requirements during new product development (Paula Pinheiro et al., 2018). The Mokichi Okada Research Center (CPMO) in Ipeúna holds laboratories, experimental fields, and technical staff for research on sustainable agriculture, animal husbandry, and environment responding to farmer and industry needs.

This study extends others conducted about the same case of NF poultry production, which investigated its complexity by exploring the dimensions of multifunctionality of agriculture in the territory (Dematteê Filho, 2014), the capacity of value creation and appropriation by smallholder farmers (Dematteê Filho et al., 2023) and the assessment of the sustainability of the organic broiler production system under the Emergy analysis perspective (Nacimento et al., 2022). These previous research works also justify the choice of case.

3.2. Conceptual framework

The study adopted a qualitative research technique (Creswell, 2014). The method used was the case study, applied as a description of the organizational situation of a poultry supply chain, which incorporated a practical problem of developing a standard with the collaboration of different actors in the production chain. The data collection technique used semi-structured interviews and document analysis, such as production process flows, administrative reports, newspaper and magazine articles, and publications on the Internet.

The case study method is suitable for describing the situation of the context in which research was conducted and is made robust given the richness of the phenomenon and extent of the context, which makes it essential to use multiple sources of evidence with the data converging in triangulation. Five components are essential in the design: questions, propositions (if any), unit(s) of analysis, the link between data and propositions, and criteria for interpreting the findings (Yin, 2009; Creswell, 2014).

For the research planning, we used a methodological association matrix based on Mazzon (2018) to check whether the articulations were well-established, linking problem and objectives; theoretical support of propositions; operationalization of questions; and analysis techniques. The research conceptual framework (Fig. 4) proposes a basic model, where the construct "Nature Farming and alternative poultry production" revised in literature, is associated with the constructs "Governance of the poultry chain" and "Private and public standards" to proceed to the consequent construct "Private standard". Some potential data sources are company managers, integrated poultry producers, farm

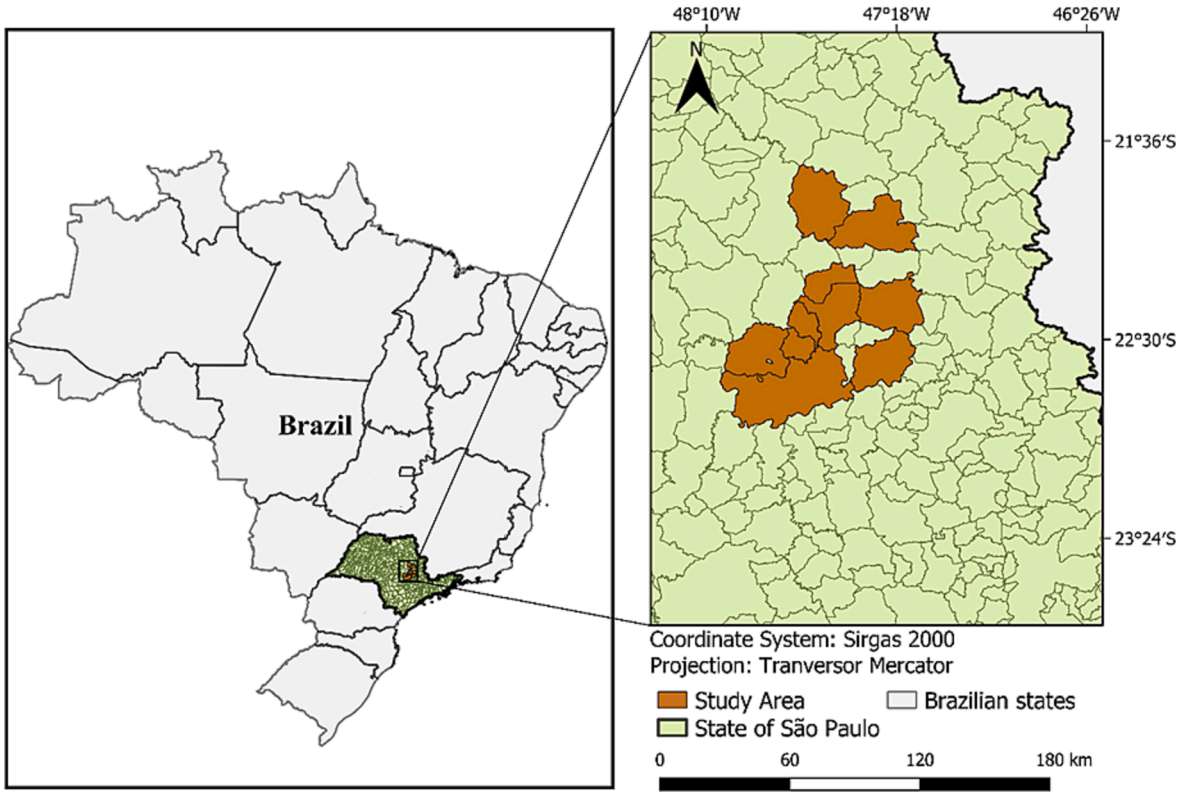

Fig. 2. Location of the study area in the region of Ipeúna, São Paulo State, Brazil. Source: INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2022. https://www.ibge.gov.br/geociencias/organizacao-do-territorio/malhas-territoriais/15774-malhas.html.

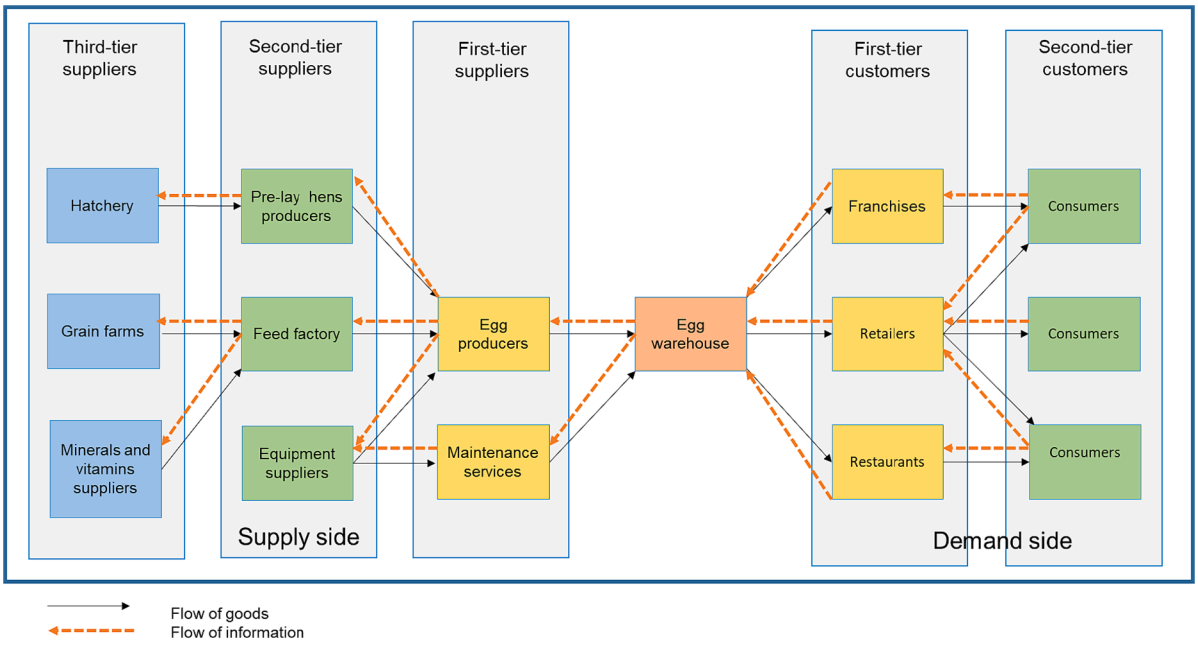

Fig. 3. Operations and supply network for Korin's egg processing plant. Source: Own author based on Slack et al. (2007).

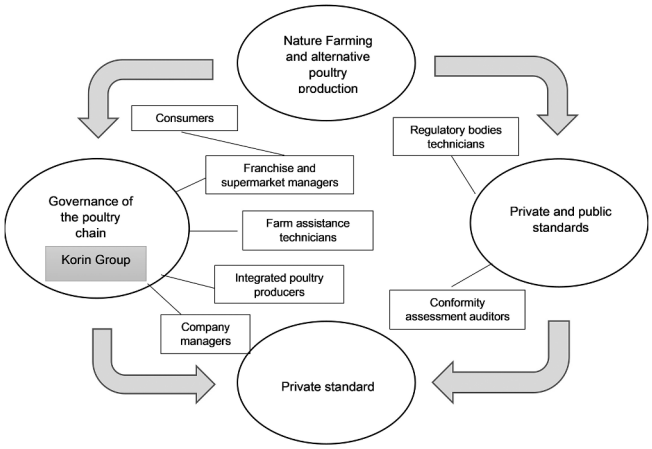

Fig. 4. Research conceptual framework. Legend: Ellipses represent constructs, and rectangles contain primary data sources. Source: Own author.

assistant technicians, franchise and supermarket managers, and consumers. The elements of this analysis were brought together based on the theoretical references to ensure that the objectives were achieved and that the project could answer the research question (Table 1). The matrix formulated seven propositions (P1 to P7) to test. It contains a summary of methods, techniques of analysis, and criteria for validating the expected results. In this regard, we used strategies (Creswell, 2014) with adaptations: triangulation of data with collection from multiple sources such as interviews, observations, and documents; and confirmation of results with participants through meetings with specialists.

3.3. Semi-structured interviews and analysis of content

A pre-test of questionnaires was applied to 30 participants to adjust and clarify questions. From November 2020 to March 2021, we interviewed 80 participants of the supply chain led by Korin, distributed into five groups: 27 company managers from research and development, business administration, and sales (34%); 23 integrated poultry producers of chickens and eggs (29%), 12 commercial managers of franchises, food stores, and supermarkets (15%); 11 managers/auditors of conformity assessment bodies (14%), and seven farm assistance technicians (8%). They answered specific semi-structured questionnaires proposed to each group (Appendix presents one type of questionnaire). Questions about product attributes and relevant requirements were formulated based on the dimensions of sustainability (Kirwan et al., 2017a, 2017b). During the field research, the company had 38 broiler and nine egg suppliers in the Ipeúna region of the State of São Paulo, Brazil (Fig. 2). We interviewed 23 poultry farmers in the municipalities of Ipeúna, Rio Claro, São Pedro, Corumbataí, Descalvado, Limeira, Piracicaba, Pirassununga, Charqueada, Araras, and Descalvado; the majority (21 producers) raised broilers and two supplied eggs. All the interviewees were experienced; the professionals had two or more years of work, and the sales managers had previous contact with the studied products.

Interview data were analyzed using the content analysis method (Bardin, 1977). Qualitative analysis involves reducing data by coding units of text, and subsequently categorizing them by thematic criteria (Sekaran & Bougie, 2016). This method allows finding a pattern in the data as a beginning for developing concepts, themes, and even an original theory (Saldaña, 2009). Data were processed with the support of the NVivo software (QSR International, 2021), which, among other features, allows importing data in text, images, and sounds; management of the sources of information; and code, finding categories and attributes, and thus classify themes automatically. The program associates the codes with the text fragments in the reported themes, reducing the time spent grouping responses. Generally, the process is complete when the researcher understands that there is no more to code in the data sources. NVivo is an example of computer-assisted qualitative data analysis software (CAQDAS), used to code a large volume of narratives. However, Yin (2009) emphasizes that it is up to the researchers to analyze the results and find meaningful patterns since the analytical strategy is theirs and not the tool's.

We used NVivo's functionalities in data preparation, coding and analyzing questionnaire responses, and preparing the results report. In the pre-analysis, the material collected was organized in computer spreadsheets. In exploring and treating the data, the NVivo program organized the qualitative analysis. The interview answers were imported and automatically coded by creating categories and subcategories. Subsequently, the codes were reformulated according to the questions

Table 1
Methodological association matrix of research on the development of a private poultry standard based on Nature Farming principles.

Research Model	Research Objectives	Propositions	Methods	Analysis Techniques	Results Validation Criteria
Governance of the poultry chain → Nature Farming and alternative poultry production	Characterize Korin's poultry production chain	P1: An NF-based poultry standard interferes with the coordination and efficiency of the chain	Case study Analysis of documents and production process flowcharts Interviews with questionnaires for groups CM, FAT, IPP	Content analysis	Identify characteristics of the chain Assess interference of standard and certification in chain governance Use different sources of data information Discussion with participants
	Characterize the criteria of the Nature Farming-based poultry production system	P2: The principles and values of Nature Farming cover and extend alternative and organic poultry farming on topics such as farmer's commitment, sustainability, antibiotic-free farming, animal welfare, environmental preservation, food quality and vital energy, eating habits, and consumer benefits	Literature review Case study Document analysis Interviews with questionnaires for groups CM, COM, CAB, FAT, IPP	Content analysis	Identify criteria for differentiated aspects such as farmers' mission, ethics, social responsibility, environmental restoration, soil care, use of adapted varieties, foods with high biological value, and consumer benefits Using different sources of data information Discussion with participants
	Develop a private poultry standard based on Nature Farming principles	P3: A private poultry standard based on Nature Farming can be adequately developed and implemented for an agribusiness	Literature and legislation review Case study Interviews with questionnaires for groups CM, COM, CAB, FAT, IPP	Content analysis	Elaborate text of the standard Validate text in discussion meetings Use different sources of data information

(*continued on next page*)

Table 1 (*continued*)

(conclusion)

Research Model	Research Objectives	Propositions	Methods	Analysis Techniques	Results Validation Criteria
		P4: A private standard would be well accepted by those involved in this production chain	Interviews with questionnaires for groups CM, COM, FAT, IPP	Content analysis	Assess perceptions and opinions of producers, assistance technicians, company managers, franchise and supermarket managers (and through them get answers about consumer perceptions) Use different sources of data information Discussion with participants
	Identify product quality attributes relevant to the company and consumers	Q5- There are characteristics of the quality of NF poultry products that would be recognized and valued	Interviews with questionnaires for groups CM, COM	Content analysis	Collect a list of relevant quality attributes Use different sources of data information Discussion with participants
Private standard draft	Propose expressions and claims about quality attributes for clear communication by phrases and a certification label	P6- There are expressions and claims about quality attributes that would be clearly communicated by phrases and a label	Interviews with questionnaires for groups CM, COM	Content analysis	Produce a list of phrases with quality claims and suggested seal for the products Use different sources of data information Discussion with participants
Private standard finalized	Base the NF standard on private standards literature	P7- NF practices can be summarized in an auditable standard format	Literature review	Content analysis	Discussion of text with professional experts Discussions with poultry producer and qualified auditor

Legend: NF - Nature Farming; P - proposition; groups of interviewees: CM - company managers, COM - commercial managers, CAB - conformity assessment body managers, FAT - farm assistance technicians, IPP - integrated poultry producers.
Source: Own author based on Mazzon (2018).

and propositions. Reports with word frequency analysis and a project map with categories and subcategories recorded the research.

A draft standard was written and discussed with specialists such as the company's production and quality managers. Also, one integrated poultry producer and one qualified auditor validated the text in discussion meetings. These experts suggested making the text clear, objective, and auditable. We analyzed their comments and wrote the final version.

4. Results and discussion

We developed an NF poultry production standard considering the agents' perspectives in the supply chain. Interview data were codified and systematized into themes in order to approach the research questions: "development of the standard", "acceptance of the standard", and "quality attributes and claims considered important" distributed in 12 categories and 36 subcategories described in Tables 2–4.

Table 2
Theme "Development of the NF Poultry Standard", categories and subcategories obtained from interviews with actors in the supply chain.

Categories	Subcategories	Meaning
1. Ensuring compliance with the standard	1.1. Role of the certifier	The certifier is important for compliance with the standard
	1.2. Certification of suppliers	Certification of suppliers is essential to ensure compliance
	1.3. Nature Farming seal is different from organic	As there are differences between these lines of agriculture, a certified NF seal should be differentiated
2. Defined processes	2.1. History of studies	Reported existence of studies to support a new standard
	2.2. Legislation and standards	Brazilian laws and standards serve as a reference for the new standard
	2.3. Objective and broad definition	The standard will make it possible to broaden NF for diverse audiences
3. Compliance with the requirements of the standard by producers	3.1. Farmers' commitment to Nature Farming principles	Producers already know about alternative poultry production and want to understand the new standard well
	3.2. Farmers' training and transition periods	The need for constant training and an adaptation period
	3.3. Working together with neighboring farms	should be considered in the implementation
		There are interactions with the neighbors' environment to discuss
4. Integrated supply chain	4.1. Relations with the integrator company	A good relationship with the company is a positive aspect of the implementation of the standard
	4.2. Preservation of the environment	Environmental preservation requirements must be addressed throughout the production chain, from the production of inputs to the distribution
	4.3. Valorization of the producers	The main point is to guarantee the valorization of the producers but with the challenge of not making the products too expensive

Table 3
Theme "Acceptance of the NF Poultry Standard", categories and subcategories obtained from interviews with actors in the supply chain.

Categories	Subcategories/Quote	Meaning
5. Benefits to the agribusiness chain	5.1. Benefits of standards for actors in the production chain *"a standard based on NF could guide the principles that differ from organic and other alternative standards. I think it would also help internalize the NF principles, both in producers and consumers"* (Manager of conformity assessment body).	Interviewees' perceptions as to the existence of advantages with the implementation of the standard
	5.2. Benefits of certifications	Certifications have caused positive impacts on poultry producers
	5.3. Improvements in the capacity building of producers	Producers perceived themselves as more qualified by knowing alternative poultry production standards
6. Importance of the alternative poultry standard and certification for consumers	6.1. Seal knowledge by consumers	A standard and certification would influence consumers' understanding of how poultry is produced
	6.2. Involvement of actors in the chain	Stakeholders' involvement would be significant for the implementation of the standard
	6.3. Perception of the brand by consumers	Consumers would probably have a good acceptance of the brand due to the standard
7. Coordination and efficiency of the chain	7.1. Based on Nature Farming *"[a standard is developed to have] association of the system with the company's mission, vision, and values. That is not found in the general protocols. The private standard gives identity to the production system"* (Manager of conformity assessment body).	The entire chain must comply with Nature Farming, from grain supply to product processing
	7.2. Logistical complexity of the chain	The complexity of the grain supply chain is a challenge to overcome
	7.3. Value generation	There is a perception that value will be generated through the supply chain until consumption

4.1. Development of a Nature Farming poultry standard

The results of the qualitative analysis are in Table 2. The column "Categories" presents the interviewees' main concerns about the standard to be developed. "Subcategories" brings a closer look, and "Meaning" expands each topic as premises to develop the standard.

Discussing producers' commitment, they were confident in their capacity to meet the requirements, and with training, their skills and satisfaction would increase. Some affirmed that they had already practiced NF, learned in training sessions led by Korin, and the company's technicians effectively transmitted knowledge. Some reported improved quality of life; the remuneration was a positive differential compared to other integrators. Some farmers used pesticides on pasture or crops and understood the need for a sustainable transition; they suggested involving neighbors who used herbicides on sugar cane. According to interviewees, a transition period must be established to ensure the successful implementation of the standard.

The interviewees considered the formation of an NF grain supply chain fundamental and complex, involving processes such as 1) supply of inputs (seeds, machinery, implements, organic composts, biofertilizers); 2) distribution of inputs to properties; 3) organization of the production, storage, and transportation of NF grains (soy, corn, sorghum, and wheat); and 4) processing of poultry feed. The lead company should ensure technical and economic incentives for farmers. Research and technical assistance should reach farmers for soil life conservation, plant management, composting techniques, and biological inputs as alternatives to agrochemicals. It was understood that Korin should pay the costs of audits and certification. These findings agree with the work of Schäfer (2019). Managing processes and agents is the function of a sustainable SCM, which can face challenges in implementing ecological and ethical production and maintaining the necessary cooperation along the value chain to the consumer (Ahi and Searcy, 2013).

In this value chain, forms of hierarchical governance were identified since it is an integration in poultry breeding, in addition to relational governance, with a high capacity of suppliers, trained and certified in animal welfare and antibiotic-free systems. This chain is characterized by high informational and transactional complexity. However, there is the ability to codify information/transactions, and, in this particular, the organic and welfare standards adopted by the leading company fulfill this role (Gereffi et al., 2005; Ponte & Gibbon, 2005). However, a new

Nature Farming standard would broaden the system for diverse audiences.

4.2. Acceptance of a Nature Farming poultry standard

The second theme extracted to answer a research question was "acceptance of the NF standard". In Table 3, "Categories" lists the main factors of interviewee acceptance, "Subcategories" explores those factors in more detail, and "Meaning" expands on each factor. Acceptance of the standard will be significant, and there will be benefits by extending and standardizing knowledge to grain producers, poultry farmers, processors, and traders. There will be improvements in coordination, process efficiency, quality management, and shared value creation. A certification and seal will serve as proof of the system's suitability.

Fuchs et al. (2011) argue that the global governance of agri-food chains contributed to some improvements in food quality and safety, and even in environmental conditions, but with potential social problems, such as the marginalization of small farmers in developing countries. Mechanisms of participation, transparency, and accountability would legitimize governance through private standards that affect multiple actors and localities. Our results corroborate these findings. Some respondents suggested that the developed standard could allow actors' participation in implementation and monitoring.

Interviewee suggested that transaction costs may decrease through the commitment of the supply chain agents and better communication about requirements and procedures. However, difficulties should be overcome with mechanisms of integration, process standardization and control, lot segregation, traceability, and communication, especially in the logistic chain for the supply of feed ingredients. On the other hand, all these steps may represent some value chain opportunities leading to a differentiated product, as occurred in the adoption of Voluntary Sustainability Standards reported by Piao et al., 2019.

One farmer declared that the NF standard would be an innovation. Once implemented, it may help the company to remain competitive. Innovative companies usually face difficulties when exploring new markets, especially because of the lack of legislation and clear definitions. Third-party Certification (TPC) was recommended by some respondents to avoid unethical situations, as Bowman et al. (2016) pointed out. TPC is an important regulatory mechanism in the global agri-food system, representing a change in the scenario from public to private governance (Hatanaka et al., 2005). Due to the regulatory power of supermarket chains in food safety and quality, prospects for sustainable, socially and environmentally sound practices have increased.

Busch and Bingen (2006) defend that the role of standards extends beyond the technical character, given their influence in ethics, economics, politics, and society. They allow the creation of complex socio-technical networks (Busch, 2011). Our findings agree with this vision because an NF supply chain has been built by Korin, in aspects beyond the strictly technical framework. Governments, processors, and retailers set and enforce standards to communicate attributes to ensure consumer confidence about food quality and safety with consequent value addition. The standards contribute to product differentiation, brand and market niche strengthening, chain coordination, and competitive advantage (Fulponi, 2006; Marques Vieira, 2006). Private standards often serve as the basis for quality certifications, intending to confirm compliance with requirements and the veracity of supplier claims, through third-party evaluation. A standards system supported by certification is a trend as a value chain coordination mechanism in the context of changes occurring in regulatory controls and new demands by consumers. Private standards can be intertwined with laws and public norms because the interests go beyond the firm and reach a collective dimension (Thankappan & Marsden, 2006).

4.3. Attributes of the Nature Farming supply chain

This study found attributes (Table 4) that reinforce the scheme of sustainability dimensions and attributes proposed by Kirwan et al. (2017a, 2017b). It was evidenced that sustainability was incorporated into Korin's strategies and business, contemplating the environmental, social, and economic pillars, in addition to ethical and philosophical dimensions related to corporate values.

Respondents suggested environmental practices such as using vegetal compost for the soil; no use of synthetic fertilizers, animal waste, or chemical pesticides; efficient use of resources; no pollution; and avoidance of environmental degradation and destruction of ecosystems and wildlife. The NF poultry standard should provide advances in environmental management for farms.

An ethical dimension was revealed, from production to commercialization. Some respondents expressed opinions about ethical and

Table 4
Theme "Quality Attributes and Important Claims in the NF Poultry Standard", categories and subcategories obtained from interviews with actors in the supply chain.

Categories	Subcategories/Quotes	Meaning
8. Environmental	8.1. Copy Nature	Nature is the model for Nature Farming practitioners
	8.2. Understanding and preserving Nature	Practitioners seek to understand and respect Nature
	8.3. Respect the rhythm of Nature and the local environment	The dynamism of Nature and features of the place should be respected
9. Ethical	9.1. Based on the philosophy of Nature Farming *"The great differential of poultry products based on NF, in the sphere of ethics, lies in the feeling of gratitude that is worked out with all those involved in the production chain (…) in addition to the respect and care for people, animals and nature"* (Conformity assessment body manager).	The philosophy is reflected in the ethics of relationships
	9.2. Following the philosophy of consumers *"The traceability of the whole process needs to provide standards and obligations aligned with ethics; otherwise, it makes no sense. The target consumers tend to be more demanding about ethics because they will consume values that will be promised (…)"* (Company manager).	Consumption must contemplate the philosophical principles of the buyers
	9.3. Animal welfare	It is fundamental as the basis of productive processes that involve farm animals such as poultry
10. Health	10.1. Health benefits for the population and producers	The health of consumers and producers is an imperative requirement in food production
	10.2. Food safety	Production must guarantee food safety at all stages of the production chain
	10.3. Food with vital energy	The vital energy of food appears as a differential in poultry production
11. Economic	11.1. Affordable prices	Food should reach consumers at more affordable prices, a challenge to overcome
	11.2. Regional production	Regional and local production should be valued and prioritized
	11.3. Standard should not make the product more expensive	The production and distribution stages need to be adequate so as not to raise the cost of the products
12. Social	12.1. Fair remuneration and relationships for workers	Fairness in transactions and relations with workers must be preserved
	12.2. Family farming	Agriculture practiced by small producers must be encouraged
	12.3. Quality of life in the countryside	The quality of life in the countryside must be improved

responsible production chains, fair relationships with producers and suppliers, appreciation of higher values and good relationships, and benefiting customers and consumers. Respect and consideration for animals are central points in the NF system. Some producers expressed esteem and gratitude for the birds, confirming that the interaction between humans and animals is positive and desirable, resulting in attentive and responsible care. These findings corroborate the work of Demattê Filho et al. (2023). They argue that a philosophical and ethical dimension is observed throughout the production chain beyond the technical-productive and environmental requirements.

There is the perception that consumers value: birds' access to the outdoor area, controlled housing density, natural day-night rhythm, environmental enrichment, and humane slaughter. These results agree with De Jonge and Van Trijp (2013). One interviewee suggested graduated requirements to facilitate alternative poultry products to gain market share. De Jonge et al. (2015) assumed that segmentation with intermediate levels of welfare (neither minimal nor organic) and price encourages the migration of consumers who start choosing alternative products to replace conventional ones, demonstrating a choice effect of the middle way and not the extremes of attributes.

Expressions such as "physical/mental/spiritual health" and "farmers' happiness", revealed the expectation of guaranteeing the health of producers and consumers by growing and consuming safe food with vital energy. Values focused on ecology, human well-being, and spirituality appeared, corroborating the work of Hughner et al. (2007) with consumers of organic products, which identified values such as altruism and ecology (associated with health attributes), universalism, benevolence, spirituality, and self-direction.

Commercial managers of franchise stores, supermarkets, and other sales channels responded about theirs and consumers' perceptions of the NF poultry standard. Consumers would be interested in products with an NF seal and certification.

Economic issues appeared, such as the expectation of a larger scale for the production chain, the need for adequate distribution and certification to avoid increasing product cost, and the generation of wealth in a productive system. The company should provide commercialization channels with better conditions of proximity and accessible prices. Korin already fosters food-buying groups, and this approach with consumers represents an innovation when creating/recreating sustainable businesses (Korin, 2021). These concerns conduct to the alternative food networks studied since the 1990s. They connect producers and consumers directly, using a different logic from that of the dominant market of chains led by supermarkets. There is growth in sales of local, regional, fair trade, organic, and specialized products through channels such as farmers' markets, cooperatives, and groups of Community Supported Agriculture, constituting short supply chains that allow sales by producers with smaller scale (Maye & Kirwan, 2010).

As for social attributes, respondents mentioned that there should be compliance with labor laws and dignified treatment, training and job creation, and social projects for farmers and technical support teams. The valorization of local production by small farmers may add value to regionally produced food, associated with territorial, cultural and social values, and geographical indication or denomination of origin, perceived by consumers as a quality product (Tregear et al., 1998). Notably, there is evidence of an NF poultry production territory due to Korin's work over several years (Demattê Filho, 2014).

Since this research identified attributes of NF poultry products that

Table 5
Poultry product quality characteristics based on Nature Farming principles.

Attributes valued	Expressions and claims suggested	Phrases allowed on labels and advertisement materials
Healthy production, without any pesticides or harmful drugs	Nature is the model for Nature Farming practitioners	Poultry products from Nature Farming
Differentiated quality and poultry breeding with animal welfare certification, without the use of antibiotics and transgenic ingredients	The health and safety of consumers and producers are requirements of vital energy food production	Feed for birds raised in the Nature Farming system
Socio-environmental responsibility	The philosophy of Nature Farming is based on sustainable production and fair, ethical relationships	Eggs produced in the Nature Farming system
Quality of life for producers and consumers	Nature Farming supports small regional producers and quality of life in the countryside	Food with poultry meat/eggs produced in the Nature Farming system

Table 6
Characteristics of Korin's Antibiotic-free poultry production compared to Nature Farming poultry standard.

Item	Requirements and indicators	
	Korin's Antibiotic-free poultry production[a]	Nature Farming poultry standard
Socioenvironmental responsibility	Not formalized	Farms must protect soil; provide nutritive plants in external areas for birds; ensure good management of waste
Ethics	Not formalized	Involved personnel must engage in ethical and good practices in business, favoring regional and local production, community development, family agriculture, employees' welfare, and access to clients and consumers
Origin of grains	GMO-free or organic grains	100 % grains from audited Nature Farming suppliers
Training	Provided by Korin's technicians	Suppliers must engage and train personnel in operations
Origin of birds	100 % birds from evaluated and approved hatcheries (1 day-old chicks) or laying rearing units (minimum of 40 days before the start of laying)	
Diet production	100 % feed mills are audited; GMO grains are prohibited; animal ingredients such as meat, bone, blood, and feather meals are prohibited	
Feed transport to poultry houses	Must prove traceability	
Raw materials and feed additives	Suppliers are audited and must provide proof of traceability	
Poultry raising	100 % of production units are audited and adopt animal welfare and sanitary control procedures; cages are prohibited; access to an external area is allowed	
Catching and transportation of birds	Procedures following animal welfare criteria	
Slaughter of birds	100 % of slaughterhouses are audited, adopt animal welfare procedures, and demonstrate traceability	
Collection of samples of feed, chicken meat, and eggs	Periodic analysis of antimicrobial residues	
Antimicrobials and coccidiostats (anti-protozoal agents) are prohibited	There is a list of banned substances – all prohibited	
Conformity assessment	Audit program	

Source: based on communication from Korin's production department [a]. It applies requirements of Antibiotic-free production standards issued by the Brazilian Association of Alternative Poultry Production (ASSOCIAÇÃO BRASILEIRA DA AVICULTURA ALTERNATIVA – AVAL, 2018a; ASSOCIAÇÃO BRASILEIRA DA AVICULTURA ALTERNATIVA – AVAL, 2018b).

are recognized and valued, we suggest expressions and claims to communicate them, as well as some phrases for possible use in labels and advertisements (Table 5).

Claims on labels involving credence attributes are a complex matter and there are risks for companies, which mitigate them by demonstrating clarity and transparency in information with the support of standards and verifications. The NF poultry standard will probably improve the clarity of information for consumers, favoring the purchase decision. Similarly, in the case of short food supply chains, this type of clear communication embedded in products, printed on the packaging or reaching consumers in retail market, may enable connections with the values of the people and the production methods involved, allowing potential differentiation from commodities (Marsden et al., 2000).

Records of certification and traceability may prove product quality in transactions between supply chain agents (Passuello et al., 2015). Private standards can clarify attributes such as food safety, environmental protection, ethical trade, animal welfare, and organic production. Sustainability, food safety, and guarantee of origin verified by an independent certifier can affect the consumers' purchase decisions (Cunha et al., 2011).

Based on the development process of the NF standard, we point out some features, especially in the areas of socioenvironmental responsibility, ethics, origin of grains, and training. Other characteristics equal the Korin's actual antibiotic-free poultry production. Table 6 summarizes these requirements.

5. Conclusions

This article aims to communicate sustainability dimensions and attributes for poultry production by developing a private standard of the Nature Farming system. This research identified attributes of NF poultry products that are recognized and valued by supply chain agents. We suggested expressions and claims to communicate attributes. We found that acceptance of the standard will be significant, and there will be benefits by extending knowledge to grain producers, poultry farmers, processors, and traders. There will be improvements in coordination, process efficiency, quality management, and shared value creation. However, we expect that adaptations will occur in implementing the standard, relying on broad discussion with farmers and other actors. The production system was described so processes and products can be objectively identified by their differentials, respecting socio-environmental responsibility, health, and ethics, and communicating specificities to consumers. Specific requirements regarding animal welfare, the origin of animals, and diet were established. Our findings extend the sustainability attributes studied by Kirwan et al. (2017a, 2017b) by adding: respect for human well-being, spirituality, personal relationships, family farming, and farmers' happiness.

There is little academic literature about Nature Farming. Xu (2001, 2006) addressed it regarding history, principles, and perspectives. This paper advances by reporting research on NF applied in a poultry system. Based on a case study, it reflects the perceptions of actors in the supply chain. The method allowed for an in-depth investigation of the production processes and incorporation of elements into the NF poultry standard. There was complementarity to compiling a body of theoretical and empirical knowledge. Our findings indicated that Nature Farming is a specific style of agriculture that is diverse from other currents of alternative agriculture.

We unraveled the phase of the establishment of the NF standard. We suggest that further functions such as adoption, implementation, conformity assessment, and enforcement (Henson & Humphrey, 2010) of the standard system be analyzed in future studies. The research presented a limitation because grain suppliers, processors, and consumers were not interviewed, and it is recommended that they be included in future studies. We suggest that the process of writing a private standard be replicated in differentiated agri-food chains such as milk or meat production.

The NF poultry production standard resulted in an innovative SCM tool due to the sustainability embedded in the NF production system. The governance states that: (1) Korin acts in the establishment of the standard, adoption, implementation, and technical assistance; (2) qualified auditors perform the conformity assessment; and (3) food inspection agencies verify compliance with legislation on quality, food safety, and labeling. The standard provides for a future certification process and a distinctive seal. However, an accreditation body is not mandatory. The authors expect that the expansion of the NF poultry system will be improved.

This paper contributes by studying a supply chain of Nature Farming poultry production in Brazil and the development of a private standard. The results contribute to sustainable development in agriculture and food supply chain management. The authors expect the findings will inspire insights for entrepreneurs, farmers, researchers, and students working in practical and academic areas.

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Appendix. Overview of Questionnaire for the Group of Company Managers

a. How important is a voluntary poultry standard based on Nature Farming?
b. If Korin implemented an NF poultry standard, would there be benefits for the agents of the agri-food chain (grain producers, poultry producers, processors, or traders)?
c. Would this standard improve the coordination and efficiency of the agri-food chain?
d. What quality attributes or requirements (e.g., differentials, claims, expressions) would be relevant for NF poultry products in the spheres: economic, social, environmental, health, ethical, or other?
e. How to ensure that the actors (grain producers, poultry farmers, feed mills, slaughterhouses, processors, marketers) in the agri-industrial chain meet the requirements of this standard and certification (e.g., procedures such as internal audit, audit by a buyer company, audit by an independent certifier, contracting, training, technical assistance, or others)?

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