AGRIBUSINESS, DEVELOPMENT AND THE 2030 AGENDA

INTERDISCIPLINARY CONTRIBUTIONS

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List of figures

List of boxes

List of tables

List of Abbreviations and Acronyms

ABMRA - Brazilian Association of Rural and Agribusiness Marketing
ACS - Community Health Agents
A.F - Family Farmer
AFN - Alternative Food Networks
ANA - National Water Agency
APS - Primary Health Care
ARS - Social Network Analysis
ASA - Systemic Approach to Agribusiness
BCG - Boston Consulting Group
BNCC - National Common Curricular Base
CADE - Administrative Council for Economic Defense
CAF - Family Farming Register
CAPES - Coordination for the Improvement of Higher Education Personnel
CCI - International Scientific Congress
CE - Ceará

CEPP - Research Ethics Committee
CETESB - State Company for Environmental Sanitation Technology and Defense
CIMI - Indigenous Missionary Council
CNPq - National Council for Scientific and Technological Development
CONAMA - National Environment Council
CONSEA - National Food Security Council
DAP - DAP
DBO - Biochemical Oxygen Demand
DCNTs - Non-Communicable Chronic Diseases
DF - Federal District
DQO - Chemical Oxygen Demand
EAN - Food and Nutrition Education
ECP - Purchasing Processing Company
EMATER - Technical Assistance and Rural Extension Company
EMBRAPA - Brazilian Agricultural Research Corporation
ENAPEGS - National Meeting of Researchers in Social Management
FAAC - Faculty of Architecture Arts Communication and Design
FAO - United Nations Food and Agriculture Organization
FCE - Faculty of Sciences and Engineering
FETAG - Federation of Agricultural Workers in Rio Grande do Sul
FIDA - International Fund for Agricultural Development
FLV - Fruits, Vegetables, and Greens
FNDE - National Fund for Educational Development
FUNAI - National Indian Foundation
GDWQ - Guidelines for Drinking Water Quality
GEDGS - Study Group on Democracy and Social Management GO - Goiás
GP - People Management
GPS - Global Positioning System (GPS)
GPKamby - Kamby Research Group
IA - Artificial Intelligence
IBGE - Brazilian Institute of Geography and Statistics
IoT - Internet of Things
IPA - Food Loss Index
IPEA - Institute of Applied Economic Research

ISSL - Lipp's Adult Stress Symptom Inventory
LP - Research Line
MEC - Ministry of Education
MID - Integrated Disease Management
MIP - Integrated Pest Management
MS - Mato Grosso do Sul
MT - Mato Grosso
NRDC - Natural Resources Defense Council
OC - Collective Organization
OD - Dissolved Oxygen
ODS - Sustainable Development Goals
OMS - World Health Organization
ONGs - Non-Governmental Organizations
ONU - United Nations
OPAS - Pan American Health Organization
PA - Pará
PAA - Food Acquisition Program
PANC - Non-Conventional Food Plants
PDA - Food Loss and Waste
PGAD - Agribusiness and Development Graduate Program
PGEA - Research in Management and Environmental Education
pH - Hydrogen Potential
PIB - Gross Domestic Product
PIBIC - Institutional Program of Scientific Initiation Scholarships
PMVA - Green Blue Municipality Program
PNAE - National School Feeding Program
PNEA - National Environmental Education Policy
POAs - Advanced Oxidation Processes
PRONAF - National Program for Strengthening Family Agriculture
PRoNEA - National Environmental Education Program
RA - Augmented Reality
REAP - High Paulista Environmental Education Network
RedeCT - International Network of Researchers on Indigenous Peoples and Traditional Communities
RS - Rio Grande do Sul

SAN - Food and Nutritional Security
SFSC - Short Food Supply Chains
SGA - Environmental Management System
SISAN - National System of Food and Nutritional Security
SP - São Paulo
SUS - Unified Health System
TBA - Take-Back Agreement
TD - Digital Transformation
TDIC - Digital Information and Communication Technologies
THE - Times Higher Education
TO - Tocantins
UFNT - Federal University of Northern Tocantins
UFRR - Federal University of Roraima
UFT - Federal University of Tocantins
UNAMA - University of the Amazon
UNEMAT - State University of Mato Grosso
UNESCO - United Nations Educational, Scientific and Cultural Organization
UNESP - São Paulo State University
UNFPA - United Nations Population Fund
UNICEF - United Nations Children's Fund
UNIR - Federal University of Rondônia
UNU - United Nations University
WHO - World Health Organization
WFP - World Food Programme

Contents

Preface

To whom the book is directed:

The book I have the pleasure of prefacing represents the consolidation of the efforts of the group of Professors and Researchers from the Graduate Program in Agribusiness and Development (PGAD) of the São Paulo State University at the Tupã Campus. The reader should not be mistaken in thinking this is an occult work aimed only at the academic audience. As I read the material, I understood its usefulness for defining public policies focused on agriculture, agribusiness, and regional development and formulating private strategies, whether for rural producers and agribusinesses or collective entities like cooperatives and producer associations. Additionally, I believe that the chapters that make up the book can attract the public's interest in contemporary issues involving the environment, social organization, and governance of complex organizations.

For professionals dedicated to academia like myself, the work demonstrates the vigor of a group of researchers who succeeded in establishing a postgraduate program focused on Agribusiness and

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Development, embracing the challenge of interdisciplinarity. It follows that this work is also a celebration of the qualification of researchers from UNESP in Tupã, who dedicated themselves for a decade to training masters and doctors with a defined focus of skills. The results obtained reflect the broad relationship maintained with research groups in Brazil and abroad and the dedication to themes applied to agribusiness and development. For those who know the challenges of research in Brazil and the work of research groups and universities abroad, the message remains of the competence of Brazilian scientific achievement, which on the one hand has challenges to overcome, on the other demonstrates that there are possibilities to be explored by researchers dedicated to academic work.

Aspects to Highlight in the Work:

I believe five elements deserve to be highlighted in the work, directly or indirectly.

The first element is the use of the concept of agribusiness according to its original, scientific conception, untainted by ideological values. When Professor Ray Goldberg, together with John H. Davis, published the book "A Concept of Agribusiness" in 1957 at Harvard University, they embraced a systemic view they called Agro-Industrial Systems, coining the term "agribusiness," then a neologism. The term was and still is used to study phenomena occurring in Agro-Industrial Systems regardless of the type of rural producer, whether large, small, family organization, or investor corporation. Reflecting on the book, it is clear the authors, and the graduate program itself, are concerned with the fragility of agriculture as part of a value-generating system. This concern magnifies the importance of the UNESP program, and the results composing the work reflect an integrated concern between society, the environment, and governance, focusing on small-scale production, which is an integral part of agribusiness, a fact often overlooked by many.

I highlight the courage of the UNESP research group, which was not intimidated by the undue erosion of the concept of agribusiness, incorrectly associated only with large-scale, corporate, and capital-

intensive activity without concern for social and environmental aspects. Such a stereotype does not align with the original scientific concept of the term. This characteristic alone would value the work, but it goes beyond it.

The second element I highlight is the research program's concern with humanistic and social aspects, emphasizing medium and small-scale agriculture. The themes addressed in the first section, chapters 1 to 4, illuminate the social theme through topics such as: people management, satisfaction of rural workers dedicated to production, organizational culture and climate, governance, and sustainability on rural properties. The concern with the governance-society-environment triad is emphasized in the second part of the work, in chapters 5 to 11, which present the results of studies conducted by the program's researchers. I emphasize that in this second part, besides conceptual aspects, the studies are concerned with incorporating the impacts of digital technologies and technological infrastructure. It should be recognized that an element present in the studies is nourished from the core, that is, the central element of the concept of "agribusiness": the shared responsibility for achieving strategies such as environmental goals, involving all links in the production chains, including the responsible consumer. Agriculture, therefore, is not an isolated sector but organically connected to other sectors that make up the Agro-Industrial Systems.

The third element I highlight is the alignment of the PGAD proposal reflected in the book's content with the primary characteristic of UNESP, which was born with the sense of organizing research-teaching and extension considering the territory of the State of São Paulo. The applied studies, components of the work, are based on global trends and apply to regional problems where the research was conducted. The concern with local problems amplifies the importance of the obtained results, as the problems and themes are repeated in other agricultural production areas, and the results can be used in other areas. A good example is the concern with water management.

The fourth element I highlight contrasts with the previous one; it deals with the concern with global problems and challenges, in this case related to the 2030 agenda. The interesting counterpoint of the local

focus with a global vision reflected in the sustainable development goals to which Brazil is committed appears clearly in the themes addressed by the studies. I highlight some elements reflecting the concern with the millennium goals: Clean Water and Sanitation, Decent Work, Sustainable Economic Growth, Industry, Innovation, and Infrastructure, Responsible Consumption and Production. The graduate program in Agribusiness and Development, by considering the concerns defined in the 2030 agenda, demonstrates that regionality can and should be aligned with the broad global movements characterizing the 21st century.

To conclude, I elaborate on the fifth element of highlight characterizing the work in question: interdisciplinarity. I preferred to leave this dimension as the concluding element of this preface because I consider it the most relevant and difficult to implement. When most graduate programs in different disciplines excel in unidisciplinary advancement, UNESP's Agribusiness and Development Program refocuses, challenges the academic environment, and proposes a project that seeks to explore interfaces and build connections between the hermetic bodies of scientific knowledge. Such an attitude is courageous and aligns with the thinking of important academic figures who advocate for an interdisciplinary approach. I affirm it is courageous because the evaluation structures of graduate programs have long privileged and induced hyper-specialization. Scientific journals, for the most part, do not accept submissions of articles not aligned with the specialized elements of a particular field of knowledge. By reading the work and understanding the graduate program proposal, it is worth praising the institutions that supported its implementation over a decade, considering that the program explicitly states its intention for an interdisciplinary approach.

The interdisciplinary proposal has the endorsement of thinkers like Edgar Morin, who defines it as the only means to tackle the complex problems faced by contemporary society. The same author argues that excessive specialization can lead to a fragmented view of reality and elaborates on how different fields of knowledge can be connected to allow problem comprehension. According to Morin[1], multidisciplinarity allows

[1] Edgar Morin. O Método: conhecimento do conhecimento. Editora Sulina, 2008, 286 p.

overcoming the limitations imposed by knowledge segmentation, crucial for facing contemporary complex challenges.

In conclusion, I consider that the present text represents not only the celebration of a decade of a graduate program, which certainly required a critical look from the authors at the work carried out since its implementation but also a sincere exposure of the researchers involved to society, which will have access to content generally circumscribed to restricted groups of readers connected to academic journals. I am certain that the next decade will still be a period of harvesting results, and I wish the researchers involved to maintain their focus on tackling the highly complex problems on the horizon.

I congratulate the Faculty and Students of PGAD and wish the readers to make use of the rich material made available here.

Decio ZYLBERSZTAJN

Presentation

The Graduate Program in Agribusiness and Development (PGAD) was created in Brazil in 2014 and belongs to the "Agrarian and Environmental Sciences" Thematic Chamber of the Interdisciplinary Area of the Coordination for the Improvement of Higher Education Personnel (CAPES). PGAD is based at the Faculty of Science and Engineering at Unesp, Campus of Tupã, and offers both Master's and Doctoral academic courses.

Currently, PGAD comprises 21 permanent faculty members, one collaborating faculty member, and two international collaborating faculty members, one from Italy and the other from the United States. The multidisciplinary nature of the faculty's education and activities (exact sciences, humanities, and biological sciences) and the diversity of the students' and graduates' backgrounds support the interdisciplinary dialogue in teaching, research, and extension of the Program.

Interdisciplinarity implies a "process of interrelation of processes, knowledge, and practices that overflow and transcend the field of research and teaching concerning strictly scientific disciplines and their possible

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articulations" (LEFF, 2011, p. 311), being necessary for the analyses of agribusiness, seeking a broad vision for investigating responses to complex themes and solving multidimensional problems.

In this sense, the mission of PGAD is to promote the qualification of people guided by ethical and humanistic principles through interdisciplinary research in agribusiness, contributing to sustainable development.

The structure of PGAD presents a concentration area in "Agribusiness and Development" and comprises two lines of research: Competitiveness of Agro-industrial Systems (CSA), which aims to develop analyses that promote agro-industrial systems from the perspective of productivity and economic, managerial, social, and environmental efficiency, contributing to the improvement of competitiveness and sustainable economic development of productive systems, organizations, and institutions; and Development and Environment (DMB), which aims to contribute to economic, social, environmental, and institutional development from the perspective of the sustainability paradigm, innovating methodologically in the production of interdisciplinary knowledge to support decision-making by public and private managers.

Through different theoretical and methodological approaches, the research developed at PGAD permeates the complexity of agribusiness and development within an interdisciplinary approach. The dynamics of the courses promote the problematization, renewal, and transformation of knowledge through different areas of knowledge. These experiences transcend disciplinary boundaries and are developed by researchers (faculty and students) through discussions in research groups, the development of research projects, participation in scientific events, and collectively constructed intellectual productions.

Thus, the vision of PGAD is to be a reference in the formation of people and interdisciplinary research in agribusiness and its contribution to sustainable development. The principles of the Program are based on excellence, ethical conduct, commitment to society, and the scientific nature of knowledge.

In 2024, PGAD celebrates 10 years of operation, during which more than 150 graduates, including masters and doctors, have been trained. The

objectives and mission of the Program, as well as the defended dissertations and theses and the projects developed by PGAD researchers in national and international scientific and technological cooperation, are strongly aligned with the Institutional Development Plan (PDI) of Unesp, the priority technological areas of the Ministry of Science, Technology, and Innovations (MCTI), and the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda.

The results of a recent survey conducted with the Program's faculty show that, in general, SDGs 12 – Responsible Consumption and Production, 2 – Zero Hunger and Sustainable Agriculture, and 8 – Decent Work and Economic Growth were the most associated with the themes of the defended dissertations and theses at PGAD. Following these were SDGs 9 – Industry, Innovation, and Infrastructure; SDGs 4 – Quality Education; and SDGs 6 – Clean Water and Sanitation.

In this decade-long trajectory, the academic maturity of the faculty is marked by great dynamism in seeking to train people committed to societal problems and generating interdisciplinary research capable of impacting sustainable development in agribusiness.

Finally, it is important to highlight the regional impact of PGAD, as it is the only public postgraduate program in Agribusiness and Development in the state of São Paulo and plays a relevant role in training people, especially for the Alta Paulista region, contributing to regional and national development from a sustainable perspective.

It is in the context of the consolidation and strengthening of PGAD that this work was elaborated to bring together research results developed by the program's faculty and students, giving visibility to the works and initiatives carried out in recent years. The guiding thread of this work was delineated into three major parts, each containing a set of chapters addressing themes that converge on common issues.

The first thematic block is composed of the initial four chapters and seeks to represent the three most important pillars in the current economic development debate: social, environmental, and governance actions. In the context of this work, the first pillar – social – is represented by chapters addressing aspects of work and people management in agribusiness, dealing

with issues such as job satisfaction, organizational culture, and climate in rural properties and enterprises. The aspects related to the second pillar are directly linked to the social, as it is in the environment that people carry out their professional and daily activities. Seeking environmental sustainability tied to social development is fundamental for balancing people's needs with environmental assets, and in this sense, chapters addressing water issues and environmental preservation are presented, generating significant debates, especially in the context of agricultural production. There is also a third pillar in this dynamic, represented by governance actions in organizations. Decisions and strategies increasingly demand transparency, professionalization, and compliance, and in this sense, the first part of this work concludes with a chapter on governance actions aligned with sustainable practices in agribusiness.

The second part of this collection comprises a block of six chapters (Chapters 5, 6, 7, 8, 9, 10, and 11) presenting theoretical and practical results from studies on problems derived from the intersection of factors associated with the three pillars represented in the first part of this work: social, environmental, and governance. This block emphasizes the relationship between technological infrastructure and digital transformation with new forms of diversification in agricultural production and means of marketing and consumption. Its effects reach all links in the production chain, from increased productivity to the emergence of innovative forms of marketing and responsible consumption, all fundamental for achieving sustainability. It is in this part of the work that the roles of the main actors directly involved in the dynamics of agri-food production chains are highlighted, including producers, agribusinesses, input suppliers, service providers, and final consumers.

The pursuit of sustainability extends through all links in the production chains in agri-food systems and depends on the development of new technological resources and the proposition of innovative practices, usually associated with market agents, as presented in the second part. Thus, the third and final part of this work brings together a block containing the last five chapters, addressing the role of other actors adjacent to the chains but essential for this dynamic: the Government and Academia. The responsibility for proposing new technologies and innovations that provide sustainability to agri-food systems should not rest solely on the

market. In the national scenario, the public sector and universities are extremely relevant in ensuring this dynamic, whether through institutions like Embrapa, rural extension bodies, research institutes, or laboratories located in the country's main universities.

Regarding the public sector, the third part contains two chapters that discuss government programs for rural development, such as marketing assistance and school feeding. The academic responsibility is represented here by three other chapters showcasing initiatives from the Graduate Program in Agribusiness and Development at the College of Science and Engineering, UNESP/Tupã. Thus, the last part of this work consolidates the guiding thread that establishes relationships with the other axes – the fundamental pillars and economic agents, not neglecting the role of the Government and the University, which must act synergistically for rural development tied to the SDGs, either by providing scientific evidence for public policy formulation or through the relevance of public funding for the research developed.

With this collaborative portfolio of theoretical and practical research, this work takes shape and will continue the journey of promoting the dissemination of accessible and high-quality scientific knowledge, valuing the joint efforts of all those involved in PGAD, whether faculty or students. With much gratitude, we welcome the important reflections presented here, resulting from studies converging from different scientific domains to contribute interdisciplinarily to the evolution of Brazilian agribusiness.

Enjoy the reading.

Ana Elisa LOURENZANI
Sandra Cristina de OLIVEIRA
Wagner Luiz LOURENZANI
and Fábio Mosso MOREIRA

Part I

Chapter 1

Financial stress and job satisfaction: an analysis among family farmers in the municipality of Araçatuba (SP)

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Introduction

Financial issues exert a high influence on people's lives, with money considered a source of stress for 66% of people (APA, 2022). In Brazil, in 2021, 52% of people were stressed about expenses and financial commitments (FSB, 2021). Certain activities, due to their peculiarities, present greater financial instability, such as family farming.

Brazilian family farming faces several challenges, such as heterogeneity within the category itself, income inequality, capitalization, production systems, and the variation in property sizes (Batalha; Souza Filho, 2013; Aquino *et al.*, 2018; Preiss *et al.*, 2020; Pereira, 2021). These factors, coupled with climatic fluctuations, low qualifications of farmers, an uncertain political and economic scenario, and variations in production costs, make the sector unstable.

According to Heo, Lee, and Park (2020), family farming has peculiar market characteristics that can generate financial insecurity. This instability places farmers in a unique and often precarious financial situation (Sprung, 2021). It is important to note that these long-term financial difficulties can cause financial stress. This stress characteristic represents a bodily response involving physical, psychological, and biological aspects to the perception of imbalance, uncertainties, and risks in managing personal and family financial resources, as well as debts (Heo; Cho; Lee, 2020).

Life satisfaction, especially work satisfaction among family farmers, can be affected by financial stress (Heo; Lee; Park, 2020). For Besser and Mann (2015), financial issues, property size, type, and form of production influence satisfaction with agricultural work. Additionally, financial stress is one of the main reasons for abandoning work in the field (Waldman *et al.*, 2021).

Although family farming in Brazil is significant and financial stress causes various problems, there are no national studies on the influence of financial stressors on the stress level of family farmers and whether these affect their level of satisfaction. The study by Roy and Tremblay (2015)

conducted in Canada highlights that workload has been considered a source of stress, especially when farm demands confront the roles of parent and spouse. According to the authors, there is a high-stress factor when the farmer faces the need for provision and the conception of being financially responsible for the family.

Given these aspects, this chapter aims to analyze a list of financial stressors and their influence on the stress level and job satisfaction of family farmers in the municipality of Araçatuba, in the state of São Paulo. Specifically, it aims to compare financial behaviors and perceptions between family farmers with and without stress.

The results presented in this chapter contribute scientifically, economically, and socially by focusing on the financial stress of family farmers. Firstly, financial stress is an interdisciplinary theme that encompasses various fields of knowledge (psychology, physiology, sociology, neuroscience, among others). Understanding the impacts of financial stressors on the stress level and satisfaction of family farmers contributes scientifically to the development of health protocols for stress management and educational programs that foster a financial culture. It contributes socially by analyzing a high-impact phenomenon that is little studied in a relevant economic population but presents vulnerabilities in various aspects. Knowledge and management of financial stress can provide a better quality of life, reflecting in the productivity of family farmers, contributing to their socioeconomic development and their permanence in the field.

Such premises align with the Sustainable Development Goals (SDGs) of the United Nations (UN, 2015). Specifically, SDG 2 – Zero Hunger and Sustainable Agriculture; SDG 3 – Health and Well-being; and SDG 8 – Decent Work and Economic Growth.

Family farming

In Brazil, family farming is the agricultural activity developed on small rural properties, demarcated by up to four fiscal modules, predominantly

with family labor, and the activity carried out on the property must be the family's main source of income (Brasil, 2021).

Family farming, in some regions, is the sector with the greatest potential for social and economic vulnerability (Preiss *et al.*, 2020), as its members are mostly older people, with low educational levels, difficulties in accessing health services, as well as technical assistance and bank loans; factors that place family farming at a relative disadvantage compared to large producers.

Family farming includes 3,897,408 agricultural establishments, with an average area of 21 hectares. However, 26.6% of the establishments have an area of one to five hectares (IBGE, 2019). The predominant economic activity in family farming establishments is livestock and other animal breeding (48.82%), followed by temporary crops (32.60%), and permanent crops (11.09%), among others of lesser expressiveness (IBGE, 2019).

Family farmers have socioeconomic characteristics that distinguish them from other categories. Regarding the educational level, 18.06% declared not knowing how to read and write, 66.85% have primary education, 12.39% have secondary education, and only 2.70% have higher education (IBGE, 2019). The educational level impacts the productivity of the property, as Lindoso *et al.* (2010) state that schooling provides independence to the farmer in seeking information available in various media, which can equip them for decision-making. Clune and Downey (2022) add that the lack of entrepreneurial skills of family farmers results from broader cultural factors, affecting their ability to make assertive decisions.

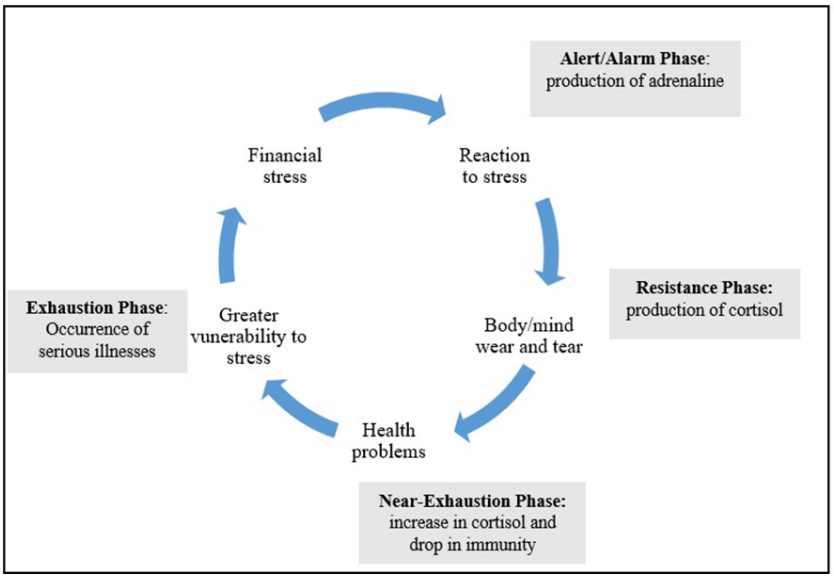
Stress in farmers and financial stressors

In several countries, agriculture has been considered one of the activities triggering high levels of stress, depression, and suicide (enning-Smith *et al.*, 2020; Keeney; Hernandez; Meng, 2020; Kolstrup *et al.*, 2013; Yazd; Wheeler; Zuo, 2019).

Agriculture is affected by several external factors beyond the farmers' control, such as climatic changes, economy, crop pests, livestock diseases, high production costs, and fluctuations in product sale prices, among others, generating uncertainties for the farmer and increasing the risk of stress and mental illnesses (Heo; Lee; Park, 2020; Yazd; Wheeler; Zuo, 2019). Additionally, in many cases, there are debts, long working hours, loneliness, and stress. The farmer must deal with many factors that are beyond their control (Finnigan, 2019).

Stress is an interdisciplinary concept understood as an evaluative process that triggers psychophysiological responses aimed at adapting a person to situations perceived as stressful. When stressors are evaluated as exceeding the individual's capacity to deal with them, or when exposure is repeated or long (Figure 1), it can harm physical and psychological health (APA, 2014; Lazarus; Folkman, 1987; Lipp; Lipp, 2020; McEwen; Wingfield, 2003; Pereira, 2023).

Figure 1 – Stress Cycle



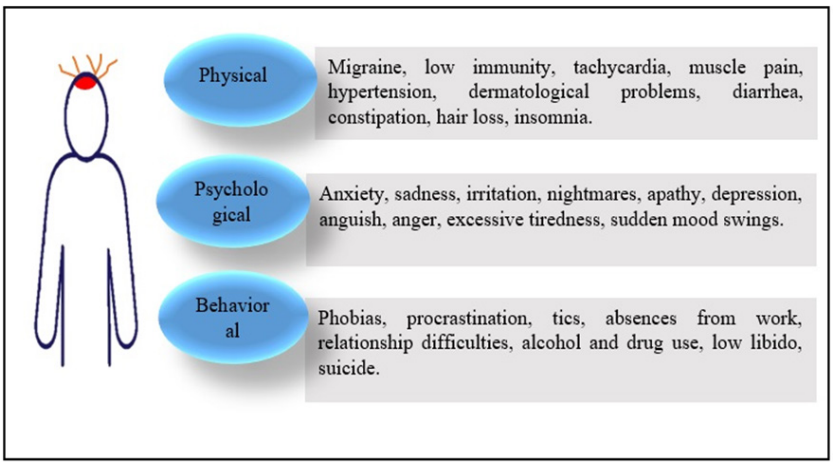
Source: Prepared by the authors, based on Lipp (2005).

Stressors are environmental situations or chronic stimulus conditions that are evaluated as threatening to physical or psychological well-being (Calvo; Gutiérrez-Garcia, 2016). Stressors can be evaluated as irrelevant when they do not threaten the individual; positive, when they generate motivation in the person; or stressful, when they cause harm to the individual (Alhurani *et al.*, 2018).

Financial stress arises when, repeatedly, the individual or family cannot meet financial obligations, which can result in physical, mental, and behavioral symptoms (Friedline; Chen; Morrow, 2021). Figure 2 summarizes the main symptoms of stress. The financial stressor involves the decrease or loss of income, assets, unemployment (Park; Kim, 2018), housing insecurity, and debts (Kelley *et al.*, 2023), among other factors.

Studies conducted in countries such as the United States, Australia, France, Finland, Denmark, and India, among others, highlight financial factors as one of the main stressors in family farming activities (Furey et al., 2016; Besseler; Stallones, 2020; Olowogbon et al., 2018; Rudolphi; Berg; Parsaik, 2020; Sprung, 2021; Hagen *et al.*, 2021; Keeney; Hernandez; Meng, 2020; Waldman *et al.*, 2021).

Figure 2 – Symptoms of Stress



Source: Prepared by the authors, based on: APA (2014); Bryant, Garnham (2014), and Lipp (2005).

Issues related to farmers' finances, including debts, difficulties in obtaining credit, increased production costs, and fluctuations in product sale prices, have been cited in research as having a high potential to trigger stress in farmers. Small farmers cannot exert full control over financial decisions and property management (Heo; Lee; Park, 2020), as the activity is subject to various climatic and macroeconomic contingencies, such as droughts and water scarcity (Fennel *et al.*, 2016), which in turn cause increased production costs and decreased harvest quantities (Henning-Smith *et al.*, 2020).

Job satisfaction[4] is the affective perception (positive or negative) that a person has regarding aspects of their work. It is a multifaceted phenomenon resulting from the interaction between the individual expectations of the worker and the working conditions (Hansen; Straete, 2020; Maidabadi *et al.*, 2022). The financial situation is a relevant condition that influences job satisfaction, as the level of satisfaction is an equation between what is desired and valued and what is obtained from work (Locke, 1976). Hansen and Straete (2020) state that if economic compensation aligns with desired goals, workers will be satisfied. Although job satisfaction involves various aspects, this research focuses solely on the financial factor of job satisfaction among family farmers.

The impacts of financial stressors

The data used in this chapter were collected in the municipality of Araçatuba, located in the northwest region of the state of São Paulo (SP). This is an excerpt from a dissertation that aimed to analyze the levels of stress and stressors among family farmers. The municipality was chosen because it is the largest in the geographical region and due to the economic importance, that agriculture holds in the municipality. Araçatuba is a municipality with approximately two hundred thousand inhabitants (IBGE, 2022) and has

[4] It is important to distinguish between job satisfaction and life satisfaction. The former relates to satisfaction with the content, tasks, income, and benefits provided by the job. The latter refers to other aspects of life, with work being only one of them (Besser; Mann, 2015; Herrera; Gerster-Bentaya; Knierim, 2018).

776 establishments that qualify as family farming (IBGE, 2019). Of this total, 286 establishments are owned by the farmers themselves.

To measure the level of stress, the Lipp Adult Stress Symptom Inventory (ISSL) was used. This inventory was developed in Portuguese by Lipp and validated by Lipp and Guevara (1994). The inventory consists of three sections corresponding to the phases of stress and allows for determining which phase of stress the person is in alert, resistance, near exhaustion, and exhaustion. It also allows for identifying the prevalence of symptoms, whether physical or psychological. The evaluation is done using standardized tables for this instrument, which convert raw data into percentages. According to the inventory manual, the ISSL has a Cronbach's alpha of 0.91 for the overall scale.

To identify and measure financial stressors, a questionnaire was developed based on a literature review of peer-reviewed articles in the Scopus, Web of Science, and PubMed databases. The questionnaire was validated by professionals associated with family farming (agronomists from the municipal agriculture department and presidents of rural associations) and psychologists.

The questionnaire contained the main financial stressors identified in the literature review, such as irregular and/or uncertain monthly income; difficulties in obtaining financing; debts with agricultural and other loans; increased production costs; and fluctuations in product sale prices. The questionnaire was developed using a five-point Likert scale, where farmers were asked to indicate: (0) does not cause stress; (1) very little stress; (2) little stress; (3) moderate stress; and (4) a lot of stress.

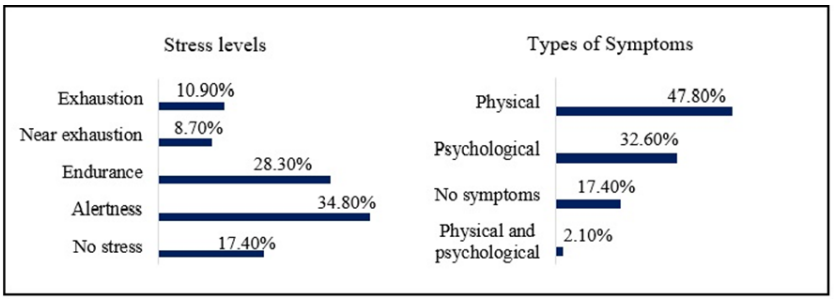
The sample consisted of 46 participants (n=46), contacted through the presidents of rural associations in the municipality. Of these, 57% were male and 43% were female. Among the participants, 30% were aged 61 to 70 years, 26% were 41 to 50 years, and 20% were 31 to 40 years. The average age was 53.23 years with a standard deviation (SD) of 12.60. Regarding marital status, 76% were married, 9% single, 9% widowed, and 7% selected the "other" option. Most of the samples, 59%, identified as white, 22% as brown, 11%

as black, and 9% as yellow. Regarding educational level, 57% had primary education, 26% had secondary education, and 17% had higher education.

Regarding property size, 54% of respondents owned properties of 10 to 20 hectares, with predominant activities being cattle breeding and the cultivation of vegetables, fruits, and soybeans. The family income from agricultural activity was up to one minimum wage for 9% of respondents, one to two minimum wages for 35%, two to three minimum wages for 15%, three to five minimum wages for 22%, and above five minimum wages for 19%.

The sample analyzed in the municipality of Araçatuba-SP showed considerable levels of stress (Figure 3), with 34.8% in the alert/alarm phase (first phase of stress) and 28.3% in the resistance phase (second phase). Although most of the sample showed stress in the two initial phases, both are accompanied by physical and psychological symptoms that can compromise the quality of life of family farmers. Almost 20% are in the higher phases of stress, which denotes greater attention. According to Lipp (2005), up to the near-exhaustion phase, the person can manage the symptoms, but in the exhaustion phase, the help of doctors and psychologists is necessary. Physical symptoms (47.8%) predominated in the analyzed sample.

Figure 3 – Levels of stress and symptomatology of the sample



Source: Prepared by the authors (2024).

The stress levels of family farmers in the municipality of Araçatuba-SP are like those found in the United States by Rudolphi, Berg, and Parsaik

(2020), which obtained the following stress levels: no stress (29.4%), mild (35.9%), moderate (18.2%), and high (16.5%). Other studies conducted in countries such as Ireland (Furey *et al.*, 2016), Finland (Kallioniemi *et al.*, 2016), the United States (Kearney *et al.*, 2014; Keeney; Hernandez; Meng, 2020; Sprung, 2021; Waldman *et al.*, 2021), Australia (Wheeler; Zuo; Loch, 2018), and France (Truchot; Andela, 2018), found moderate stress in most of the analyzed samples. High-stress levels were found in studies conducted in Australia (Gunn *et al.*, 2022), Canada (Jones-Bitton *et al.*, 2019; Hagen *et al.*, 2021), and Vietnam (Hoang *et al.*, 2020).

The identification and measurement questionnaire for stressors revealed the financial stressors that most caused stress among family farmers, as shown in Box 1.

Box 1 – Descriptive Statistics of Financial Stressors

Code	Financial Stressor	Average
F1	Irregular and/or uncertain monthly income	3.6
F2	Difficulties in obtaining agricultural and other financing	2.4
F3	Debts with agricultural and other financing	1.3
F4	Increased production costs or fluctuation in product sale prices	3.8

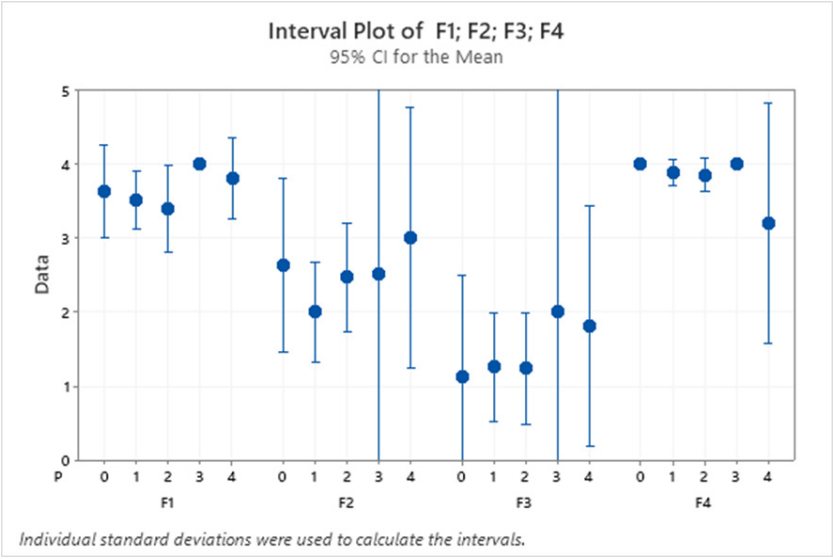
Source: Prepared by the authors (2024).

Two stressors demonstrated greater concerns among the analyzed farmers, with higher averages. Figure 4 shows the dispersion of responses relative to the average. This analysis allows for a comprehensive visualization of the overall behavior of the interview conducted. In Figure 4, a certain response pattern for F1 and F4 can be observed, which resulted in a high average for both stressors.

Of the four financial stressors evaluated by family farmers, the one with the greatest impact was the fluctuation in production costs and product sale prices (3.8), with a maximum score of 4. These factors impact the farm's financial results (Jahangiri *et al.*, 2020; Kearney; Hernandez; Meng, 2020; Wheeler, Zuo; Loch, 2018). To produce, whether, in crops or livestock, the farmer must make investments at a high cost, but without the guarantee of

how much the product will be worth at the time of sale, as prices are regulated by the market (demand and supply). The result found in Araçatuba is like the research conducted by Liang *et al.* (2021) in the United States, which pointed out the decline in sale prices as a stress-generating factor.

Figure 4 – Dispersion of responses relative to the average



Source: Prepared by the authors (2024).

This reflects the second financial stressor, irregular or uncertain monthly income (3.6). Income irregularity is caused by production seasonality, livestock diseases, pests, and market-regulated prices, among others. The unpredictability of monthly income compromises the property's budget and consequently the family's budget. This causes 26% to delay bill payments and 10.8% to seek work off the property to supplement their income. According to Logstein (2016), the decrease in agricultural income directly impacts the increase in mental complaints. Furthermore, the higher the proportion of agricultural income in the total family income, the greater the stress caused by the income drop.

Difficulties in obtaining agricultural financing (2.4) were the third financial stressor. Among the respondents, 48% reported having some type of agricultural financing, and 78% reported finding it difficult to obtain it. Financing, mainly through the National Program for the Strengthening of Family Agriculture (Pronaf), is a way to generate cash flow for investments. However, farmers face a lot of bureaucracy, extensive documentation, and the requirement of collateral to obtain financing. Farmers with smaller properties, low income, and no assets face more difficulties in obtaining agricultural credit. This difficulty in obtaining financing causes a lot of distress among farmers (Pankey; Bandyopadhyay, 2019).

Debts with financing (1.3) proved to be a low-impact stressor for the analyzed farmers. Among the respondents, 50% declared having some type of debt. Farmers with debts have higher stress levels and lower job satisfaction (Heo; Zuo; Park, 2022; Waldman *et al*., 2021), in addition to triggering disagreements between spouses (Friedline; Chen; Morrow, 2021).

All the financial stressors mentioned above directly impact the final income of family farmers. Among the various factors that predispose to stress, income is considered a factor that generates considerable levels of stress (Orpana; Lemyre; Gravel, 2009).

Anova considering income/stress and subsequent Tukey test revealed a significant difference (Box 2) between the class of stressed and non-stressed farmers.

Box 2 – Income versus stress using the Tukey method and 95% confidence

Has Stress?	N	Average	Grouping
No	8	3.875*	A
Yes	38	2.158*	B

Source: Prepared by the authors (2024). *Indicates a significant difference between the observed values.

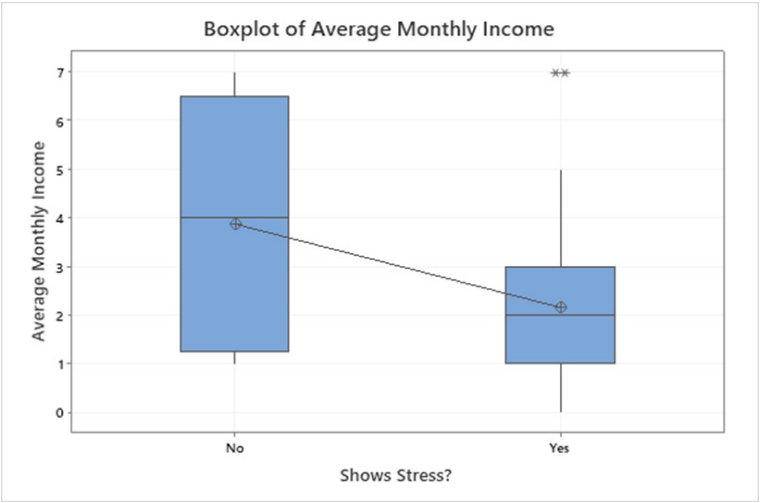
Those who do not show stress earn almost twice as much compared to those who show some level of stress, as shown in Figure 5. In addition to low-income individuals being more exposed to various stressors, this factor

limits their ability to seek stress-coping strategies (Demenech *et al.*, 2022; Hobkirk; Krebs; Muscat, 2021), such as social support and psychological and medical treatment. Income proved to be an impactful factor in the stress of the analyzed farmers.

The income of the farmer is affected by various factors, such as educational level, property size, type of activity, and uncontrollable factors like economic and climatic issues (Kohlbech et al., 2023). Like the general population, income affects the stress levels of family farmers (Feng; Ji; Xu, 2015; Guan *et al.*, 2022). Having another source of income (36% of the sample) can serve as a moderator of financial stress, especially when this income source is from retirement or leases, which do not fluctuate.

Qualitative data collected during interviews with farmers allowed for understanding and comparing the behavioral profiles of family farmers who showed stress with those who did not. Factors influencing the onset of stress related to finances, others that may be consequences of stress, and factors that can be understood as stress moderators were observed.

Figure 5 – Average monthly income: comparison between Family Farmers (A.F) with stress and without stress



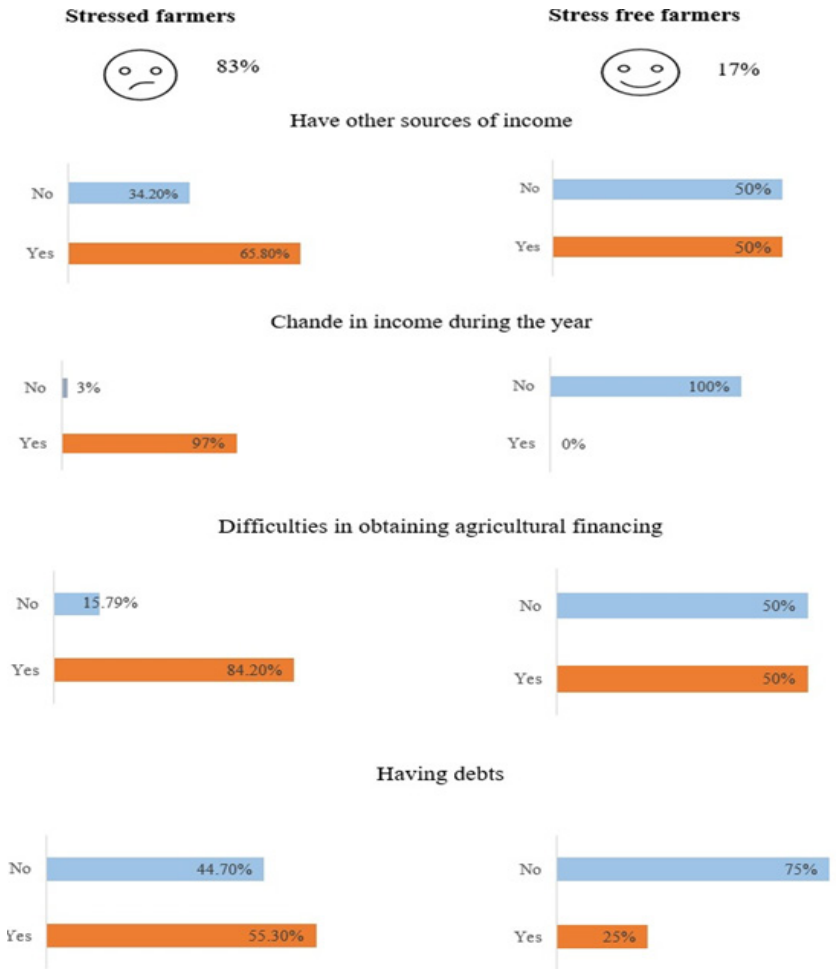
Source: Prepared by the authors (2024).

Among the factors that can influence the stress levels of family farmers are: not having another source of income, variation in monthly income throughout the year, difficulties in obtaining financing, and having debts. Figure 6 compares the responses between those who showed some level of stress and those who did not.

Relying solely on income from the property can be a stress-generating factor, as income is not constant throughout the year, and individual farmers cannot exert full control over the property's earnings due to external factors (Heo; Lee; Park, 2020). The percentage of farmers with stress who do not have another source of income is higher (65.79%) compared to those without stress (34.2%). The research results show that annual income stability occurs for all interviewed farmers without stress, with 100% reporting no income fluctuation throughout the year. Conversely, nearly all farmers with stress experience income variation during the year (97.3%). Not having sufficient income to meet present or future financial obligations creates insecurity in families (Friedline; Chen; Morrow, 2021).

The annual income fluctuation can lead to the accumulation of bills and debts. Debts lead to financial stress (Brit, 2016; Feng; Ji; Xu, 2015; Heo; Cho; Lee, 2020). The research revealed that the number of stressed individuals with debts (55.26%) is much higher than those without stress (25%). Furthermore, the number of farmers with stress who have difficulties in obtaining agricultural financing is proportionally higher (84.21%) compared to 50% of those without stress. Agricultural financing allows the farmer to invest in machinery, purchase fertilizers, irrigation, among others, which can increase property productivity.

Figure 6 – Factors influencing stress: comparison between Family Farmers (A.F) with and without stress



Source: Prepared by the authors (2024).

Some data collected for the chapter can be considered stress moderators. Stress moderators are environmental factors or behavioral characteristics of people that can reduce the negative effects of stress

(Hirschle; Gondim, 2020). In the results, the moderators, as shown in Figure 7, are: actions to minimize the impact of income fluctuation and control property costs. These are factors that, when well employed, contribute to better property management, improve income, and consequently reduce financial stress.

The fluctuation of monthly income is a reality for 97% of farmers with stress, and to minimize this, 28.95% make financial reserves, 18.42% cut expenses, and 10.52% earn extra income, which are considered coping strategies. However, there is a discrepancy in the attitude of delaying bill payments, as 28.95% of those stressed practice this behavior compared to 12.5% of those without stress (Figure 4), demonstrating more assertive behavior in those without stress.

Another behavior that could minimize financial concerns is the control of property costs. Cost control generates better financial forecasting; however, only 55.26% of farmers with stress do this, compared to 87.5% of those without stress. Clune and Downey (2022) reinforce that the lack of entrepreneurial skills among family farmers is a consequence of their low education levels and impacts property results.

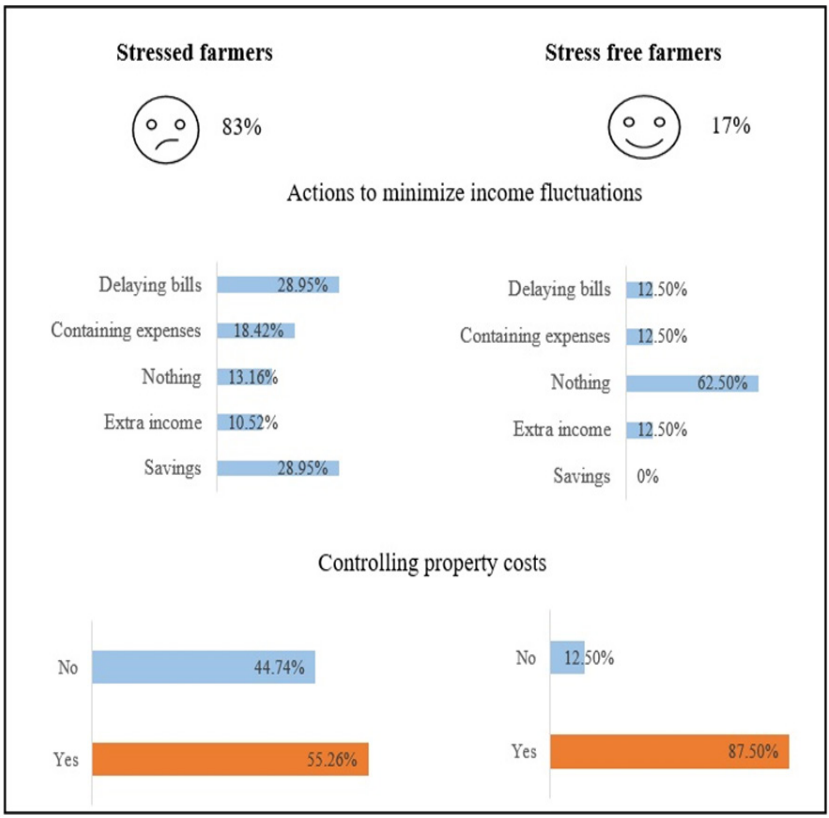
The financial limitation of families[5] makes them more vulnerable to stress (Dinterman; Katchova, 2018; Hagen *et al.*, 2021), which affects job satisfaction (Guan *et al.*, 2022). Figure 8 shows a divergence in perception between family farmers with stress and those without stress regarding job satisfaction, profitability view of the activity, and thoughts of leaving the field.

Job satisfaction includes the positive view that a person has about their job, and for farmers, income and consequently stress from financial factors highly impact the level of satisfaction (Heo, Lee; Park, 2020; Herrera; Gerster-Bentaya; Knierim, 2018; Majdabadi *et al.*, 2022). Regarding the degree of satisfaction, most farmers with stress consider themselves satisfied with their work, but attention should be drawn to the low percentage (13.16%) of those who consider themselves very satisfied compared to 50% of those without stress. The level of dissatisfaction showed a small

[5] Stress in family farming affects the person responsible for the property and consequently the entire family context involved in production, causing suffering in the family environment and difficulties in marital and family relationships (Friedline; Chen; Morrow, 2021; Sprung, 2021).

variation between farmers with stress (29.95%) and farmers without stress (25%). Farmers with stress are more pessimistic about the profitability of their property, as 55.26% believe it is not profitable compared to 25% of those without stress. Farmers with stress show a greater propensity to leave the field.

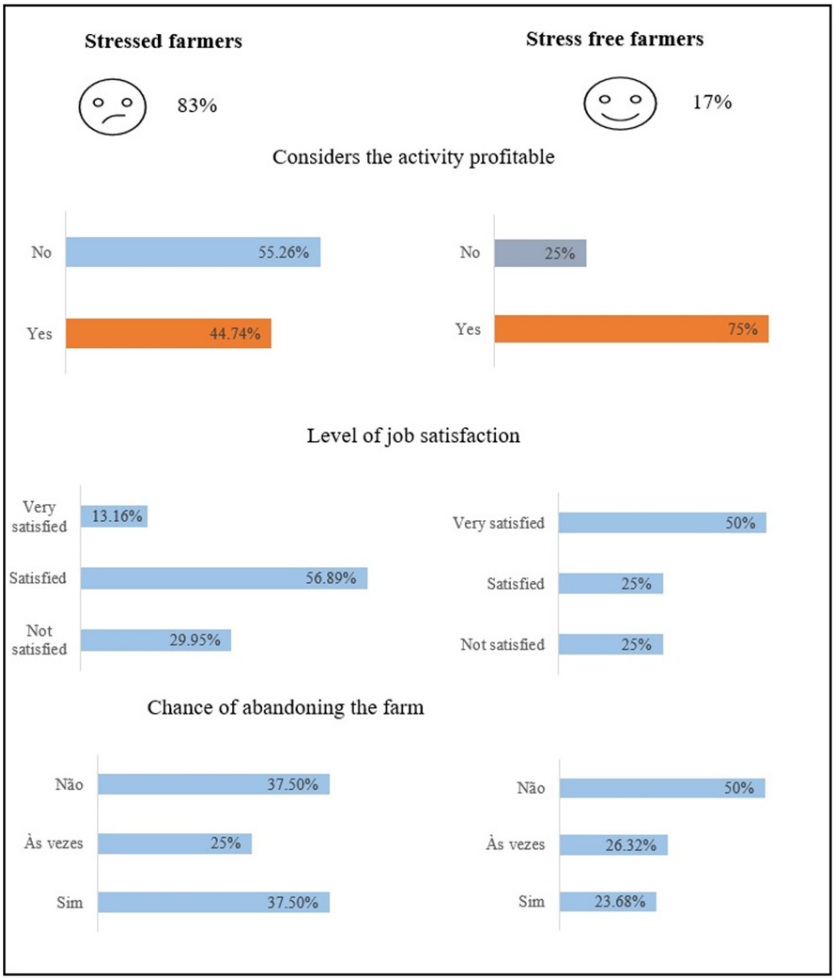
Figure 7 – Factors influencing stress



Source: Prepared by the authors (2024).

Although income is a relevant factor in job satisfaction, it should be noted that there are non-pecuniary benefits that also influence satisfaction. Social benefits, lifestyle, autonomy, among others, are factors that promote a balance in the job satisfaction of family farmers.

Figure 8 – Degree of Job Satisfaction: comparison between A.F with stress and without stress



Source: Prepared by the authors (2024).

Final Considerations

The sustainable socioeconomic development of an agro-industrial production system goes through family farming. Family farming is a social and economic activity of great relevance for several countries, including

Brazil. It is responsible for food production and generating income for many families. As an economic and labor activity, it has its own peculiarities that distinguish it from other activities and requires specific studies to understand its dynamics and develop strategies that help its development.

Like any labor activity, family farming generates stress in its workers, and even though the prevalence is in mild and moderate levels, these levels already require some attention as they affect the quality of life and over time can evolve into more aggressive phases and compromise physical and mental health.

As an economic activity, family farming presents unpredictability, as it depends on climatic, market, and productive factors for its good performance. This unpredictability directly influences the income earned in the field, which can compromise the family's ability to sustain itself. Various financial problems surround family farmers; however, irregular income, fluctuation in production costs, and uncertainty of the production value at the time of sale have been revealed to be more impactful.

Farmers with stress showed characteristics (education level, income, and difficulties in obtaining financing) and behaviors (control of production costs, financial reserves, among others) different from farmers without stress. Such differences can be both a consequence of stress and, on the other hand, something that contributes to stress.

Although financial stress interferes with the level of job satisfaction, many farmers declared themselves satisfied. The way of dealing with stressors and the perception of job satisfaction is associated with cognitive evaluation and the coping strategies used by people.

Identifying how financial stressors affect family farmers is the first step in developing stress treatment protocols and enabling specific financial education programs for this group.

These actions contribute to the development and improvement of the competitiveness of family farmers (one of the objectives of the Graduate Program in Agribusiness and Development – PGAD). Additionally, it contributes to the Sustainable Development Goals by promoting health

and well-being (stress management); decent work and economic growth (fewer physical and mental health complaints caused by stress and financial literacy that will help manage the property) and zero hunger and sustainable agriculture (keeping farmers in the field and food production).

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Chapter 2

The Interfaces between People Management, Culture, and Networks in Agricultural Systems

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Introduction

The agribusiness sector plays a fundamental role in the Brazilian economy, contributing to job creation and exports, accounting for a quarter of the national Gross Domestic Product (GDP). However, the interface between agribusiness and People Management (PM) practices presents significant challen ges that need to be overcome to achieve sustainable development. The shortage of qualified labor, working conditions in the field, and the seasonality of activities are some of the issues that require attention.

In the dynamic scenario of Brazilian agribusiness, the analysis of PM practices reveals a crucial intersection with the Sustainable Development Goals (SDGs) established by the United Nations. PM in agricultural companies is not limited to operational issues but encompasses a broader spectrum that includes social, economic, and environmental responsibility.

Regarding the promotion of safe and healthy working conditions for rural workers, investment in training to increase efficiency and the adoption of inclusive practices contribute directly to SDG 8, which addresses "Decent Work and Economic Growth."

The analysis of PM practices cannot overlook the study of networks, as organizations are influenced by their environment. This degree of influence is an essential element in understanding the dynamics of organizations in various sectors. Management styles are deeply influenced by cultural factors, whether organizational or local. Culture also influences the behavior of work teams and the decisions made by these organizations. It is necessary to understand how values, beliefs, and norms reflect PM practices and how they can promote a healthy and productive work environment.

The theory of social networks, as developed by Granovetter (2007), suggests that the ties established in networks can play a crucial role in disseminating information and forming professional connections. In the agribusiness sector, where collaboration and knowledge exchange are vital,

it is essential to understand how social networks can facilitate or hinder PM practices. These networks can create informal communication channels, accelerate the diffusion of best practices, and even impact innovation in the sector.

Therefore, this chapter aims to analyze PM practices in the context of Brazilian agribusiness, considering the challenges and opportunities considering the Sustainable Development Goals, specifically SDG 8, as it relates to generating decent employment, innovation in an interrelation with culture, and the dynamics of social networks, providing insights for agribusiness organizations.

Interfaces between Culture, Networks, and People Management

According to Bohlander and Snell (2015), it is possible to observe that PM has assumed a strategic role, surpassing the traditional support function and constituting an essential organizational competence since people are the main protagonists in achieving results, given their potential in producing knowledge and innovation.

It is important to highlight that, according to Pedraza-Rodriguez *et al.* (2023), different cultural elements have a positive effect on the outcome of innovation. This result suggests active efforts by managers to develop a culture of innovation based on best practices rather than traditional ones. Obviously, companies need new technological capabilities to achieve competitive advantages, but they also require the adoption of belief systems, norms, and rules to consider innovation as a key asset.

In summary, PM should not only have a traditional role but also expand and constitute the essential competencies to achieve organizational and individual objectives; people are valuable and constitute a source of competitive advantage. PM policies and practices need to contribute to greater well-being, allowing greater personal and professional fulfillment. These actions reduce turnover and generate higher job satisfaction rates,

highlighting how to stimulate shared values and retain employees (Fiusa, 2008; Pham, 2023).

The relevance and recognition of informal interactions within organizations have gained increasing importance. As a result, studies have emerged that address the intersections between social networks and organizations (Lazzarini, 2008). According to Granovetter (2007), social activities are fundamental in configuring economic actions.

The theory of social networks emerges with the objective of establishing an intermediate approach in characterizing the structures of social interactions in economic activity. According to social network theory, individuals do not act or make decisions in isolation, like independent atoms; instead, their actions are deeply embedded in complex and continuous systems of social relations (Granovetter, 2007).

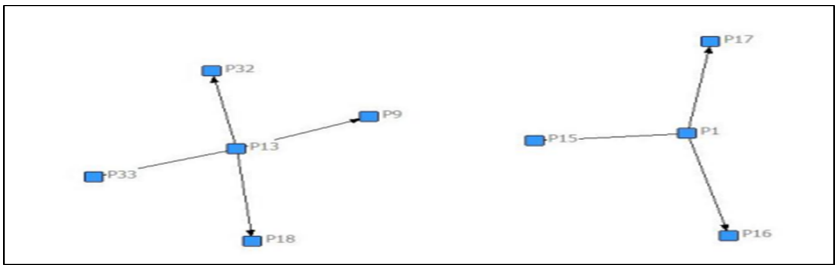
Marteleto (2001) highlights social networks as composed of sets of autonomous participants who share ideas and resources based on the same values, becoming systems of nodes and links from a structure without geographical boundaries.

The information presented here is some of the results of research conducted with the Postgraduate Program in Agribusiness and Development (2017). This research highlighted the importance of forms of relationship and information exchange between peanut farmers and agrarian agents to map information networks on production and PM practices (Yamauchi, 2017).

The data obtained for configuring the social network of information exchanges (Figure 1) on production demonstrated the presence of a network composed of sub-networks, where the connection of these sub-networks is made by key agents, the main ones being input suppliers and the producers themselves (P1, P2, P4, P6, and P13). Thus, it is possible to identify in the information networks the elements that can drive the adoption of new PM practices as being input suppliers due to the centrality occupied in the network and the main producers (P1, P2, P4, P6, and P13).

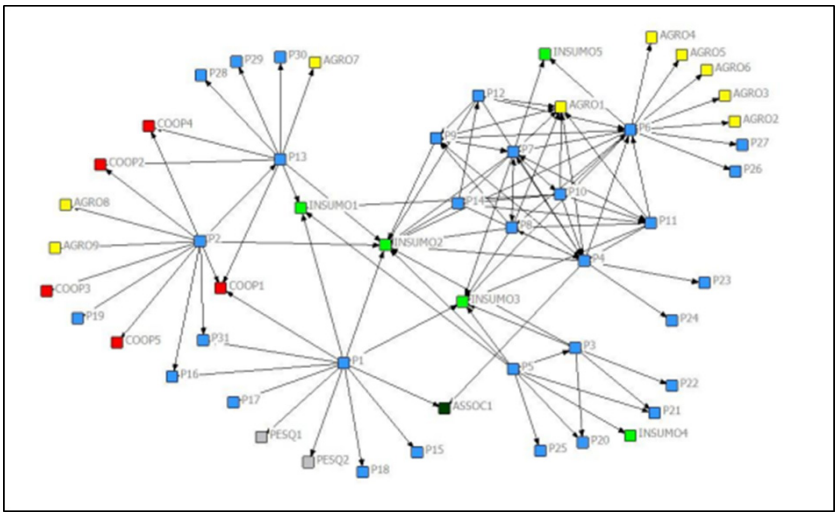
The second network identified (Figure 2) presents relationships in information exchanges regarding PM practices, revealing that these relationships are scarce and demonstrate fragility in the exchange of information on this topic, especially when compared to the network of information exchange on production. These analyses demonstrated that production and productivity circumstances occupy a more important role for producers than issues related to PM practices, even for those who export, P4, for example, does not even appear as an actor in this network. The analysis of the PM network revealed the insufficiency previously shown when asked the producers what structures and models were used.

Figure 1 – Information network between producers and support agents



Source: Yamauchi (2017).

Figure 2 – Information network on people management



Source: Yamauchi (2017).

This observation leads to the conclusion that producers who have more central roles in the network are the same ones who exchange information about HR practices. In this sense, although there are laws regarding rural workers that directly or indirectly influence their practices, the exchange of production information is still higher than those focused on HR.

From this perspective, production and productivity are at a higher level of attention, even among producers who interact with the external market. Here, special attention is given to the obtained data, as no HR strategies directed toward future demands that could be incorporated into certifications for participation in the international market were identified. For example, in environmental aspects, there is pressure for companies to develop sufficient initiatives to reduce obstacles and increase exports (Onjewu *et al.*, 2023).

According to Kremer and Talamini (2018), based on the characterization of the production chain and the responses obtained from the questionnaires (Figure 3), it was possible to identify the networks of

personal relationships present in transactions between the different links of this chain. It was found that social relationships among individuals of a certain link, such as producers, proved to be more solid, driven by the organization in cooperatives that promote the exchange of experiences and information among members. This highlights the importance of cooperation in this context, where the formation of social ties can contribute to the sharing of knowledge and competitive advantages.

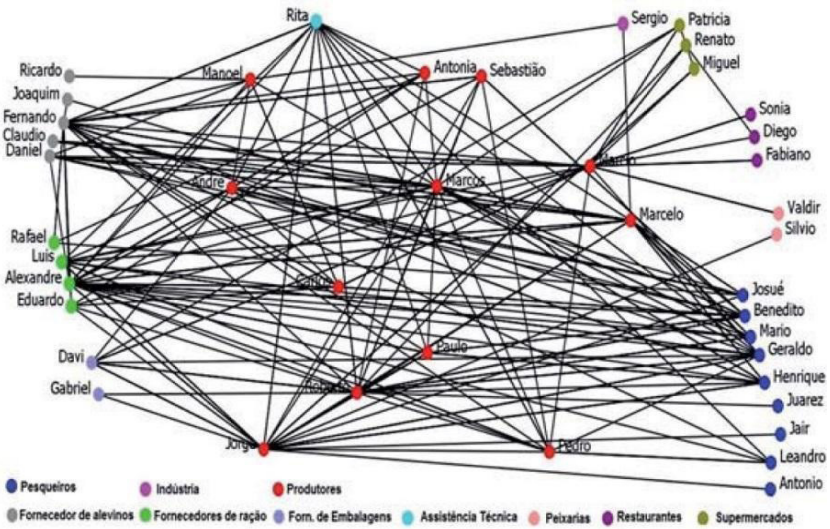
However, it is noted that the same pattern of central actors is observed in the presentation of the previous case with peanut producers, where some occupy this central role as well as the support of cooperatives as important actors for disseminating and increasing information.

In links associated with supply and commercialization, social relationships seem to be less prominent. However, it is relevant to note that friendship and kinship relations also play a role in creating these networks of social relations, especially among producers, where there are family ties that directly influence social connections (Kremer; Talamini, 2018).

According to Kremer and Talamini (2018), the results of this study can be widely applied in the management of the fish production chain. In the agribusiness context, where the exchange of experiences among producers plays a crucial role, social relationship networks become fertile ground for obtaining competitive advantages and sharing knowledge. Identifying the central individuals in the network, who have access to information and act as intermediaries among agents, can facilitate the process of knowledge dissemination and the use of these individuals as facilitators in information transmission.

It is important to note that identifying central agents within a social network can support the implementation of public policies and development programs in the analyzed chain. For instance, as shown in studies on the peanut and fish markets, these agents have the potential to positively influence others by serving as references, thereby facilitating the acceptance and engagement of all network participants. Effective information management, therefore, contributes to sustainable development (Kremer; Talamini, 2018; Yamauchi, 2017).

Figure 3 – Social Netchain of the fish supply chain in Mundo Novo



Source: Kremer and Talamini (2018).

Given that central agents exert greater influence compared to other actors, it is crucial to emphasize their impact on promoting and disseminating information related to the PM theme, as well as the importance of trust and commitment as essential elements in forming a solid structure and effective governance. Relationships based on trust and commitment help establish a more balanced network capable of addressing asymmetries and potential conflicts synergistically, with clearly defined roles and rules that the group establishes and accepts (Bertóli; Giglio; Rimoli, 2015).

Certain categories highlight key factors (Box 1) when considering the organization of social networks as a strategy to promote and disseminate information and PM practices in agribusiness.

Box 1 – Organizing categories of networks and some indicators of their presence

Categories	Dominant Concept	Content to be Observed	Some Indicators
Commitment	Making oneself available for collective actions.	Attitudes and actions to achieve collective objectives, or help another actor, even without personal gain.	1. Regularly participating in meetings and decisions. 2. Helping others, even without personal benefit. 3. Taking responsibility for joint actions. 4. Fulfilling agreements and ensuring others do as well. 5. Existence of promises for continued relations among partners.
Trust	Placing oneself in dependency on another.	Attitudes and actions where the individual exposes themselves to the collective or depends on another without resorting to formal control mechanisms.	1. Sharing a problem or weakness of their business with others. 2. Taking on a responsibility whose execution depends on another. 3. Making their resources, of any kind, available for others to use, without needing safeguards. 4. Signs that an actor believes in and follows the established informal rules and goals of the network. 5. Signs that an actor trusts the integrity of people in the network.
Structure Configuration	More defined roles and positions of actors in the network.	The repetition, frequency, and content of relationships between actors, in both directions (receiving and sending), indicate the positions of actors in the network and the network's relational structure. The convergence of responses about roles indicates clarity of actions and each one's position.	1. Knowledge about how many actors participate in the network. 2. Position of some actors based on the number of cited relationships. 3. Signs of dominance of the content of ties (more commercial, more social, more political, more institutional).

Governance	Set (or system) of rules for incentives, resource protection, and behavior control.	Any explicit or implicit rule that imposes behavior restrictions, protects resources (collective or individual) and encourages collective actions.	1. Rules about admission and exclusion of actors from the core group. 2. Rules about penalties. 3. Control by authority or reputation (e.g., a more powerful actor) or knowledge dominance. 4. Social controls (e.g., the existence of blogs, community sites, and others with information about participants).

Source: Bertóli, Giglio and Rimoli (2015).

The analysis of social networks shows a significant interconnection between the categories of commitment, trust, structure configuration, and governance in the agribusiness context. Commitment, highlighted as the willingness to engage in collective actions, is essentially linked to trust, where actors depend on each other. Commitment is manifested in actions such as regularly participating in meetings, taking on joint responsibilities, and fulfilling agreements, while trust is evident when actors expose themselves to the collective and trust the integrity of other participants (Bertóli; Giglio; Rimoli, 2015).

Based on these assumptions, social network analysis becomes a valuable tool for understanding the intrinsic dynamics of agribusiness and how HR practices can be disseminated. Through this analysis, it is possible to identify central actors who play influential roles in the network, understand how commitment and trust affect collaboration, analyze the structure of relationships, and the rules that govern them. With this information, HR can be more effectively directed, promoting cooperation, knowledge transmission, and sustainable development in the agribusiness sector.

Similarly, organizational culture, as initially discussed, is also interconnected with social network analysis, as the culture of an organization profoundly influences how HR policies are perceived and adopted by employees and organizations in agribusiness. Understanding this interaction is crucial for implementing and enhancing HR practices.

Likewise, the SDGs, notably SDG 8, mentioned earlier, are also related to these issues, as the dissemination of aligned HR practices is fundamental to promoting a more sustainable approach in agribusiness. Therefore, social networks play a vital role in raising awareness and collaboration around these goals, connecting professionals and organizations that seek to contribute to more sustainable development.

Based on these principles, the proposed research in this chapter aimed to present how these elements connect and how they can be optimized to achieve more effective HR practices in Brazilian agribusiness. Social network analysis and organizational culture are key pieces of this puzzle, contributing to promoting a more sustainable, collaborative, and efficient sector.

Final Considerations

This chapter explored the complex interaction between HR management, organizational culture, social networks, and Sustainable Development Goal (SDG 8) in the context of Brazilian agribusiness, specifically considering different agrarian systems.

Agribusiness plays a crucial role in Brazil's economy, however, it faces significant challenges related to HR management, such as the scarcity of qualified labor and working conditions in the field. In this dynamic scenario, HR practices are not limited to operational issues but encompass social, economic, and environmental responsibility.

The network analysis revealed that social relationships play a vital role in shaping economic actions and can be a fertile ground for sharing knowledge and competitive advantages. Identifying central actors in the network who are committed and trustworthy can facilitate information dissemination and use these individuals as facilitators in knowledge transmission.

Organizational culture plays an essential role in how HR practices are perceived and adopted by organizations and employees. Understanding this interaction is necessary for programming more effective HR policies.

Finally, aligning HR practices with the SDGs, specifically SDG 8 – Decent Work and Economic Growth – can contribute to promoting sustainable development in agribusiness, and social networks are vital in raising awareness of these goals, connecting professionals and organizations with more collaborative and sustainable HR practices.

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Chapter 3

Agro-industrial Wastewater: One of the Challenges of Sustainable Development Goal 6

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The objective of this chapter is to present a brief contextualization about water uses and the generation of wastewater, relating them to some indicators and challenges of Sustainable Development Goal (SDG) 6: clean water and sanitation. Additionally, important parameters for water analysis and the proposal of advanced oxidative treatment are presented[4].

Water Uses

Discussing environmental safety and protection is extremely important, mainly due to water scarcity in some regions and the rapid population growth. These facts have significantly reduced ecosystems, including the aquatic ecosystem, where we have found various new chemical pollutants in recent years. These factors have drastically altered the environment, and we need to understand more deeply and quickly how humans relate to nature.

According to the National Water Agency (ANA), only 2.5% of the planet's water resources are fresh water, and a large part is found in glaciers and headwaters. Brazil has the largest reserve of fresh water in the world, with approximately 12% of available fresh water (Brasil, 2021). However, it is not equally distributed across Brazilian territory, with 9.6% in the Amazon region and 2.4% in other regions, where 95% of the Brazilian population is located.

Currently, the country faces structural difficulties in the political and administrative management of water resources, making it necessary to adopt national strategies and regulations to provide not only access to quality drinking water for consumption but also for various productive economic sectors (Brasil, 2021; Lima, 2018).

In this context, the comprehensive report "Conjuncture of Water Resources in Brazil 2021" (Brasil, 2021) described that in 2020, 1,947.55 m^3/s of water were withdrawn and distributed among the following

[4] This text is based on: FRIGULIO, M. A. P. Application of pre-treatment for the reduction of organic pollutants in effluents from an agro-industry. Dissertation (Master's) - São Paulo State University (Unesp), Faculty of Sciences and Engineering, Tupã, 2023.

sectors: (a) irrigation 50%, (b) urban supply 25%, (c) industry 9%, (d) animal husbandry 8%, (e) thermoelectric plants 5%, (f) rural supply 2%, and (g) mining 2%. Over the past decades, there has been an 80% increase in water use, and it is estimated that by 2040 this percentage will increase by 42%. This history is mainly related to the country's urban, agricultural, and economic expansion. Concerning the expansion of industry, the sectors highlighted for water use in Brazil in 2020 include the sugar and ethanol production sector with 40% of industrial demand, followed by the pulp and paper, meat production, and alcoholic beverage industries. It is worth noting that the sugar-energy sector stands out for reusing its effluents in the irrigation and fertigation of sugarcane fields (Brasil, 2021).

However, until the 1990s, water used by the industrial sector was considered an irrelevant input, both economically and in terms of availability. Consequently, water resources were used without parsimony and without adequate control mechanisms, either for meeting demand or for the final disposal of effluents (Santos, 2009). Currently, however, various economic sectors, as well as civil society, are effectively concerned with adopting concrete measures to reduce water consumption and effluent generation (wastewater).

Producing sustainably, that is, mitigating environmental degradation and using limited natural resources—among them water—consciously, are challenges currently faced not only by industries but by all of society. These challenges are directly linked to the Sustainable Development Goals (SDGs) established by the United Nations General Assembly in 2015, specifically SDG 6: clean water and sanitation, ensuring the availability and sustainable management of water and sanitation for all (UN, 2016).

SDG 6 outlines eight targets and eleven indicators to be effectively achieved by 2030 (UN, 2016). In this chapter's context, Target 6.3 of the United Nations (UN, 2016) is highlighted:

> By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally (UN, 2016).

In Brazil, the target was adapted to:

> By 2030, improve the quality of water in water bodies by reducing pollution, eliminating dumping, and minimizing the release of hazardous substances, halving the proportion of untreated effluent discharge, and substantially increasing local recycling and safe reuse (Brasil, 2019).

The term "water bodies," according to the Institute for Applied Economic Research (IPEA) (Brasil, 2019), was added to indicate that the target does not only address water use but also the management of water resources. The terms "release of hazardous chemicals and materials," "untreated wastewater," and "globally" were respectively changed to "release of hazardous substances," "untreated effluent," and "locally," as these terms better fit the context of Brazilian legislation.

This target has two evaluation indicators: (a) 6.3.1 "Proportion of wastewater safely treated" and (b) 6.3.2 "Proportion of water bodies with good ambient water quality" (Brasil, 2019).

However, according to the National Water Agency, the 6.3.1 indicator still lacks systematic data on a national and regional scale for industrial effluent treatment, as this indicator includes data on industrial, domestic, and total effluents. In Brazil, the data used to calculate this indicator comes from national surveys conducted with service providers in each municipality, covering (a) urban effluents, (b) economic activity effluents (services and commerce), and (c) a small portion of industries located within urban perimeters (Brasil, 2022).

These data, along with data on septic tanks not connected to the public sewer system, are aggregated and used for calculation (Brasil, 2022). Thus, in 2019, for example, only 58.3% of effluents were safely treated in the country, an improvement of 15.5% since 2019 (Brasil, 2022), highlighting the need for enhancements in monitoring effluent treatment in the country.

Regarding the second indicator of Target 6.3 (6.3.2), it closely relates to the previous indicator (6.3.1), as it monitors water quality. Improper discharge of untreated effluents will impact receiving water bodies. According to the National Water Agency (Brasil, 2022), in Brazil, the 6.3.2 indicator data show that in 2018, 77.45% of water bodies had good environmental water quality. The monitoring from 2010 to 2018 indicated a 12.11% improvement during that period.

The fourth target of SDG 6, target 6.4, states:

> By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity (UN, 2016).

In Brazil, the text of the target was simplified for clarity without changing its meaning, removing the repetitive term water scarcity, defining it as: Target 6.4: "By 2030, substantially increase water-use efficiency across all sectors, ensuring sustainable withdrawals and supply of freshwater to substantially reduce the number of people suffering from water scarcity" (Brasil, 2019).

The indicators responsible for data collection for this target are: (a) 6.4.1 "Change in water-use efficiency over time" and (b) 6.4.2 "Level of water stress: proportion of freshwater withdrawal to total renewable freshwater resources" (Brasil, 2019). Indicator 6.4.1 aims to evaluate water-use efficiency in the following sectors: services, agriculture, and industry. Being an economic indicator—a higher efficiency reflects a reduction or increase in Gross Value Added (GVA)—this evaluation reflects to what extent a country's growth depends on water resource use. According to the National Water Agency, from 2010 to 2018, there was a reduction in water-use efficiency, with recovery in recent years, ranging from 80.93 R$/m³ in 2010 to 78.02 R$/m³ in 2018 (Brasil, 2022).

The second indicator of Target 6.4 (6.4.2) estimates the consumption pressure on the country's water resources and considers the environmental

need for water to conserve aquatic ecosystems. Between 2006 and 2019, the evolution of water stress levels in Brazil ranged from 1.33% to 1.72%, respectively, according to estimates by the National Water Agency (Brasil, 2022), results considered satisfactory by the United Nations (UN), which considers a percentage below 10% as satisfactory. Nevertheless, continuous and effective monitoring is essential, as changes in demand intensity or unfavorable balances can lead to scarcity and conflicts over use in certain regions.

Wastewater: important parameters

To achieve the challenges described so far, the precise and efficient management of water resources is required, before, during, and after agro-industrial production, including raw material production to the final product's realization. The liquid and solid wastes generated by processing industries must necessarily be classified and identified according to their specificities before final disposal, considering the country's current laws. For industrial effluents, the Federal Resolution of the National Environmental Council—CONAMA No. 430, of May 13, 2011—establishes national conditions and standards for effluent discharge into receiving water bodies. Additionally, each federation state has its legislation, which is usually stricter than federal legislation.

In the State of São Paulo, Decree No. 8.468 of September 8, 1976, updated by Decree No. 54.487 of June 26, 2009, provides parameters for treated effluent discharge into rivers or sewage networks, specifically Articles 18 and 19 of Decree No. 8.468/76, which address each case in detail. The decree also defines that, where a public sewage system is available, effluents from any polluting source must be discharged into it and establishes that the State Basic Sanitation Technology and Environmental Protection Company (CETESB) will supervise and define, and, when necessary, indicate the appropriate means for the enterprise to discharge its effluent (São Paulo, 1976).

In addition to legal aspects, it is important to note—concerning technical aspects—that the various components present in wastewater that alter its purity are defined and quantified through parameters that evaluate its quality. These parameters include: (a) physical characteristics, (b) chemical characteristics, and (c) biological characteristics. According to Von Sperling (2005), the main parameters to be analyzed in raw and treated wastewater are presented in Box 1.

Regarding temperature, it must be below 40°C according to effluent emission standards (São Paulo, 1976), as increased temperature reduces viscosity and surface tension, while thermal conductivity and vapor pressure increase. The reduction in surface tension of the medium can interfere with aeration rates (O_2 replenishment), causing air bubbles to stay in contact with the aquatic medium for a shorter time. Additionally, the solubility of a gas in a liquid is inversely proportional to temperature, so increased temperature reduces gas concentrations in water, including dissolved oxygen. According to CONAMA Resolution 430/2011, for the preservation of aquatic life, 5.0 mg/L of dissolved oxygen is necessary, as species tolerance varies (Metcalf; Eddy, 2016). Temperature variation also affects aquatic organisms, as they have optimal temperatures for growth, migration, spawning, and egg incubation (Metcalf; Eddy, 2016). Changes in surface temperature depend on the seasons, time of day, altitude and latitude, flow rate, and depth, but are also caused by industrial effluent discharges.

It should also be noted that pH changes influence aquatic ecosystems due to their effects on the physiology of various species. Although each aquatic organism has an ideal pH, most require pH values between 6.5 and 8.0 for growth, reproduction, and survival (Parron; Muniz; Pereira, 2011). The CONAMA Resolution 430/2011 establishes pH values between 6 and 9 for the protection of aquatic life for various classes of natural waters and values of 5 to 9 for effluent discharge. In addition to directly affecting the physiology of aquatic organisms, other aspects of lake dynamics are influenced by pH. Low pH can cause the release of toxic elements and compounds from sediments into the water, where they can be absorbed by animals or aquatic plants. Changes in pH also influence the availability of

nutrients for plants, such as phosphate, ammonia, iron, and toxic metals in water (Addy; Green; Herron, 2004).

Box 1 – Main Parameters to be Evaluated in Wastewater

Characteristics	**Parameters**	**Wastewater**	
		Raw	Treated
Physical	Temperature (°C)	x	
Chemical	Hydrogen Potential (pH)	x	x**
	Alkalinity	x	
	Nitrogen	x	x
	Phosphorus	x	x
	Dissolved Oxygen (DO)		x**
	Organic Matter (COD and BOD)	x	x
Biological	Indicator Organisms	x	x
	Algae (various)		x**
	Decomposer Bacteria (various)		x**

Source: Von Sperling, 2005. Adapted by the authors. Notes: **process control, during treatment.

Alkalinity is a measure of the water's capacity to neutralize acids, that is, the number of substances in the water that act as a buffer, the capacity to resist pH changes, with the main constituents being bicarbonate ions (HCO_3^-), carbonate (CO_3^{2-}), and hydroxides (OH^-). Alkalinity comes from rocks and soils, salts, certain plant activities, and industrial wastewater discharges (detergents and soap-based products are alkaline). If the geology of an area contains large amounts of calcium carbonate ($CaCO_3$, limestone), water bodies tend to be more alkaline. The addition of lime as a soil amendment to reduce acidity in domestic lawns can run off into surface waters and increase alkalinity. Higher levels of alkalinity in surface waters mitigate acid rain and other acidic wastes, preventing pH

changes. Alkalinity is also important considering wastewater and drinking water treatment because it influences treatment processes such as anaerobic digestion and coagulation (Metcalf; Eddy, 2016).

In relation to chemical characteristics, parameters such as nitrogen, phosphorus, and potassium (N, P, and K) are essential nutrients for plant growth, but when discharged in excess into the aquatic environment, they can cause eutrophication, i.e., the excess of nutrients causes excessive growth of aquatic plants (planktonic and adhered) leading to the deterioration of water body quality by accumulating decomposing organic matter. This accumulation hinders light penetration and decreases dissolved oxygen, causing the death of aquatic animals. The sources are sewage, industrial effluents, and fertilizers washed off by rainwater from agricultural areas (Fugita, 2018).

As previously mentioned, dissolved oxygen is essential for maintaining life forms and is crucial for water quality control. In addition to temperature, the discharge of effluents into a water body directly affects the oxygen balance in the system. This discharge causes a decrease in dissolved oxygen as microorganisms use it to degrade organic matter. Therefore, near the discharge point, bacteria proliferate, dissolved oxygen decreases, resulting in zones of decomposition and septic areas where there are no fish. With the natural reaeration process (oxygen from the atmosphere and photosynthesis) and the absence of new effluent discharges, the water body can recover its initial dissolved oxygen conditions kilometers after the discharge point, a process called self-purification (Manahan, 2013).

Indirectly, two analyses are performed for quantifying organic matter: Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). BOD measures the amount of oxygen used by microorganisms during the biochemical oxidation of organic matter: high BOD values indicate pollution as a large amount of oxygen is needed for the biodegradation of organic matter. According to CONAMA Resolution 430/2011, the maximum permitted BOD for effluent discharge is 120 mg/L, with this limit only being exceeded in the case of effluent from a treatment system with a minimum removal efficiency of 60% BOD (Brazil, 2011), but in the state of São Paulo, by State Decree 8468/1976, it

is 60 mg/L O2 or a minimum overall treatment process efficiency of 80% (São Paulo, 1976). COD is the amount of O2 needed for the oxidation of organic matter by a chemical agent, and when COD is high, it represents that a large amount of oxygen is needed for the degradation of organic matter. There is no Maximum Permitted Value (VMP) for COD, but it is very useful when used together with BOD.

Water Pollution: Organic Compounds

Water pollution by organic chemical compounds is extensive, with these compounds being largely responsible for aquatic pollution due to their constant use and presence in domestic, industrial, and agricultural effluents. Many of these compounds are toxic, persistent, have high Chemical Oxygen Demand (COD), and are not treated by conventional methods. Among the organic compounds present in effluents are biodegradable and recalcitrant or refractory compounds.

Biodegradable compounds are chemicals that, after a certain period, are decomposed by the action of microorganisms. Examples of these compounds include proteins, carbohydrates, lipids, and soaps. There are two types of biodegradation pathways: (1) aerobic pathway: decomposition by microorganisms using O_2 + carbon source (glucose) and nitrogen source (NH_3) + essential nutrients (P, S, Fe) producing biomass + CO_2 and H_2O; (2) anaerobic pathway: decomposition by microorganisms using carbon source (glucose) and nitrogen source (NH_3) + essential nutrients (P, S, Fe) + electron acceptors (NO_3^-, SO_4^{2-}, Fe^{3+}) producing biomass + CH_4 and H_2O.

Non-biodegradable organic compounds or those with very slow biodegradation rates are called recalcitrant or refractory. These compounds are present in most agro-industrial effluents. Due to their complex chemical structure, many are stable (persistent), and in cases of prolonged exposure to very low concentrations (chronic toxicity), some can be carcinogenic, mutagenic (alterations in genes and chromosomes), or teratogenic

(problems in newborns), and can also cause kidney and liver dysfunctions, sterility, and neurological problems. Moreover, they can affect non-target organisms (cattle, bees, humans), and often their partial degradation byproducts are also toxic and persistent (Manahan, 2013).

Organic compounds referred to as micropollutants or emerging contaminants are substances that have been used for a long time and new substances that are part of our daily routine, such as pesticides, dyes, pharmaceuticals, personal care products, cosmetics, cleaning products, chemical additives, and plastics/microplastics. The recent focus on these contaminants is due to access to new technologies capable of detecting compounds at very low concentrations, on the order of micrograms (μg/L) or nanograms (ng/L), thus enabling the quantification of hundreds of compounds in different environmental areas. The main analytical techniques that made these quantifications possible are chromatography, especially liquid chromatography coupled with mass spectrometry.

Many of these micropollutants are not included in environmental control regulations or legislation and are not part of routine monitoring programs by environmental and health agencies. Therefore, there is a need for studies aimed at treating refractory organic molecules in water, as traditional water and sewage treatment methods do not show satisfactory efficiency for these compounds, which are increasingly present in our waters.

Alternative for Treatment

Among the different processes available (physical, chemical, or biological), Advanced Oxidation Processes (AOPs) have been successfully studied for the degradation of toxic and persistent organic pollutants. AOPs are considered a highly competitive technology for water treatment to remove recalcitrant organic pollutants that are not treatable by conventional methods (Wang; Zhuan, 2020). The development and research of such AOP applications have been stimulated due to the pollution of water resources through agricultural and industrial activities and the requirement for industries to meet effluent discharge standards.

AOPs are based on the generation of hydroxyl radicals ($HO^{\bullet}$), a strong (E^{o} = 2.80 V) and non-selective oxidant that reacts with most organic compounds very quickly, ensuring the effectiveness of AOPs both in terms of oxidation capacity and kinetic standpoint (Oturan; Aaron, 2014). These radicals attack carbon chains, potentially degrading them completely into CO_2, water, and inorganic ions or partially, producing fewer toxic compounds that are more degradable by conventional processes. In AOPs, the generation of $HO^{\bullet}$ can be achieved by chemical, electrochemical, photochemical, and the more recent Sono chemical and Sono electrochemical methods. They are divided into homogeneous and heterogeneous processes (which use solid catalysts, electrodes), which can occur in the presence or absence of Ultraviolet (UV) light, which can be of artificial or natural (solar) origin.

The generation of $HO^{\bullet}$ can be achieved through the reaction between iron ions and hydrogen peroxide, known as the Fenton reaction or reagent (Fenton, 1894). The classic application of the Fenton reagent is a homogeneous system, requiring only the mixing of reagents at ambient temperature and pressure, not requiring sophisticated equipment. Therefore, it is considered safe for handling and has a low environmental impact (Oturan; Aaron, 2014).

Fenton's catalytic reactions basically consist of the oxidation of Fe^{2+} to Fe^{3+}, producing $HO^{\bullet}$, which will oxidize any organic compound present in the solution. The reactions of the Fenton Reagent and its interaction with the organic molecule (R), in a simplified form, are shown in Table 1.

Table 1 – Fenton Reagent Reactions

Reaction		
$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + HO^{\bullet}$	(Start of the reaction chain)	(1)
$RH + HO^{\bullet} \rightarrow R^{\bullet} + H_2O$		(2)
$R^{\bullet} + Fe^{3+} \rightarrow R^{+} + Fe^{2+}$		(3)
$Fe^{2+} + HO^{\bullet} \rightarrow Fe^{3+} + OH^-$	(End of the reaction)	(4)

Source: Moravia; Lange; Amaral, 2011. Note: Fe^{2+} and Fe^{3+} represent hydrated molecules; R represents an organic molecule

The efficiency of the degradation of organic pollutants during the application of the Fenton process will depend on some operational factors, such as the concentration of reagents, operating pH, temperature, and the concentration of contaminants in the wastewater (Zhang *et al.*, 2019).

The molar concentration ratio between Fe^{2+}/H_2O_2 is extremely important because the efficiency of the degradation of organic compounds will depend on this ratio. If the concentrations of Fe^{2+}/H_2O_2 are excessive, there will be low concentrations of $HO^{\bullet}$ to oxidize the organic matter, as unwanted reactions may occur with excess reagents causing their elimination (Aarslan-Alaton; Kabdaşli; Teksoy, 2007; Kallel *et al.*, 2009).

Despite numerous studies, there is no consensus on the appropriate molar ratio for oxidation between Fe^{2+}/H_2O_2, as it may vary depending on the type of effluent/compound to be treated. Aarslan-Alaton; Kabdaşli and Teksoy (2007) report that for removing color in effluents containing dyes, the ratio 1:3 was efficient, while Lange *et al.* (2006) report that the concentration range of Fe^{2+}/H_2O_2 can vary from 1:5 to 1:25. Araújo *et al.* (2016) conclude that this ratio varies according to the type of effluent to be treated.

Regarding the optimal pH range for the application of this technique, studies report values of 2 to 4, as with the increase in pH, H_2O_2 decomposes rapidly into water and oxygen, and iron precipitation may also occur, reducing the production of HO• and, consequently, decreasing the efficiency of the oxidation process (Zhang *et al.*, 2019; Ziembowicz; Kida, 2022). Bello, Raman, and Asghar (2019) report that pH above 3.5 promotes the precipitation of Fe^{3+} in the form of iron hydroxide, which decreases its interaction with H_2O_2 and, consequently, reduces the production of HO•. Additionally, large amounts of chemicals are spent to adjust organic wastewater to pH 2-4 before decontamination, which is a disadvantage that needs to be evaluated and improved.

Studies have been conducted on the application of the Fenton process to various types of effluents, such as tannery effluents (Kalyanaraman *et al.*, 2012), olive mill effluents (Kallel *et al.*, 2009; Lucas; Peres, 2009), paper and pulp effluents (Jamil *et al.*, 2011), yeast effluents (Pala; Erden,

2005), slaughterhouse effluents (Almeida *et al.*, 2015), water with humic substances (Júlio *et al.*, 2006), coke plant effluents (Jiang *et al.*, 2011), landfill leachate (Lange *et al.*, 2006; Moravia; Lange; Amaral, 2011), and pesticide effluents (Forti *et al.*, 2020; Tadayozzi *et al.*, 2021; Da Silva *et al.*, 2022). In all these varieties, the method applied at the laboratory scale was efficient, showing a reduction in phytotoxicity and a reduction in COD. The reduction also ensured improvements in other parameters such as color and BOD in all the studies.

The combination of the Fenton process with biological treatment was applied and evaluated by Kalyanaraman *et al.* (2012). The Fenton reagent was applied as a pre-treatment for tannery effluents before the biological process and showed satisfactory results after the treatability of this combination of methods. The pre-treatment improved the biodegradability of the tannery effluent, resulting in the formation of short-chain hydrocarbons and reducing its COD and BOD load.

The application of the Fenton process to various types of industrial effluents is extensive; therefore, the study and deepening of the AOP by the Fenton process has become a subject of constant improvement and investigation, given its easy applicability and high benefit, which can make industries more competitive and improve the biodegradability of difficult-to-treat effluents.

One way is to apply the Fenton reagent with irradiation addition, called photo-Fenton, to increase the production of HO•. Under light irradiation, $[Fe(OH)]^{2+}$ is excited, regenerating Fe^{2+} that catalyzes the decomposition of $_{d}$e H2O2 and producing HO• that degrades organic pollutants, according to reaction 5. In addition, direct photolysis of H_2O_2 also produces HO• (reaction 6).

$$[Fe(OH)]^{2+} + h\nu \rightarrow Fe^{2+} + HO\cdot \quad (5)$$

$$H_2O_2 + h\nu \rightarrow 2\ HO\cdot \quad (6)$$

The essence of the photo-Fenton process is to accelerate the reduction of Fe^{3+} to Fe^{2+} using the energy provided by light. Since the use of artificial light makes the process expensive, utilizing sunlight can remedy this inconvenience. The combination of ultraviolet or visible light with conventional Fenton can increase the efficiency of organic pollutant degradation, reducing sludge formation.

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Chapter 4

Governance and Sustainability in Cocoa and Orange Agro-Food Systems

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Introduction

Agrifood systems have taken on various forms due to the number of agents involved and their locations, influenced by practices of proximity to the consumer, technological advancements, logistics, among other factors. All these systems, whether characterized by high-quality attributes or commoditization, require governance systems that entail proper transaction management, impacting economic, social, and environmental levels. This chapter aims to discuss how governance established in productive systems has contributed to the sustainability of supply chains. It includes an analysis of the productive systems of oranges and cocoa.

The conceptual approaches and methodological procedures involved analyses of Transaction Cost Economics (transaction characteristics, agent characteristics, and governance) and Sustainability, as well as two case studies: a) a cooperative of small orange producers in the interior of São Paulo state, Bebedouro (SP). The research subjects were 29 cooperative members and a representative of the analyzed cooperative[4], in June 2019; b) a case study involving certified cocoa producers located in the southern region of Bahia state during 2016 and 2017, and processing companies that trade for export and the domestic market. This case study included six producers (organic certification), a Collective Organization (CO), and a Buying Processing Company (BPC).

The evidence presented in this chapter contributes to achieving the United Nations (UN) Sustainable Development Goal (SDG) number 12, aiming to ensure sustainable consumption and production patterns.

In terms of structure, the next sections of this chapter discuss coordination and governance aspects in high-quality systems, the agrifood systems of oranges and cocoa, with respective case studies presented and analyzed, followed by final considerations.

[4] Inferential statistical techniques were used for data collection and general analysis, beginning with a statistical procedure to determine the sample size for qualitative variables to select the exact number of participating cooperatives.

Coordination in High-Quality Systems

National and international literature has been depicting coordination aspects of systems and governance forms concerning differentiated and certified agricultural products. Ménard (2022) contributes to the topic by stating that cooperation between distinct partners and competitors can be achieved through low-cost coordination, without losing the advantage of decentralized decisions, maintaining autonomy and transactional interdependence. This is made possible by utilizing hybrid governance forms and aligning them with the types of transactions conducted.

Ménard (2004, 2013) and Aguiar (2020) assert that hybrid transactions, an intermediate form, have multiplied and are much more common compared to market or hierarchy transactions. The growing literature on this mode of governance indicates increased interest in the surrounding issues. According to Ménard (2004, 2013), the significant role of these arrangements in shaping and monitoring economic activities will likely continue to generate a flow of theoretical models and empirical studies from academia, where hybrid organizations are considered "institutional production structures" and deserve attention from scholars in the field.

There is a common understanding of the "market" concept where supply and demand mechanisms play a central role, and price is the most important factor in regulating aspects such as adaptation. Similarly, the "hierarchy" concept represents the central role of the firm, with vertical decision-making and necessary internal adjustments. However, the concept of hybrid governance is not stabilized and can involve different formats such as clusters, networks, strategic alliances, franchises, symbiotic arrangements, supply chains, administered channels, joint ventures, non-standard contracts, among others (Aguiar, 2020; Ménard, 2004; Ménard, 2022).

Regarding empirical contributions on hybrid formats, Marchini *et al.* (2020) show how regulation and contractual freedom act as drivers for food safety investments, such as traceability and certification, in the Italian

meat sector. Wever *et al.* (2010) investigated the relationship between quality management systems among firms and the governance structures between them, suggesting that misalignment between these spheres can result in high transaction costs.

Following this, the chapter presents how the established governance in production systems has contributed to sustainability in the analyzed cases.

The Orange Agrifood System

Brazil stands out as the world's leading supplier of orange juice, responsible for 34% of global orange production and 61% of global juice production, with 95% of the total destined for exports (Citrusbr, 2019; Neves; Trombin, 2017). In 2021, the country reached a production of 16 million tons, nearly double that of the second place, India, followed by China, Mexico, and the United States (FAO, 2023).

Orange production for industrial processing in Brazil is concentrated in the citrus belt, an area extending through the state of São Paulo, part of the Triângulo Mineiro, and the southwest of Minas Gerais (Citrusbr, 2019).

According to Stuchi, Girardi, and Moreira (2021), several aspects affect the sustainability and competitiveness of citrus production in Brazil, including phytosanitary issues like Huanglongbing (HLB), which require proper management for control; climatic adversities and the need for management techniques and plant selection; growing demand for differentiated, sustainable, and agroecological products; and the intensification of technology use, such as precision agriculture.

Both citrus farming and industrial juice processing activity involve significant investments in specific assets, exposing parties to opportunistic renegotiation actions in transactions between citrus growers and juice processors (Aguiar, 2020; Ito, 2014). For example, an analysis process of a cartel formed by processing companies was concluded in November 2016, confirmed by the Administrative Council for Economic Defense (CADE).

In 2023, the companies were sued by the Federal Public Ministry, in conjunction with the Federal Court of São Paulo, with a demand for R$12.7 billion in fines (Brito, 2023).

Orange Case Study

For strategic reasons related to market positioning and branding, since 2017, an agricultural cooperative[5] decided to focus its sales solely on Fairtrade-based commercialization[6]. O principal – e único – produto comercializado no ano de 2019 foi a laranja *in natura*, que respondeu por 100% das vendas da entidade, sendo comercializada integralmente no nível regional para uma empresa processadora de grande porte, em suas sedes nas cidades do interior paulista, por meio da entrega direta do agente cooperado à processadora e sob intermédio e negociação da cooperativa (Aguiar, 2020; Aguiar *et al.* 2021).

The main – and only – product sold in 2019 was fresh oranges, accounting for 100% of the entity's sales, entirely marketed regionally to a large processing company in São Paulo's interior, through direct delivery by the cooperative member to the processor and mediated by the cooperative (Aguiar, 2020; Aguiar *et al.* 2021).

Box 1 presents the general parameters used regarding the levels of analysis concerning transaction characteristics and agents in the case in question. The investment degree in orange production by the cooperative member to supply the cooperative was classified as high, including land preparation, use of implements, fertilizers, and specific systems to meet the fruit's contractual specifications (Aguiar, 2020; Aguiar *et al.* 2021). Thus, it can be said that the specificity of the asset (orange) transacted between the cooperative member and the cooperative is classified as high. This verification is based on the degree to which the orange can be used for

5 The cooperative was founded in 2012 and includes 90 citrus growers.

6 Fairtrade is a third-party certification based on a partnership relationship between producers and consumers, enabling the improvement of living conditions and future planning for producers (Fairtrade International, 2023).

alternative purposes, such as direct supply to wholesale/retail markets and fairs, without losing its value, according to Williamson (1991) and Tadelis and Williamson (2013) *apud* Aguiar (2020); Aguiar *et al.* (2021) (Box 2).

The uncertainty involved in the transaction is classified as low, both from the perspective of the cooperated members selling oranges to the cooperative and from the cooperative's perspective in acquiring oranges from the members. This is due to the high level of knowledge by the members about the supply, demand, and price of oranges, the cooperative's social statute, and the cooperative's behavior in purchasing oranges. Similarly, the cooperative has a high level of knowledge about the supply, demand, and price of the fruit, the social statute, prevailing rules and laws, and the members' behavior in selling oranges to the cooperative.

Box 1 – Parameters of the Levels of Analysis Regarding Transaction and Agent Characteristics for the Selected Case

Parameters	Low	Medium	High
Asset Specificity	Use of simple planting and harvesting.	Use of land preparation, implements, fertilizers, and general systems.	Use of land preparation, implements, fertilizers, and specific/exclusive systems.
Uncertainty	High knowledge about the economic environment (supply, demand, and price of oranges), institutional environment (cooperative's social statute, current rules, and laws), and behavioral environment.	Medium knowledge about the economic environment (supply, demand, and price of oranges), institutional environment (cooperative's social statute, current rules, and laws), and behavioral environment.	Low knowledge about the economic environment (supply, demand, and price of oranges), institutional environment (cooperative's social statute, current rules, and laws), and behavioral environment.
Frequency	Sporadic and irregular supplies (e.g., spot, occasional).	Interval and somewhat regular supplies (e.g., alternate crops).	Regular supplies (e.g., every crop).

Opportunism	Low frequency of self-interest (market information distortion and contract breach) by the principal.	Medium frequency of self-interest (market information distortion and contract breach) by the principal.	High frequency of self-interest (market information distortion and contract breach) by the principal.
Limited Rationality	High frequency of use of market information (price, supply, and demand of oranges) and managerial information (costs, stock, technology).	Medium frequency of use of market information (price, supply, and demand of oranges) and managerial information (costs, stock, technology).	Low frequency of use of market information (price, supply, and demand of oranges) and managerial information (costs, stock, technology).

Source: Aguiar (2020) and Aguiar *et al.* (2021), based on Williamson (1991, 2012), Balestrim and Arbage (2007), and Tadelis and Williamson (2013).

Box 2 – Characterization and governance structure of the orange case study

Type	Producer Scope	Cooperative Scope
Characterization	Quantity: 29 producers; Classification: Small producers; Number of Properties: 1 per producer; Time in Activity: More than 40 years; View on Activity: Unstable (due to prices, pests and diseases, and production costs); Means of Survival: Cooperativism and Fruit Growing; Main Production Destination: CL	Year of Foundation: 2012; Number of Members (citrus farming): 90 producers; Product: Fresh oranges; Certification: Fairtrade; Production Destination: Processing industry.
Commercialization and Governance	Main Buyer: CL; Product: Fresh oranges; Governance Structure: Contract; Asset Specificity: High (land preparation and use of specific implements, fertilizers, and systems); Transaction Uncertainty Level: Low (high level of knowledge of supply, demand, price, and cooperative statute); Transaction Frequency: High (regular supplies throughout the harvest); Opportunism (ex-ante and ex-post): Low; Bounded Rationality: Low-medium.	Main Supplier: Members; Product: Fresh oranges; Governance Structure: Contract; Asset Specificity: High (land preparation and use of specific implements, fertilizers, and systems); Transaction Uncertainty Level: Low (high level of knowledge of supply, demand, price, statute, and behavior of agents); Transaction Frequency: High (regular supplies throughout the harvest); Opportunism (ex-ante and ex-post): Low; Bounded Rationality: Low.

Source: Authors' own elaboration, based on Aguiar (2020) and Aguiar *et al.* (2021).

The frequency of the orange transactions from the members to the cooperative is classified as high, with regular supplies occurring throughout the harvest season (Aguiar, 2020; Aguiar *et al.*, 2021). The frequency of using market information (such as price, supply, and demand of oranges) and managerial information (costs, stock, and available technology) by the members for decision-making in negotiating the sale of oranges to the cooperative is classified as medium. This demonstrates a medium level of bounded rationality on the part of the members, indicating the inability of the agents to fully comprehend and process all necessary information for decision-making in negotiation situations, according to Arbage (2004) as cited by Aguiar (2020); Aguiar *et al.* (2021). The use of these same pieces of information by the cooperative for decision-making in negotiating the acquisition of oranges from the members is classified as high, indicating a low level of bounded rationality by the cooperative. Furthermore, the proximity between the cooperative and the market facilitates and accelerates access to information by the institution.

Overall, from the perspective of Aguiar (2020) and Aguiar *et al.* (2021), the characteristics of the orange transaction between the members and the cooperative consist of an asset with high specificity, low uncertainty, and high supply frequency. The characteristics of the agents (members and cooperative) are highlighted by a low level of opportunism and a medium-low level of bounded rationality, based on responses from both parties.

Given the above, the contract was chosen as the regulatory means of the economic transaction, characterizing the governance in its hybrid form. The contract includes items such as the required product specificity to meet export demand through Fairtrade, the purchase price of oranges by the cooperative, the supply frequency by the producer, and the producer's responsibility for transporting the goods to the processing industry.

The low degree of transaction uncertainty reflects the institutional preparedness by the cooperative and its dissemination to the cooperative members, as well as prior knowledge of behavioral attributes by the agents involved in the transaction. This positively correlates with the low opportunism and low ex-ante and ex-post risks of this economic relationship. In this sense, hybrid governance appears to effectively coordinate transactions,

minimizing opportunism in relationships and providing an efficient solution to the historical issue of commercial integration difficulties among citrus growers (Aguiar, 2020; Aguiar *et al.*, 2021).

In the relationship between the cooperative and the processing industry, the uncertainty surrounding this transaction can also be classified as low, as the vice-president of the entity states that the cooperative has a high level of knowledge about the institutional rules involved in the transaction and the behavior of the processing company in acquiring oranges.

From the cooperative's perspective, the processing industry does not exhibit self-interest behaviors such as distorting information about demand, price, and breaching contracts in purchasing oranges, classifying the level of opportunism in this relationship as low or nonexistent. The frequency of using market information (such as price, supply, and demand of oranges) and managerial information (such as costs, stock, and available technology) by the cooperative for decision-making in negotiating the sale of oranges to the processing industry is classified as high, indicating a low level of bounded rationality by the cooperative (Aguiar, 2020; Aguiar *et al.*, 2021).

Overall, and as initially highlighted in the member-cooperative relationship, the characteristics of the orange transaction between the cooperative and the processing industry involve an asset with a high investment degree, low uncertainty, and high supply frequency. The characteristics of the agents are highlighted by low levels of opportunism and bounded rationality, from the cooperative-buyer's perspective (Aguiar, 2020; Aguiar *et al.*, 2021).

The Cacao Agri-Food System

Brazil has been making efforts to expand cacao production since the end of the 20th century, when the industry faced stagnation due to various reasons, including decreased productivity caused by phytosanitary problems,

particularly the fungal disease witches' broom (Moniliophthora perniciosa), conservatism within the agricultural production segment, among others. From 2016 to 2021, the growth rate of cacao cultivation in Brazil was 42%, reaching a production of 302,000 tons of beans in 2021 (FAO, 2023). This production growth has been accompanied by new institutional arrangements in the supply chains motivated by the increasing value placed on sustainability and origin aspects. In this context, certifications play a significant role. Examples of voluntary certifications used for sustainability in the sector include organic, Fairtrade, UTZ, and Rainforest Alliance. Brazil accounted for 1% of global organic production in 2020 (Presse, 2020). Organic certification ensures that products have indeed been produced within the standards of organic agriculture, primarily due to the absence of pesticides and chemical fertilizers, for example (Organicsnet, 2023).

Case Study on Cacao

The analysis focuses on the state of Bahia, specifically the southern region of Bahia, as it accounted for 83% of national production in 1990, with this production being 51% in 2020 (Brainer, 2021). This region and other organizations have been making efforts to implement higher-quality cacao production through support policies and the establishment of a geographical indication. These actions involve projects from processing companies and other organizations acquiring raw materials, as well as local governance.

The governance structures established in the producer-buyer relationship were evaluated, focusing on the economic, environmental, and social aspects of sustainability, based on contributions from Sachs (1993) and Elkington (2004, 2006). In the economic realm, analytical categories indicated by Transaction Cost Economics (TCE) were used, adapted from the works of Reys, Arbage, and Oliveira (2009, 2010) and Arbage (2004)[7].

[7] In the case study on cacao, the economic analysis can be comprehensively carried out from the perspective of the purchasing processing company towards the collective organization, although there was no triangulation of the information.

For environmental and social aspects, the concepts of sustainability and authors like Neumeier (2012) and Moulaert (2009) were considered.

The case of cacao production analyzed highlights the characteristics of organic certification, which includes quality attributes such as the absence of chemical inputs, sustainable cultivation methods, and environmental and social preservation. These attributes are not easily perceived through observation, hence the necessity for third-party verification. Certifications are thus employed to make this information clear to all agents involved in the production processes along the agribusiness system, including the consumer (Santini Pigatto *et al.*, 2020).

It can be observed that the demands of purchasing agents extend to contractual relationships, as they involve aspects related to organic product certification. The processing purchasing organization focuses on meeting both national and international markets with high-quality cacao beans that offer better performance in chocolate production and flavor. These quality attributes surpass the product standards established by the government through IN38/2008[8] which sets standards for cacao beans. In the relationship between the producing agents and the collective organization, no formal contracts were identified. However, the relational value involved is very high due to factors such as the origin of the producers (many from the European Union, bringing with them 'values' of the land) and the nature of the production itself. The production is conducted in a cabruca system[9], which motivates and gathers agents who value nature preservation (Box 3).

8 Normative instruction no. 38/2008 presents a classification of cocoa beans from type 1 to 3 and out of type, with tolerance percentages for defects such as mold, smoke, insect damage, slate, germination and flattening, from lowest to highest tolerance from type 1 to out of type (Brazil, 2008).

9 The cabruca system consists of a traditional cocoa agroecosystem that involves traditional knowledge, conservation and preservation of native species, promoting interaction with the ecosystem (Setenta; Lobão, 2012).

Box 3 – Characterization and governance structure in the cacao case study

Type	Producer Scope	Purchasing Company (ECP1) Scope
Characterization	Six producers; average age: 58 years Average experience in cacao production: 25.5 years. Educational background: majority with higher education or postgraduate degrees. Agricultural properties for cacao production: mostly owned, with most owning two to three properties Economic activities: diversified, including cacao, cupuaçu, açaí, peach palm, coffee, palm heart, cacao processing, and rural tourism services. Labor used: family labor (1-2 people); predominantly permanent labor (average of five people). Cacao production system: Organic cabruca. Average production (2013-2015): 845 arrobas. Certifications: Organic Brazil (since 2002), USDA organic (since 2003), and equivalent standards for European regulation (since 2002).	National family-owned company. Founded in 2005, with a prior history in chocolate production for final consumption. Economic activity: primary cacao processing. Crushing capacity: 20,000 tons per year. Product portfolio: Conventional line (80%) and special line (with certifications, 20%), for the years 2014-2015. Certifications: Organic Brazil, USDA organic, EU organic regulation, Kosher, Fairtrade, Rainforest, and Raw. Market: 50% for export and 50% for the domestic market, including cosmetic companies, chocolatiers, and dietary supplement companies.

Type	Producer Scope	Purchasing Company (ECP1) Scope
Commercialization and Governance	Purchasing Agents: Collective Organization (OC) and local market. Vertical Integration: One producer is also involved in chocolate manufacturing. **– Transaction with OC:** 50-65% of the average production (2013-2015). Product sold: cacao beans **– Governance Structure:** No formal contracts (high relational value). Payment: Immediate Premium: 30% above market price + a percentage of the net gains of the current year, proportional to the volume each producer delivers during the year. **– Transaction OC to downstream (secondary information):** Purchasing agents: national and international chocolate companies (including ECP1). Product sold: cacao beans.	Suppliers: Producers and cooperatives from the states of Bahia and Pará. Product Acquired: Organic cacao beans (20% of total production, certified) and conventional beans (80%) for the years 2014-2015. **– ECP1 Transaction with OC:** Acquires approximately 90% from OC. **– Transaction Characteristics:** Long-term transaction (11 years). Uncertainty: Low level, due to high information sharing in three areas (demand forecast, production forecast by OC, and production innovations by producer-OC). Asset Specificity: High (physical, locational, dedicated), Medium (temporal). **– Agent Characteristics:** Opportunism: Low level in both the ECP1-OC relationship and ECP1's view of the OC-ECP1 relationship. Limited Rationality (RL): Low RL, with extensive information on the quality cacao market (price, demand, supply); from suppliers regarding production technologies and quality; processing technologies; and management (costs, inventory, and marketing). **– Governance Structure (with OC):** Annual contract, detailing the volume purchased, payment terms, and price. Payment Method: Immediate. Transportation: Conducted by the company without discounting. Premium: 50% to 70% above market price; price benchmark based on downstream purchasing companies.

Source: Santini Pigatto *et al.* (2020).

The transaction between the collective organization (OC) and the purchasing agent (ECP) occurs with annual supply contracts. It is noticeable in this transaction an economic governance that translates not only into the existence of a contract but mainly into the efficiency and productive, informational, and economic coordination between ECP and its client, which leads to a valuation of the purchased product, given the on-site verification of preservation and work aspects in agricultural production. This valuation is both economic—higher premiums attributed to the marketed cacao beans—and related to the appreciation of the Atlantic Forest, given the production in the cabruca system. Another factor contributing to effective governance is the transaction and agent characteristics observed from the ECP perspective, indicating more effective governance, such as the long-term relationship (specifically 11 years), low uncertainty level, high asset specificity in physical, locational, and dedicated factors (only lower in the temporal factor due to the storage capacity of the beans), low opportunism level (in the ECP-OC relationship and the OC's view of the ECP), and low limited rationality, i.e., a higher level of information utilization regarding the market, supplier production and quality technologies, processing technologies, and managerial aspects (Santini Pigatto *et al.*, 2020).

Thus, more effective economic governance was observed at the agro-industrial system level between the ECP and its downstream purchasing agent, reflecting a valuation of the purchased product that involves both economic and non-economic aspects. The coordination and efficiency achieved—also supported by contractual governance—are evident in the relationship between the OC and the producers, given the net financial gains they obtain at the end of each year, proportionate to the volume each producer delivers throughout the year.

When analyzing whether this economic governance also impacts social and environmental aspects, it becomes clear that there is no direct influence or coordination by the purchasing agent in this regard, as the relationship is purely commercial. However, it is worth noting that the purchasing companies' willingness to pay a premium price for cocoa beans

can incentivize producers to maintain quality and adopt sustainable socio-environmental practices.

Regarding environmental factors, it is evident from the producers' perspectives that they aim to maintain or even expand forest preservation areas, including production (and replanting) using the cabruca system. In the case analyzed, all farms have protected springs that not only supply water to the families living on the property but also contribute to the preservation of regional rivers (Santini Pigatto *et al.*, 2020).

Therefore, the established governance structure fosters economic sustainability and operates based on producer and buyer incentives. The hybrid forms adopted closely resemble market structures where price acts as an incentive mechanism, such as paying premium prices for higher-quality cacao beans. However, there are other non-financial incentives indirectly affecting environmental and social sustainability, such as technical assistance, donation of seedlings, and organic inputs to producers to improve the production process. Another point to highlight is the certifications that bring a series of social and environmental requirements.

Regarding social aspects, even though there are established programs by the buyers, no significant changes in social relations or satisfaction levels of families or communities were noted (Santini Pigatto *et al.*, 2020).

Final Considerations

The cases analyzed in this chapter highlight relevant production systems for the country from economic, social, environmental, historical, and cultural perspectives, both for orange and cacao. These systems have been receiving added value and coordination promotion through certifications that signal information from agricultural production to the destination. Hybrid governance forms were observed in both cases in various transactions between system agents, specifically contracts, as higher quality attributes are crucial for both systems.

Regarding sustainability aspects, greater economic convergence was noted through premium prices. However, the cooperative format in the case of orange production and sale and coordination exercised by a secondary buyer (in prices) in the cacao case denotes important social aspects for better information exchange and reputation in the systems.

It is worth noting that the certifications used in both systems encompass requirements beyond technical aspects, also covering social and environmental aspects. Thus, the governance established in the cacao and orange production systems promotes primarily economic sustainability but also indirectly contributes to social and environmental sustainability.

In broad terms, the results contribute to the UN's SDG 12, specifically to achieving sustainable management and efficient use of natural resources and encouraging companies to adopt sustainable practices and integrate sustainability information into their reports (SDGs 12.2 and 12.6, respectively).

As a contribution of this chapter, it is hoped that the analyzed cases can inspire new analyses of coordination and governance in Brazilian agri-food systems, both complex ones.

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Part II

Chapter 5

Food and Nutrition Education: An Analysis of Consequences, Prevention Strategies, and School Development

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Introduction

In contemporary society, marked by rapid changes in lifestyle and dietary patterns, the issue of food and nutrition stands out as a crucial component for overall health and well-being. Within this complex scenario, Food and Nutrition Education (FNE) emerges as an indispensable strategic approach, aiming not only at understanding the negative impacts of inadequate dietary habits but also at implementing effective preventive strategies.

This text proposes to conduct a comprehensive analysis of the consequences associated with unbalanced dietary practices, highlighting the urgent need for educational interventions. In this context, the role of FNE as an essential tool in the prevention of health problems related to diet is examined, contributing to the formation of healthy habits from childhood. Additionally, the text addresses the impact of this approach in the school context, investigating how the promotion of conscious eating can positively influence students' academic, cognitive, and social development within the school environment, integrating the theme into the school curriculum and pedagogical practices.

By exploring the links between food education, the consequences of inadequate eating habits, and school performance, this work seeks to provide valuable insights for the formulation of efficient preventive strategies. A deep understanding of these relationships is essential not only for the individual development of students but also for building a healthier and more resilient society.

The Global Syndemic Between Health and Food

Since the 1970s, the definition of hunger by the Food and Agriculture Organization of the United Nations (FAO) has become more

restrictive, linking it to chronic malnutrition. This condition not only implies the lack of food but is also associated with vitamin and mineral deficiencies, contributing to the occurrence of these deficiencies when chronic malnutrition is present (Ribeiro Junior, 2021).

On the other hand, the problem of malnutrition emerges as one of the main public health challenges in contemporary times. Both malnutrition and obesity, along with the ramifications of climate change and its impacts on human health and vital ecosystems for our survival, are now widely recognized as components of a global syndrome or syndemic that significantly affects the population worldwide. Food systems play a crucial role in this syndrome, encompassing three fundamental elements: the chain from food production to commercialization, the environment in which eating occurs, and the eating habits adopted by people (Swinburn, *et al*., 2019).

It is important to emphasize that besides literal hunger and malnutrition, there is a "hunger" related to knowledge, characterized by misinformation about certain foods. Often, this lack of information results from family influences and resistance to seeking or trying new food options.

Given the challenges, it becomes essential to integrate FNE into the teaching and learning process, incorporating it comprehensively into the school curriculum. This implies addressing topics such as food, nutrition, and the adoption of healthy lifestyle practices, to promote food and nutritional security. This approach should be an integral part of the school routine, with clearly defined roles for various agents, including governments at different levels, society, family, school, teachers, and students. The goal is to reshape the concepts established in society regarding food and nutrition.

A concrete example of this approach was observed during an event in Tupã/São Paulo (SP), a Scientific Dissemination Fair. In this context, it became evident that food education is necessary from early childhood, providing students, within formal education, the opportunity to learn about the complete cycle of plant development, from planting and cultivation to harvesting and conscious, healthy, and sustainable consumption. The proposal for a pedagogical garden in the educational

environment stands out as a practical tool for this education, allowing for extensive dissemination within the family and community. The aim is to break down entrenched prejudices in families and promote a change in local culture.

This theme and an interesting initiative occurred in partnership with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Ministry of Education (MEC) through the guiding document of the school curriculum called the National Common Curriculum Base (BNCC). This document, which incorporates skills to be taught in different subjects as Cross-Cutting Themes, addresses the Sustainable Development Goals (SDGs) (UNESCO, 2020), including topics such as environmental and food education, human rights, health, among others.

Food and Nutritional Security: Where We Come From and What We Aim For

About three million years ago, the basis of human nutrition consisted mainly of roots, seeds, and fruits rich in sugars. Over time, significant changes occurred, such as the introduction of a diet rich in proteins, demonstrating one of the ways to develop the species' brain. However, the global scenario has transformed with the advent of a faster-paced life, driven by increasing globalization, traffic, commuting, and the migration of families from rural to urban areas in search of employment.

In this context, industrialization played a crucial role, resulting in the increase of processed food production by industries, driven by technological advancement. This culminated in the large-scale proliferation of processed foods and beverages, leading to significantly negative consequences for human health, as highlighted by the Pan American Health Organization (PAHO) in 2018.

With the global concern over food security in the contemporary world, accompanied by rising obesity and malnutrition across all age

groups and social classes and other food-related diseases, new guidelines and documents are urgently being analyzed to promote changes in food systems. The main goal is to make them healthy, sustainable, and equitable, considering their interconnectedness with health, the environment, climate, and agriculture. In this context, the 2030 Agenda emerges, aiming to set goals to be met in agroecological food systems and promote health at local, regional, national, and global levels (Burigo, 2021).

The terms related to malnutrition: undernutrition and obesity, along with climate change, constitute a global syndemic that forms a guiding thread, i.e., the unsustainability of current food systems. In this context, national policies addressing issues related to food and nutrition emerge as important intersectoral tools to achieve sufficient, healthy food and, consequently, food and nutritional security. Besides the aspects previously mentioned, the Food Guide for the Brazilian Population, which presents information, analyses, preparation and consumption methods of foods, is used as a strategic support tool for FNE initiatives. Essentially, health, agriculture, and environmental policies need to be articulated to achieve sustainable development.

The World Health Organization (WHO) recognizes and prioritizes actions that focus on Food and Nutritional Security, nutrition improvement, and hunger eradication, including agricultural sustainability (Jones; Ejeta, 2016). Improving the global supply of vegetables remains key to reducing conditions of malnutrition and obesity. Within this theme, in September 2015, the SDGs of the 2030 Agenda were adopted by 193 countries in pursuit of a healthy future for the world, with aspects focused on food and health promotion having direct insertion and adherence in about four of these global goals of the United Nations (UN), 2023, namely:

- **Goal 1:** End poverty in all its forms everywhere.
- **Goal 2:** End hunger, achieve food security and improved nutrition, and promote sustainable agriculture, providing livelihoods for the current global population and improving the income of food producers.

- **Goal 3:** Ensure healthy lives and promote well-being for all at all ages. Notably, some efforts are being made by governments at different levels to meet the proposed goals, such as the National School Feeding Program (PNAE), a federal government program that aims to ensure adequate food for schoolchildren.
- **Goal 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, with a sub-goal (4.7) aiming to ensure that learners acquire the knowledge, and skills needed to promote sustainable development, including sustainable lifestyles. With the qualification of teachers, guarantees of equity of access and permanence, and free provision in the public network that leads to satisfactory and relevant learning outcomes, FNE can have a substantial impact on the teaching-learning process and the promotion of health and well-being.
- **Goal 12:** Ensure sustainable consumption and production patterns, such as better planning of crops, thus reducing waste and improving the daily use of food (World, 2016).

In 1988, the Unified Health System (SUS) was established to promote the general health of the population throughout the country. In addition to actions such as disease prevention, vaccination, and infectious disease prevention campaigns, SUS has made continuous progress in recent years in providing universal and comprehensive health care to the Brazilian population, contributing to reducing inequalities in access to health care. SUS works in conjunction with other public policies, mainly through Primary Health Care (APS), to combat global epidemics, contribute to the control of obesity and malnutrition epidemics, and contribute to climate change mitigation and adaptation (Ebi *et al.*, 2017).

Regarding food, SUS plays an important role in food and nutrition care, promoting and protecting health, as well as preventing, diagnosing, and treating food-related diseases. Its actions are integrated into the current food system and have the potential to influence various areas of this system,

such as the agro-food production chain, the food environment, and food consumption, with impacts on health, the environment, and the economy.

Therefore, SUS is considered a crucial tool for sustainable development, and there is an urgent need for policy convergence, greater integration, and synergistic action between actions, as well as dialogue between actors from different sectors. Advances in the field of Earth Health, which involve the collective study of human behavior in the environment and its impact on the health and sustainability of the planet, play a fundamental role in promoting sustainability in public health policies.

Additionally, people with rights and duties related to education, health, and agency, can act as citizens in demanding the fulfillment of human rights to adequate food and a healthier food environment for all. Thus, SUS should act as a catalyst in the development of a safer, fairer, healthier, and more sustainable food system (Machado, 2021).

Malnutrition and School Development

Over the years, education has emerged as a crucial partner in the fight against malnutrition, as it enables the establishment of a relationship between diet and health issues. In this context, it is essential to conduct popular education combined with nutritional education, enabling the comprehensive recognition of individuals and promoting good social relations (Quevedo Bolívar, 2019).

Concerning popular education, it is essential to promote critical awareness that allows the identification of problems associated with poor nutrition and alternatives to modify eating habits. It is essential to seek to overcome oppressive situations to make significant changes in this context (Lorenzo, 2008).

The reorientation of educational concepts with established models in the systematic process of cultural engagement suggests that education integrates two worldviews, recognizing that both do not hinder the formation of identity traits, but rather the emergence of new codes and

meanings. In this context, educating the population through schools offers an intercultural space where different worlds connect and influence each other (FAO, 2011).

Poor nutrition is one of the factors directly related to the learning process (Ferreira, 2019). It is known that every nutrient has its particularity, relevance, and importance for development, especially in childhood, a phase in which the entire organic and learning system is undergoing constant transformation, with some nutrients being indispensable for brain development, notably iron, iodine, zinc, B-complex vitamins, especially B12, and zinc (Macedo, 2019). A child who has learning difficulties has poor performance in daily activities, family, and social relationships (Cerqueira, 2022).

There must be actions related to FNE in schools, as it is one of the ways to influence students to adopt better eating habits with better quality of life, changing their culturally constructed habits (Magalhães; Cavalcante, 2019), with teachers being the promoters and facilitators of FNE actions, which should include pedagogical content related to healthy eating and health in their school planning (Silva *et al.*, 2018).

In this context, the school, as a learning environment, should promote and prevent diseases, to influence healthy eating habits. FNE actions should start from early childhood education to prevent future pathologies (Magalhães; Cavalcante, 2019).

It is important to highlight that the collaboration between the nutritionist, through the PNAE, together with the school, the community, and teachers, should promote access to healthy foods through public policies and effective actions (Vasconcelos, 2020). The educator plays a crucial role as an influencer and can use engaging learning approaches in their classes, using characters, cartoons, and a variety of playful materials related to food as pedagogical resources (Maito, 2018). Thus, the teacher should address nutrition and health topics at school in an interdisciplinary manner, not to prevent or treat diseases, but to teach students in a way that empowers them to make their own decisions (Silva *et al.*, 2017). Boff (2011), p. 143, states, "It is not about reflection on practice based solely on

experiential knowledge disconnected from theory. It is about a professional who reflects on their knowledge, obtained from practice and understood in light of a theory."

As Vigotsky (2008) states, "the child thinks syncretically about subjects they have no knowledge or experience of but does not resort to syncretism concerning familiar or easily verifiable practical things" (p. 27). Therefore, it is essential that educational activities are interest-promoting, articulated, and in line with the school's Political Pedagogical Project.

School-aged children can play a crucial role as change agents, as their tastes and preferences are being shaped. When allied with healthy eating habits, we can form a generation committed to proper nutrition. Therefore, transmitting information to different social groups can help increase collective awareness of health and nutrition (Quevedo Bolívar, 2019). It is also worth noting that students are important vectors in bringing school learning into their homes, positively influencing their families and surrounding communities.

In Brazil, the PNAE, administered by the federal government and maintained by the National Fund for the Development of Education (FNDE), ensures that school-aged students receive food during their school period. This program guarantees safe, diverse, and healthy food for students in early childhood, elementary, and high school education (Cesar *et al.*, 2018; Roque, 2017). The main objective of the PNAE is to eradicate hunger and malnutrition, contributing to increased school performance and learning by offering nutritious and quality food, aiding in growth, development, and promoting Food and Nutritional Security (SAN) for students (Gomes, 2020). The program's objectives and benefits include educating students to eat in a way that promotes health through proper, healthy, and sustainable eating, prioritizing natural foods, respecting regionalism, and prioritizing foods from family farming.

Education is a right for all, but school success cannot be confined solely to the family and school sphere; public policies are also necessary. When education encompasses issues involving health promotion, focus and effort must be maximized so that, by fulfilling the roles of governments

at different levels, the school, the community, the teacher, and the family, the student can benefit in different aspects of their life, making it healthier and richer in knowledge.

Actions of PNAE and FNDE for Food

According to Brasil (2020), the National School Feeding Program (PNAE) refers to the provision of school meals regulated by resolution CD/FNDE nº 06, of May 8, 2020, which presents guidelines for healthy school meals with safe and varied foods that support the comprehensive, biopsychosocial development and learning of students, using preferably natural or minimally processed foods, with care for those with dietary restrictions, allergies. Attention to food should be based on menus planned according to the current resolution, presented in its article 18:

> I – at least 30% of the nutritional needs of energy, macronutrients, and priority micronutrients, distributed in at least two meals, for partial period daycare centers.
>
> II – at least 70% of the nutritional needs of energy, macronutrients, and priority micronutrients, distributed in at least three meals, for full-period daycare centers, including those located in indigenous communities or quilombo areas.
>
> IV – at least 20% of the daily nutritional needs of energy and macronutrients, when offering one meal, for other students enrolled in basic education, in a partial period.
>
> V - at least 30% of the daily nutritional needs of energy and macronutrients, when offering two or more meals, for students enrolled in basic education, except partial period daycare centers.
>
> § 1º In schools that offer school meals in a partial period, menus must provide at least 280 g/students/week of fresh fruits, vegetables, and greens, distributed as follows:
>
> I – fresh fruits, at least two days a week.
>
> II – vegetables, at least three days a week.

> § 2º In schools that offer school meals for a full period, menus must provide at least 520 g/students/week of fresh fruits, vegetables, and greens, distributed as follows:
>
> I – fresh fruits, at least four days a week.
>
> II – vegetables, at least five days a week (Brasil, 2020, p. 7-8).

According to the same author, the program reinforces the need to include the topic of food and nutrition in school activities to encourage the teaching and learning process.

A significant milestone in the history of the municipality of Tupã is the partnership with the São Paulo State University "Júlio Mesquita Filho" (UNESP) in promoting courses inviting participation from municipal network teachers, directors, coordinators, and general staff. In 2022, the institution promoted a course called Scientific Literacy, which allowed public participation and served as a basis for expanding and disseminating courses, events, and sustainable development partnerships focused on healthy eating. This event resulted in the municipality's greater aspiration to fulfill the SDGs and seek strategies to achieve the green and blue municipality seal.

Based on the criteria outlined earlier, it is noteworthy that the municipality of Tupã is focused on meeting the SDG goals and aims to be one of the leading cities in healthy eating and health. This was confirmed by the first food and nutritional security conference in a proposal debate aimed at eradicating hunger and the possible actions of TUPÃ 2030, held on August 2, 2023. Coordinator Gislaine Rodrigues Treviso reports that the event follows planning according to the National Food Security Council (CONSEA). She also states that this was the first stage of several debates, focusing on the state and federal levels. The event was attended by 110 people from various sectors, secretariats, and citizens and was coordinated by the Municipal Food and Nutritional Security Council (Comsea), in partnership with the management committee of the municipal TUPÃ 2030 Program. The event discussed strategies and public policies to

mitigate malnutrition, starting with the theme "Eradicating hunger and guaranteeing rights with real food, democracy, and equity" (Tupã, 2023).

The event's themes followed these axes: 1st axis – structural determining factors and macro challenges for food and nutritional sovereignty and security; 2nd axis – Public policies that ensure the right to adequate food, the national food and nutritional security system; and 3rd axis – Participation and social democracy.

Coordinator Gislaine highlights that: "Among 21 proposals listed in a pre-conference, participants elected 9 items from Axis 1, which were taken to the regional stage. In Axis 2, we had five, and we voted on three. From the last axis, we also elected three proposals."

The TUPÃ 2030 Program is in its 3rd Forum. Additionally, Professor and Municipal Secretary of Education, Sports, and Culture Valdir Pedro Berti (2023) state that: "The project has an intersectoral perspective by nature. Today, the Health, Social Development, Environment, Agriculture, Planning, Education, Culture, and Sports secretariats presented effective work and concrete projects that will allow Tupã to become one of the ten municipalities in the state of São Paulo with the best nutritional index in childhood. An audacious goal, but one that is being put into practice daily."

According to the historical note from the São Paulo State Government related to the Green Blue Municipality program, Tupã/SP presents the following scores: 2008 (79.96); 2009 (84.84); 2010 (87.29); 2011 (91.98); 2012 (79.65); 2013 (74.00); 2014 (12.28); 2015 (14.03); 2016 (10.22); 2017 (6.23); 2018 (24.72); 2019 (30.88); 2020 (40.23) (Secretariat of the Environment, 2023). Currently, in conversation with the Municipal Secretary of Tupã/SP, Marco, from the 2023 administration, the municipality has been losing the minimum score for maintaining the seal and is currently at an average of 4. In August this year, the municipality developed projects to regain the Green Blue Municipality Program (PMVA) seal. This program was launched by the São Paulo State Government in 2007, through the Secretariat of the Environment, to evaluate and support the effectiveness of environmental management,

promoting decentralization, and valuing the sustainable environmental agenda in municipalities (Secretariat of the Environment, 2014).

The Secretariat of the Environment, in 2014, through its program, established the implementation of proposed actions based on evidence, through guidelines to become a more sustainable municipality. This involves areas such as environmental education, biodiversity, water management, local sewage treatment, and other initiatives. The municipality of Tupã/SP, in collaboration with the Education and Environment secretariats, will incorporate evidence, and work done for sustainability, culture, and biodiversity into daily school activities (Tupã Municipality, 2023).

Strategies for improving food quality and school development in line with government programs

Non-Conventional Food Plants (PANC) to a certain extent offer the possibility of their use as food, among other qualities they can also be commercialized, contributing to the income of many family farmers. They also help to complement and enrich the diet. Their use can be in various gastronomic utilities, such as colorings, meat tenderizers, condiments, obtaining oils, where more than one part of the plants can be used (Kinupp; Lorenzi, 2014).

Tropical and subtropical countries, like Brazil, hold the greatest diversity of plant species; however, the number of native fruit and vegetable species proportionally used is minimal, showing the country's potential to explore various plants with food potential. For example, among the 10 most produced fruit species in Brazil, none are native (Kinupp, 2009, p. 1). As previously mentioned, Brazil is a country that stands out in food production, however, "food and nutritional insecurity is determined by economic, political, environmental, and educational factors" according to (Santos, 2022, p.11). Thus, the construction of society is shaped including its dietary patterns. However, it is possible to seek an accessible food alternative at low cost and favoring regionality.

Thinking about its versatility, the great biodiversity found in the national territory, its commercial and food potential, the importance of using these plants is sought to be highlighted to value, promote health, school development, and make PANC visible notably through the implementation of these foods in school gardens.

The school garden is a learning strategy about food and nutrition where children have various experiences and contact with vegetables, in the case of PANC making the learning more attractive and enjoyable, contributing to the interest in experimenting with them. Thus, the planning, execution, and maintenance of these teaching-learning spaces aim to promote good eating habits that will act in promoting health.

The school garden requires small areas for the cultivation of plants such as vegetables, spices, and medicinal herbs, which can be consumed complementarily to the school meals already offered, in cooking workshops, and in the development of various pedagogical activities (Santana, 2021).

Certain authors recognize that PANC have greater nutritional factors than conventional plants, thus being able to replace other vegetables, in addition to highlighting their versatility in urban spaces such as gardens and their commercial potential (Silva Liberato; Lima; Silva, 2019). Cultural patterns can be an aggravating factor in not recognizing the potential of PANC. Thus, the possibility of taking advantage of the biodiversity of plants we have will also depend on the dissemination, availability, and processing technologies to activate the valorization of this natural resource (Kinupp; Lorenzi, 2014).

Hunger is part of a social dynamic promoted by social inequalities. It is necessary to create public policies to solve this problem. Food sovereignty is also part of this process, and in this sense, an interesting solution would be to encourage the introduction of PANC in the diet, to mitigate the effects of food insecurity and improve the quality of life (Kinupp; Lorenzi, 2014).

The creation of school gardens offers various benefits from sparking students' curiosity, and a greater understanding of sustainability, stimulating collective work, encouraging contact with nature and its resources bringing positive impacts on teaching-learning, from practices

to stimulating students' awareness and making them more responsible about environmental and food issues promoting a balance between nature, education, and food besides instructing them to develop a critical vision and transform the environment they are inserted in.

Therefore, the design and assembly of gardens in the school environment should be considered as a living and constantly changing laboratory and with the stimulus to the planting and consumption of PANC, it will be possible to consume healthier foods, economically, contributing to nutritionally enrich the food already offered in the school, which should have a balanced composition of calories, proteins, fibers, carbohydrates, and other nutrients to ensure that the student has a strictly balanced meal and the knowledge of food plants not yet explored by this group, arousing interest and curiosity and together with the support and encouragement of governments and the community, the student can benefit from the production obtained throughout the process, from its design, implementation, care, and finally consumption.

Final Considerations

The text addresses various interconnected facets related to food, health, education, and sustainability. It highlights the crucial role of industrialization, which, driven by technological advancement, resulted in increased production of processed foods. However, this large-scale proliferation of industrialized foods brought with it negative consequences for human health, as warned by the Pan American Health Organization in 2018.

The creation of the Unified Health System (SUS) in 1988 represented a milestone in Brazil, aiming to promote the population's health through comprehensive actions, such as disease prevention, vaccination, and prevention campaigns. The Unified Health System has evolved over the years, playing an important role in reducing inequalities in access to health, working together with other public policies, especially in primary health care.

Education emerges as a crucial partner in the fight against malnutrition, enabling the establishment of a connection between food and health problems. The importance of popular education allied to nutritional education is highlighted, promoting the integral recognition of the person and the construction of good social relations.

The reorientation of educational concepts, based on systematic engagement in cultural practice, suggests that education integrates different worldviews. In the school context, it offers an intercultural space, connecting and influencing different realities.

The relationship between poor diet and the learning process is explored, highlighting the importance of nutrients such as iron, iodine, zinc, and B-complex vitamins in brain development, especially in childhood. Actions related to Food and Nutritional Education in schools are emphasized as an effective way to influence students to adopt healthy eating habits.

The collaboration between nutritionists, schools, and the community, through the National School Feeding Program, is highlighted as essential to promote access to healthy foods through effective public policies. The role of the pedagogue as an influencer, using playful approaches, is highlighted, and the need for interdisciplinary work on nutrition and health in schools is emphasized.

The importance of educational activities that promote interest and are aligned with the school's Political Pedagogical Project is emphasized, recognizing the potential of school-aged children as agents of change. The National School Feeding Program is cited as an initiative that aims to eradicate hunger, promoting growth, development, and food security for students.

The discussion expands to the sustainability sphere, with mention of municipal actions based on evidence to make cities more sustainable. The importance of Non-Conventional Food Plants is highlighted, not only as food options but also as a source of income for family farmers. The potential of these plants to enrich the diet and their versatility in urban spaces is highlighted.

The text concludes by emphasizing the need for public policies to tackle hunger, highlighting food sovereignty as part of this process. The introduction of Non-Conventional Food Plants in the diet is proposed as an interesting solution to mitigate food insecurity and improve the quality of life. In short, the text highlights the interconnection between different areas, emphasizing the importance of integrated approaches to promote a healthy and sustainable life.

The comprehensive analysis of the consequences associated with unbalanced eating practices highlights the urgency of educational interventions. The proposal to integrate food education into the school curriculum, with an emphasis on creating educational gardens, emerges as a practical and effective strategy to promote healthy habits from childhood.

The research also explores the interconnection between food education, the implications of inadequate eating habits, and school performance. Highlighting the global syndemic that combines malnutrition and obesity, the research suggests that food systems play a crucial role in this complex scenario.

It is relevant to note the emphasis given to the partnership with international organizations, such as UNESCO, and the alignment with the Sustainable Development Goals. This provides a solid basis for the proposals presented, highlighting the importance of food education in the broader context of sustainable development.

The inclusion of governmental actions, such as the National School Feeding Program, demonstrates a practical understanding of initiatives at the national level. Furthermore, local initiatives, such as the conference in Tupã/SP, illustrate the real implementation of the proposed strategies and active community participation.

Suggestions for improvement include a more detailed emphasis on Non-Conventional Food Plants, specific examples of these plants and their nutritional benefits. Additionally, a more in-depth approach to the impacts of food education on academic performance and social development of students, with specific data or studies, could further strengthen the research.

Overall, the research presents a holistic and practical approach to addressing contemporary food challenges, highlighting the importance of food education as a catalyst for a healthier and more sustainable society.

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Chapter 6

Food Losses and Waste: Case Studies in Food Retail

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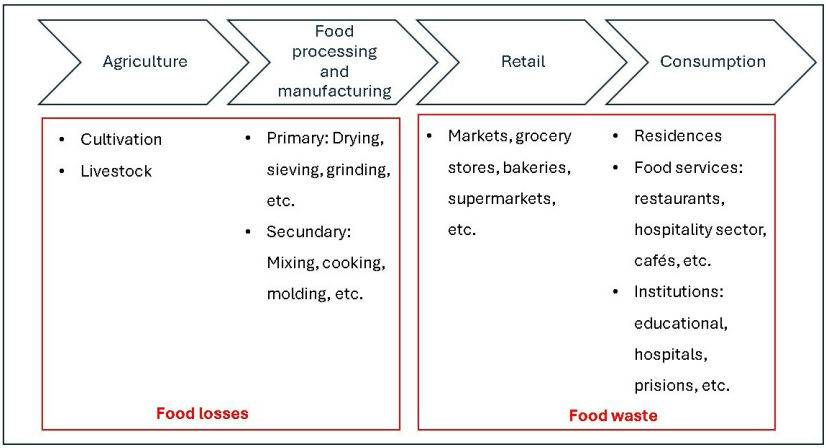
Food Losses and Waste: Context and Impacts

Food losses and waste can occur throughout the supply chain. From the producer to the final consumer, food is lost and wasted (FAO, 2019; Horós; Ruppenthal, 2021). In 2011, a study by the Food and Agriculture Organization of the United Nations (FAO) pointed out that about one-third of the food produced on the planet is lost or wasted every year. However, the organization started studying new indices to improve PDA estimates. The new index, the Food Loss Index (FLI), suggests that 14% of the food produced is lost even before reaching retail (SOFA, 2019). Even with the significant reduction, the topic is still relevant, as it represents not only economic loss but also environmental, nutritional, and moral loss, given the increasing number of hunger and food insecurity around the planet (FAO, 2023).

Although the terms "food losses" and "food waste" are used interchangeably, they are different concepts. Both represent a reduction in the availability of food for human consumption occurring along the supply chain; however, losses mainly occur in the production, post-harvest, and processing phases (Parfitt *et al.*, 2010). Waste, on the other hand, occurs at the end of the food chain (retail and consumption) due to the behaviors of retailers (in their commercial establishments) and consumers (in their homes) (FAO, 2011; Gustavsson *et al.*, 2011; Parfitt *et al.*, 2010). These distinctions are useful since strategies to reduce waste and their causes differ between the initial stages of the production chain and the final stages. Figure 1 shows the stages of the supply chain where PDA occurs.

Figure 1 – Activities that generate losses and waste along the supply chain



Source: Papargyropoulou *et al.*, 2014, p. 107.

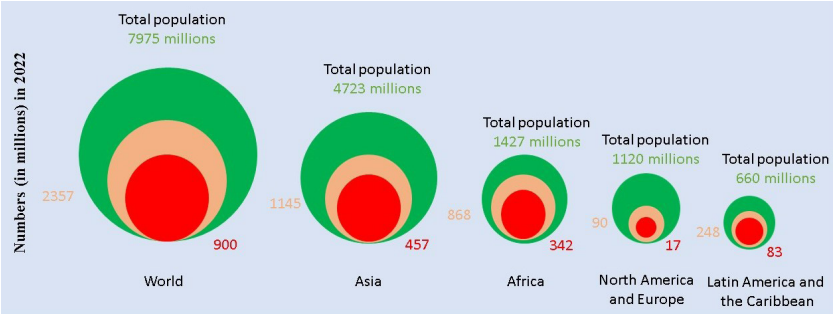
Worldwide, 1.6 billion tons of food are wasted annually. Without global actions, this figure could reach an equivalent expenditure of $1.5 trillion by 2030, according to the Boston Consulting Group – BCG (2018). According to the FAO (2017), 54% of losses occur during the harvest and handling phases, and 46% during storage, transportation, and consumption phases. At the same time as being one of the largest food producers on the planet, Brazil discards 37 million tons annually, according to data from the Brazilian Agricultural Research Corporation - Embrapa (2018).

This waste represents an estimated economic loss of R$61.3 billion per year, considering the environmental and social impacts caused by the problem, and places Brazil as the 10th country that wastes the most food on the planet (FAO, 2017).

Regarding global data, the latest edition of the report 'The State of Food Security and Nutrition in the World' (Pincer, 2023), a joint effort by five specialized agencies of the United Nations – the Food and Agriculture Organization, the International Fund for Agricultural Development (IFAD), the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Food Programme (WFP)

– reports that an average of 735 million people went hungry in 2022, representing almost 10% of the global population. This number increased rapidly due to the Covid-19 pandemic, which added about 122 million people to this condition since 2019. Figure 2 shows the concentration and distribution of food security by severity around the world and the differences between world regions.

Figure 2 – The concentration and distribution of food security by severity differ greatly among the regions of the world



Source: FAO adapted, 2023, p. 22.

Malnutrition is also concerning as it affects millions of children under the age of five, causing stunted growth (148.1 million), acute malnutrition (45 million), and obesity (37 million). Additionally, the "Global Burden of Disease" Study (2019) identified dietary risk as the second highest risk factor for deaths among women and the third among men (FAO, 2023).

The same situation is observed in developing countries like Brazil. In this country, about 21.1 million people go hungry daily, and 70.3 million live in a state of food insecurity. Additionally, 10 million Brazilians are malnourished (FAO, 2023).

Ten percent of losses/waste of Brazilian products occur still in the field, 30% in activities related to storage and distribution, 50% in transportation, and 10% in households (FAO, 2023). Half of these lost/wasted foods are fruits and vegetables (Brasil, 2022).

To reduce the problem, it is noted that among the Sustainable Development Goals of the 2030 Agenda are SDG 2 (regarding the eradication of hunger) and SDG 12 (which concerns sustainable consumption and production patterns, with a reduction of half of the losses and food waste occurring along the production and supply chain). Achieving these goals is of utmost importance, given the projection of a population of more than nine billion people by 2050 (FAO, 2015), which will require an increase of around 60% in food production to meet human needs. However, the FAO warns that if trends remain, it is estimated that by 2030, approximately 600 million people will go hungry, highlighting that despite the reduction of people with hunger in the world, the 2030 Agenda goals will not be achieved (FAO, 2023).

The FAO points out that there are greater losses and waste for specific groups of certain foods, occurring at various levels of the supply chain, to a greater or lesser extent (SOFA, 2019).

Considering the highly perishable characteristics of FLV (Gustavsson *et al.*, 2011; Lana, 2018; Silva *et al.*, 2021), their PDA percentages are high, especially in the production and distribution phases (Schneider, 2013), even being the most wasted food group in retail, according to research in various countries, such as Italy, Denmark, Sweden, the United States, among others (Bilska; Piecek; Kołożyn-Krajewska, 2018; Eriksson *et al.*, 2012).

Food is essential for maintaining human life and health. The WHO and the Ministry of Health recommend the daily consumption of 400 g of fruits and vegetables, divided into five servings per person. In Brazil, less than 10% of the population has access to this amount. This situation contrasts with the condition of the country that is among the largest food producers in the world (FAO, 2020) and, at the same time, wastes about 37 million tons of food per year (EMBRAPA, 2018).

As for the losses/waste of vegetables and fruits in Brazil, it is estimated that between 35% and 55% occur in the post-harvest phase. However, it is admitted that there is a lack of greater precision of these values, which were obtained from a restricted database and through subjective methodologies,

making it difficult to compare results, quantify volume, and identify causes more accurately, as warned by Lana (2016).

Despite numerous efforts to reuse food, such as reuse, recycling, and recovery, to avoid disposal, it is essential that their destination be, first, human consumption. Thus, the prevention of losses and waste is the most recommended action and contributes most to the better use of increasingly scarce natural and environmental resources on the planet (Hermsdorf *et al.*, 2017; Natural Resources Defense Council – NRDC, 2017; WRAP, 2018).

To combat the problem, the prevention and reduction of PDA must be prioritized by all links in the supply chain to know and understand the various causative and interrelated factors. However, it is important to emphasize the power of retail over the links in the production and distribution chain, both downstream and upstream (Mena *et al.*, 2014; Moraes *et al.*, 2020; Silva *et al.*, 2021), influencing from the food produced in the field, causing primary losses (Lana; Banci, 2020), to the consumption habits of the population. Moreover, the aesthetic standardization of commercialized foods, stimulated by FLV retailers in recent decades, has impacted consumer criteria in choosing "perfect" fruits, vegetables, and greens, contributing to the waste of these products (Baker *et al.*, 2019). Being the link that connects food production to consumption, food retail is an important link that can dictate and signal the necessary changes in the production chain, whether in production or consumer behavior.

The Role of Food Retail

The discussion around food losses and waste should be supported by the sustainability triad: economic, environmental, and social. Winterich (2019) defines sustainability as a set of ideas, attitudes, intentions, and behaviors that involve the strategic consideration of economic, environmental, and social resources for the success of current and future generations. Bravo *et al.* (2021) add two other equally important factors, health and culture, as sustainable food production models, besides

having a direct impact on the population's diet and, consequently, health, must contemplate the cultural elements of specific populations, such as indigenous groups, quilombolas, Africans, among others.

The concern of chain agents, especially retail, is profitability, however, such profitability - as one of the dimensions of sustainability (economic) - is tied to the other dimensions, social and environmental. Sustainability in the supply chain requires retailers to implement system integration throughout the supply chain to minimize damage to the environment and individuals. Beyond the insertion of recycling bins in retail stores, sustainability includes a complete consideration of the environmental and social impact of businesses, from product acquisition, disposal, reuse, or recycling; from employee safety and well-being to the safety and well-being of society in general. A notable characteristic is to evaluate the emphasis on the economic (profit), social (people), and environmental (planet) triad of supply chain activities with a view to their future long-term impact (Vadakkepatt *et al*., 2020).

Economic benefits aside, retailers are beginning to consider operational costs, limiting the use of natural resources, and minimizing ecosystem damage by reducing emissions. For example, food retailers are responsible for approximately ten percent of food waste in the United States (Weigel, 2020). Responding to this challenge, large food retailers are implementing technology to reduce food waste throughout the supply chain, saving money and environmental resources (Kleinman; Schneider; Strumwasser, 2018; Kor; Prabhu; Esposito, 2017).

In terms of social impacts, supermarkets and hypermarkets impact and are impacted by their employees, suppliers, consumers, and the communities in which the stores operate. Thus, some large retail chains in the United States, for example, invest in training their employees, training their direct and indirect suppliers to reduce losses, and in campaigns to consumers in purchasing local food (Weigel, 2020). Efficient management of supply chains leads to the prevention of losses and waste, which results in lower product prices, directly impacting the economic performance of the business and the accessibility of safe and healthy food to the consumer.

According to data from the Brazilian Association of Supermarkets (ABRAS, 2021), food waste in the supermarket sector reached 1.79% in 2020, which corresponds to R$7.6 billion. Among the categories of food products, FLV leads in terms of waste. It should be noted that these data are only estimates, indicating that there is still a need for better mapping of the situation and research related to the topic.

The retail sector is particularly affected by the lack of studies that use primary data. This can be explained by the fact that food waste data is often confidential information for retailers and suppliers and is subject to confidentiality agreements. There are several examples in the literature reporting the impediment of comprehensive investigation due to such issues (Egarrone *et al.*, 2016; Lebersorger; Schneider, 2014; Mena *et al.*, 2011; Mourad, 2016; Stenmarck *et al.*, 2011). The Food Waste Index (United Nations Environment Programme, 2021) reports that worldwide, there is insufficient data in most countries at the retail level and calls for more quantification, particularly in low- and middle-income countries.

The poorest population has less access to FLV products, as a reduction in consumption was observed between 2008 and 2018 (ABRAS, 2021).

It is urgent that to mitigate the issue of food and nutritional insecurity in the country, in addition to developing public policies aimed at promoting food security, strategies should be devised to reduce the disparity between food losses and waste on one side and hunger and food insecurity on the other (Zaro *et al.*, 2018).

However, the definition of strategies to reduce PDA, as well as the necessary public policies, first requires a better understanding of the factors that cause losses throughout the production chain (Lana; Banci, 2020). This understanding is reinforced in the report "Intersectoral Strategy for the Reduction of Food Losses and Waste in Brazil," by the Interministerial Chamber of Food and Nutritional Security (CAISAN, 2018).

In this sense, knowledge of the practices carried out by supermarket retail companies regarding food waste, from the perspective of sustainability, as pointed out by Vadakkepatt *et al.* (2020) and Bravo *et al.* (2021), is necessary.

There are studies that reinforce the hypothesis that waste - when evaluated in retail - should be considered in the supplier-seller relationship since, often, unsold products in retail are returned to the supplier, who bears all the expenses (Brancoli, 2019). According to Brancoli (2019), in studies in the bakery sector in Sweden, the model adopted by the largest bread distribution bakeries in Sweden involves a total return agreement (Take-Back Agreement – TBA) between retailer and supplier, in which the bakeries are responsible for forecasting, ordering, placing, and removing products from supermarket shelves. In addition, bakeries are financially responsible for unsold products (including their collection and waste management), operating in a reverse or circular supply chain, unlike most products sold in retail. When it comes to FLV, it is known that many of the products sold in Brazilian supermarkets and hypermarkets are consigned, meaning that if they are not sold, they should be deducted from the purchase price, and in many cases, the supplier must still remove the products from the shelves, considering the destination of the collected products (Cunha, Saes, Mainville, 2013; Souza; Scur, 2011).

In this sense, the importance of retailers concerning PDA is emphasized, as they are in a unique position to influence the generation or prevention of waste in other supply chain agents, such as primary production, distribution, and final consumption.

The following topic addresses two case studies conducted in food retail, specifically concerning waste in the FLV sector, in two municipalities in the state of São Paulo (SP), Tupã, and Ribeirão Preto.

Food Retail Case Studies

Studies were conducted in the cities of Tupã and Ribeirão Preto to identify and analyze practices for the prevention and reduction of PDA in retail establishments.

To carry out both studies, the strategies used were interviews with those responsible for the FLV sector in retail establishments, direct observations, and analysis of secondary documents.

For Study 1, interviews were conducted in four retail establishments, identified as follows: Small supermarket (M1), Medium supermarket (M2), Large supermarket (M3), and Small supermarket (M4). For Study 2, a single store of a supermarket chain was evaluated (M5); the choice was made by the network manager, who agreed to participate in the research and pointed it out as having the highest FLV waste index. In Box 1, it is possible to analyze the questions addressed and the responses obtained by the interviewees.

Box 1 – Interview responses with those responsible for the FLV sector of different retail establishments in the cities of Tupã and Ribeirão Preto

Is there any purchasing planning for FLV?	
Stores	**STUDY 1 (M1, M2, M3, and M4 - Tupã-SP) and STUDY 2 (M5 - Ribeirão Preto-SP)**
M1	Sales history from the previous year
M2	Sales history from the previous year
M3	Sales history from the previous year and analysis by the employee responsible for the sector
M4	Analysis by the employee responsible for the sector
M5	Sales history from the previous year, analysis by the employee responsible for the sector, and product purchase price
What are the criteria for defining the storage methods for FLV?	
M1	The central unit advises that more perishable products should be placed in cold rooms until they are available for sale and then depends on space.
M2	The sector employee evaluates and identifies the need for a cold room or not; in the sales area, it depends on available space.
M3	The sector employee evaluates and identifies the need for a cold room or not; in the sales area, it depends on available space.
M4	The sector employee evaluates and identifies the need for a cold room or not; in the sales area, it depends on available space.
M5	Most products go to the sales area; however, part of the food is stored in common stock without refrigeration. The sector employee directs only very sensitive products to the small cold room.

When there are leftovers of these products, who bears the loss?	
M1	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M2	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M3	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M4	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M5	Depends on the product: leafy greens and chopped vegetables on consignment are the producer's responsibility, others are the establishment's responsibility.
When there are leftovers, what is done with these foods?	
M1	Donated to farmers who use them to feed animals.
M2	Donated to charity institutions in the city.
M3	Donated to charity institutions in the city and what is unsuitable for human consumption is donated to farmers who use them to feed animals.
M4	Donated to farmers who use them to feed animals.
M5	Donated to an animal breeder.
Is there any practice that the market performs with the aim of preventing and reducing PDA?	
M1	No.
M2	No.
M3	No
M4	No
M5	In prevention, no. To reduce, some foods are processed and vacuum-packed; others are turned into fruit salads. There is also the sorting of tomatoes, potatoes, and other vegetables packed in plastic nets, which return to the sales area. On the stands, riper products are placed on top during restocking.

Source: Prepared by the authors, based on the responses of the surveyed establishments.

There was no pattern observed among the studied cases regarding the purchasing planning for the FLV section. However, among leafy greens, it is unanimous that there is no acquisition planning since all establishments reported that their products are consigned. Therefore, when there is no sale, the responsibility for the exchange or collection of the products lies with the producers themselves. Regarding fruits

and vegetables, establishments are basically based on the purchasing history from previous years or rely on the "experience" of the employee responsible for the sector for new orders, which greatly contributes to PDA, as basing on previous years does not guarantee that the same type or quantity of fruits and vegetables will be sold.

In study 2, besides the sales history guiding FLV purchases, the employee also mentioned that the prices found for each product contribute as well. If the product is offered at higher prices, the buyer may reduce the quantities purchased; and in the case of attractive prices, larger quantities are ordered, and later, the supermarket chain promotes sales in its eleven stores distributed throughout the region.

When questioned about the criteria for defining the storage locations for fruits and vegetables, in study 1, it was reported that only the degree of ripeness of each type is considered. Therefore, the food that the employee identifies as riper upon receipt will go to refrigeration until the time of sale, and may or may not be maintained later, depending on the availability of cold rooms and space in the sales areas.

Regarding the storage of leafy greens in case study 1, in establishments M1 and M4, it occurs in the establishment's own cold rooms during exposure for sale. Each producer has space to accommodate their merchandise, and they themselves handle the collection and replenishment. In establishments M2 and M3, the scenario is different. In M2, the producer provides a cold room in the sales area to ensure the quality of only their product for a longer time. However, of all the suppliers they have, only one provided a cold room, while leafy greens from other producers were kept at room temperature.

In M3, a cold room (owned by the establishment) is also available for use by leafy green suppliers, but products were also found at room temperature. When questioned about this, the employee reported that it was a new contract, and there was no available space in the cold room, so they were kept at room temperature. Additionally, those products from this producer that arrived fresh in the morning and were not sold by the end of the day were promoted (by the producer) to prevent loss.

In case study 2, most of the products, upon receipt, go directly to the sales area. The remainder is stored in the common stock, without refrigeration, alongside other grocery products in the supermarket. When large quantities of food are purchased due to low prices found by the network's buyer, product overlap occurs on the shelves (up to five layers, like tomatoes, for example). As the foods on the shelves are sold, they are replenished with stocked products. Only very heat-sensitive products are directed to the store's small cold room, which shares space with other non-FLV products.

The disposal (of FLV considered unfit for sale) in both case studies follows the same system as the criteria for defining product storage locations, i.e., it is based on visual selection. However, there is no specific training for this procedure. The orientation that employees report receiving is: "what you and your family would buy should be kept, what you would not, should be discarded," according to employee reports.

Regarding the destination of food in case study 1, two establishments reported donating those considered unfit for sale but suitable for consumption. Donations are made to charities responsible for selection and removal. The other two establishments send the food (regardless of its condition) to the common trash or to farmers who request it to feed their animals. In case study 2, there are no donations for human consumption. The products are donated to an animal breeder.

When questioned about adopting practices that could contribute to PDA prevention in the establishments, all interviewees reported that there are none, but all cited the need for more cold rooms for storage during receipt and in the sales area to prolong food shelf life, control the accelerated ripening process, and reduce PDA.

In this context, retail establishments daily remove various types of food from their shelves, and most are still suitable for human consumption. However, consumer demands contribute to increased waste, along with inefficiency—not only of the store—but from the producer, through the Supply Centers (CEASA), and the network's distribution center. It is therefore relevant to raise awareness among retail employees and consumers about the impact of PDA, and this issue should be seen as urgent so that they take responsibility and develop actions to reduce it.

Final considerations

When addressing food losses and waste, it is not possible to only address the economic loss regarding the costs associated with the production and distribution of food products. The impacts related to PDA directly reflect the final consumer price, but their extent, in terms of consequences, directly impacts social aspects when the possibility of supplying a significant number of a population suffering from food and nutritional insecurity is removed. When natural resources such as water and energy are used and greenhouse gases are emitted for the production, distribution, and availability of products that will not be consumed, it harms the planet's health.

Retail is the channel member that connects the producer and the consumer, and it becomes relevant for directing changes in habits and consumption behavior. In this sense, it can be the agent to signal necessary changes. As observed in the presentation of the case studies, despite some efforts to avoid food waste, it is still necessary to incorporate some elements, such as more efficient purchasing planning, acquisition of local products, and control and maintenance of acquired products to increase their shelf life. Additionally, it is essential that retail lead campaigns to reduce waste so that consumers adopt a more proactive stance in this process by purchasing imperfect but consumable products, handling products correctly when selecting purchased products, and prioritizing seasonal products.

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Chapter 7

Agricultural Diversification and Productive Resilience

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Introduction

The classic definition for the concept of sustainable development, established by the United Nations (UN), is the pursuit of meeting the needs of the present without compromising the ability of future generations to meet their own needs.

It is known, however, that this has not always been the concept of sustainability. The first perspective focused on the economy and had a developmental bias, disregarding environmental and social issues. After World War II, the focus was solely on economic growth, and the unrestrained consumption of natural resources was seen as a way for developing countries to prosper, just as the already developed ones did (Costabeber; Caporal, 2003; Pasqualotto; Stasiak, 2012; SMA, 2011).

This concept evolved, came to consider other dimensions, and was addressed in various international events. In 1968, at the Club of Rome, the limits of growth based on the finitude of natural resources were established. In 1972, at the Stockholm Conference, the divergences between industrialized and non-industrialized countries became evident, and the concept of environmental degradation expanded. In 1987, we have the classic definition of sustainable development mentioned earlier. Then, in 1992, at the Rio Conference, it was determined that the responsibility for environmental degradation is greater in developed countries than in developing ones (SMA, 2011).

The first perspective of sustainability presented is called ecotechnocratic, while the second is called ecosocial. The major difference is that the latter seeks a balance between the environment, economic growth, and society (Pasqualotto; Kaufmann; Wizniewsky, 2019). The current concept of sustainability is based on its multidimensionality (Box 1). The six dimensions adopted clearly highlight the need to holistically address its concept.

Box 1 – Multidimensionality of sustainability

Dimension	Description
Ecological	To ensure continuity, natural resources must be preserved and conserved.
Social	The product must be appropriately and equitably enjoyed by society.
Economic	Focus not only on obtaining profit but also on subsistence, sovereignty, and food security.
Cultural	Local knowledge and values must not be disregarded.
Political	Segments of the rural population must have participation, and their interests and needs must be heard.
Ethical	Responsibility between generations regarding environmental preservation and conservation.

Source: Costabeber and Caporal, 2003.

In the ecological dimension, the focus is on the preservation and conservation of natural resources. In the social dimension, the emphasis is on societal benefits. The economic dimension includes not only profit but also subsistence and other issues such as food sovereignty and security. The cultural dimension respects the local cultural reality. The political dimension concerns listening to the interests and needs of the local community, and finally, the ethical dimension refers to generational responsibility, emphasizing the importance of sustainability for future generations.

From this perspective and considering the context of the 2030 Agenda, the Sustainable Development Goals (SDGs) were formulated. The SDGs comprise 17 major objectives for the world to aim to end poverty, protect the environment and climate, and ensure peace and prosperity for people (UN, 2015). They represent a global action plan based on the commitments of UN member states to protect the planet and promote peaceful and inclusive societies.

Among the global goals is SDG 2 – Zero Hunger and Sustainable Agriculture, which specifically addresses sustainable agricultural development and food security. Item 2.4 provides more details on this.

> By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather conditions, droughts, floods, and other disasters, and that progressively improve soil and land quality (UN, 2015, p. 19).

As a strategy to achieve sustainable food production systems and contribute to resilient agricultural practices, the strategy of productive diversification has been an important topic. As Michler and Josephson (2017) highlight, in the past, development agencies promoted the production of some key crops for food security, but the focus has shifted towards diversification.

As a promoter of agricultural diversification, the Food and Agriculture Organization of the United Nations (FAO, 2012) posits that this is an effective strategy to address food and nutrition security, sustainable rural development, job creation, poverty reduction, and environmental and ecological preservation and conservation.

In this context, this chapter aims to discuss the strategy of diversifying agricultural production systems to contribute to achieving SDG 2. Additionally, this debate has the potential to foster the formulation of public policies and benefit rural communities, especially those most vulnerable to economic, environmental, and social changes, as this strategy contributes to resilience and the preservation of natural resources.

Threats to agricultural systems

The major threat to agricultural systems is termed the "Triple Threat of the Anthropocene to Humanity," which comprises Climate Change; Biodiversity Loss; and Food Insecurity (Kremen; Merenlender, 2018; Petersen-Rockney *et al.*, 2021).

Climate change has been a significant source of concern. In extreme situations such as heatwaves, droughts, cyclones, and floods, there is severe negative interference with agricultural productivity and food security. This impacts, consequently, rural poverty, promotes a reduction in demand for goods and services, and induces overexploitation of water, land, forests, and other natural resources (Birthal; Hazrana, 2019). Box 2 illustrates this type of situation concerning agricultural production.

Box 2 – Environmental effects of agricultural production activity

Aspect of productive activities[5]	**Effect**	**Resource or phenomenon**
Positive	Improves the productivity of renewable resources	Air
		River water
		Soil
		Organic fertility of soils and trees
Negative	Worsens the productivity of renewable resources	Desertification
		Deforestation
		Erosion
		Among others.

Source: Chambers and Conway, 1992.

The positive activities mean that there are benefits to renewable natural resources, which allow the sustainability of agricultural processes. The negative activities, on the other hand, worsen productivity and disrupt sustainability. In the long term, agricultural production tends to become unviable, and socioeconomic problems arise or deteriorate. There is a perceived link here between environmental and socioeconomic problems, with the latter being a consequence of the former. The threats in social aspects occur in the form of stresses and shocks, highlighted in Box 3.

[5] Productive activities refer to what producers do to produce food and their impacts on the environment.

Box 3 – Stresses and shocks

Stresses	Reduction of labor
	Real wage decreases
	Decrease in soil yield
Shocks	Wars
	Persecution
	Civil violence
	Droughts
	Storms
	Floods
	Burns

Source: Chambers and Conway, 1992.

Stress refers, therefore, to the reduction of labor, real wage decreases, and decreases in soil yield. These are negative interferences in the productive activity of agriculture that do not promote immediate collapse but wear it down in the long term.

Shocks refer to wars, persecution, civil violence, droughts, storms, floods, and fires. These are of greater severity, and the farmer's reaction capacity is even lower.

Regarding future problems in agricultural production, there are proactive and reactive aspects. In the first case, adaptation, the generation of changes, and continuity are considered. In the second case, it is considered to deal with stresses and shocks. The difference between the aspects is that in the first case, prevention occurs, while in the second, the problem is expected to arise and then action is taken (Chambers; Conway, 1992). This is illustrated in Box 4.

By relying on chemical agents, financial incentives, and being less resilient, conventional agriculture degrades natural resources and is not considered sustainable in the long term. This process can lead to serious consequences: soil degradation; waste and excessive use of water;

environmental pollution; dependence on external inputs; loss of genetic diversity; loss of local control over agricultural production and global inequality (Gliessman, 2000; Kremen; Merenlender, 2018). The basic practices of conventional agriculture are described in Box 5.

Box 4 – Social Effects of Agricultural Production Activity

Dimension	Aspect	Attitude
Positive	Proactive	Improve capacity to adapt
		Generate changes
		Ensure continuity
Negative	Reactive	Deal with stresses and shocks

Source: Chambers and Conway, 1992.

Box 5 – Risks Associated with Conventional Agricultural Practices

Practice	Description
Intensive soil cultivation	Regular cultivation leaves the soil without plant cover for a long time. Reduces organic matter and consequently fertility. Increases the probability of soil compaction and increases erosion rates.
Monoculture	Cultivation of a single crop aiming at the efficiency of agricultural processes and the use of machinery. Economy of scale. Industrialization of agriculture. Requires chemical protection.
Application of synthetic fertilizers	Significantly increases production. Provide more nutrients to plants. Farmers ignore long-term soil fertility. Nutrient leaching ease. Eutrophication of rivers and groundwater. Public health impacts. Dependence on oil prices.
Irrigation	Increases leaching and eutrophication. Increases soil erosion rate. Alters regional hydrography. Excessive water use.
Chemical pest and weed control	Significantly reduce pest populations. Populations can recover, however, demanding more chemical control. Human health impact. Chemicals are leached and enter the food chain of animals. Persist for decades.
Plant genome manipulation	Obtaining hybrid crops, unable to produce seeds, are more productive but makes the farmer more dependent on commercial producers.

Source: Gliessman, 2000.

Agricultural Diversity as a Productive Strategy

Agricultural diversification and concern for food security are not new. Already in the colonial period, there was concern by the Portuguese Crown with the diversification of agricultural production in Brazil, aiming to ensure the consumption of foodstuffs. There was, therefore, besides large producers, a peasantry, owner of small properties (Fausto, 2006).

The diversification of production systems is considered one of the ways to deal with the complexity and uncertainty of agricultural activity. Strategy suitable especially in global shocks, such as pandemics and prolonged droughts (Petersen-Rockney *et al*., 2021).

The central idea is to replace simplified or monoculture systems with diversified production systems. In this context, the importance of integration between animal and plant production is also inserted. It is worth noting, however, that each agro-system has its particularities and there is no recipe valid for all cases. Thus, they must be known and appropriate forms of diversification adopted (MMA, 2000).

Agricultural diversification allows for achieving goals in different dimensions. It is considered, in this sense, that cultural legacies must also be considered so that they define suitable alternatives for this productive strategy. Finally, the dependence on agrochemicals must also be reduced (Petersen-Rockney *et al*., 2021; Spangler *et al*., 2022).

It is recognized that the productive diversification strategy faces strong competition from conventional crop production systems since it does not present immediate benefits. On the other hand, however, it must be considered that diversification results in greater adaptation and resilience, being able to withstand the shocks and stresses of the threats. Diversification, then, constitutes a virtuous cycle. Considering climate change and sociopolitical inequality, diversified agricultural systems demand a change in the productivity paradigm. Thus, biophysical factors, such as climate variability, must be considered in agricultural policies, from the local to the federal level, prioritizing, then, climate adaptation to

agricultural systems (Petersen-Rockney *et al.*, 2021; Revoyron *et al.*, 2022; Spangler *et al.*, 2022).

The scientific literature exposes positive results regarding the diversification strategy. In general, this practice is seen as promoting resilience and helping in mitigating and adapting to climate change. It has been reported that the reduction of pesticides, energy consumption, water, and greenhouse gases. In the economic aspect, however, the literature indicates that higher returns are associated with specialization, but with greater volatility; while diversification, although lower, is associated with greater stability in returns (Abson; Fraser; Benton, 2013; Birthal; Harazna, 2019; Alletto; Vanderwale; Debaeke, 2022; Spangler *et al.*, 2022).

Furthermore, there is much scientific evidence that agrees with agricultural diversification[6] in various countries, such as Germany, Argentina, the United States, Ethiopia, India, Malawi, Nepal, the Arabian Peninsula, and Zambia[7].

Opportunities and Challenges of Agricultural Diversification

Diversification is a sign of the reorientation of agriculture towards multifunctional activities that combine food quality, rural subsistence, landscape maintenance, environmental preservation, and the establishment of a better agro-ecosystem (Monteleone; Cammerino; Libutti, 2018).

Some research states that crop diversification allows better long-term yields compared to monoculture. Others say that it does not necessarily lead to stable livelihoods. It is argued that this strategy contributes to poverty reduction, but the provision of credit, land, and technology is important. Overall, diversification can help consolidate new industries and

6 Antonelli, Coromaldi, and Pallante (2022), Garbelini *et al.* (2022), Godoi *et al.* (2022), Hao *et al.* (2022), Mzyece and Ng'ombe (2021), Yan *et al.* (2022).

7 Chapagain *et al.* (2018), Lal *et al.* (2017), Lydecker and Forman (2013), Maggio and Sitko (2021), Mekuria and Mekonnen (2018), Meraner, Pölling and Finger (2018), Rao, Shahid and Shahid (2010), Vázquez (2019).

help offset the adverse effects of crises (Ceceñas-Jacquez; Morales-Carrillo, 2015; Sène-Harper; Camara; Matarrita-Cascante, 2019; Vázques, 2019).

However, there are several barriers to crop diversification, such as lack of improved varieties; lack of phytosanitary protection methods; lack of crop rotation references; complexity of knowledge to be acquired by farmers; logistical limitations, and difficulty in coordinating with value chains. These are systemic obstacles and need many stakeholders to change (Meynard *et al*., 2018).

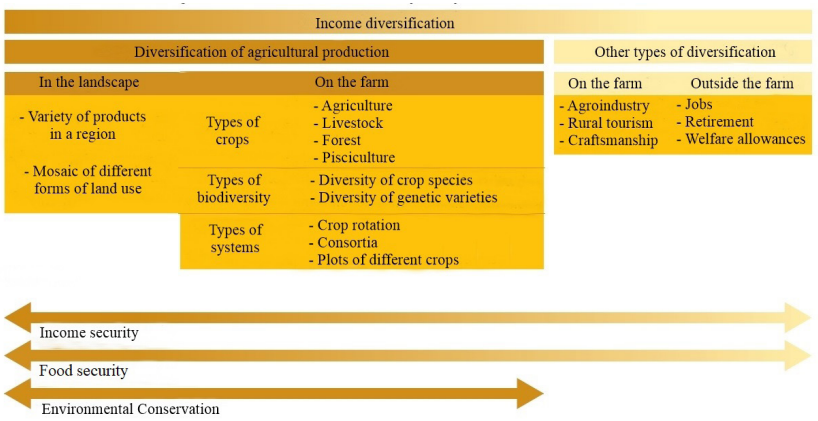
Research indicates that average household income, economically active population, and gross added value of agriculture have a positive influence on crop diversification; while the level of education (people with more years of study), inequality in credit volume, unemployment rate, and overall gross added value has a negative impact (Pacheco *et al*., 2018).

Related to this, it is important to consider the heterogeneity of cropping systems when making empirical analyses aimed at providing data for diversification policies. The spectrum of factors leading to crop diversification is numerous and complex. Diversification can occur, for example, with the promotion of subsistence, pluriactivity, reduction of commodity production, adoption of alternative markets, and even with the intensification of mechanization, but collective strategies must be associated (Maggio; Sitko, 2021; Nera *et al*., 2020; Schneider; Niederle, 2010).

Small farms practicing polyculture can help solve problems related to food security, even in arid regions. Crop diversification is, therefore, essential in maintaining a system dominated by small producers. Improving the adaptive capacity of these farmers involves formulating public policies aimed at expanding technologies related to diversification, encouraging the expansion of subsistence production, and diversifying non-agricultural income (Galeana-Pizaña *et al*., 2021; Laurenti; Pellini; Telles, 2015; Njira *et al*., 2021; Venus *et al*., 2021).

Figure 1 systematizes the issue of agricultural diversification in its various possibilities. The literature suggests benefits in income security, food security, and environmental conservation. This occurs through the diversification of income, but also brings important issues such as resilience.

Figure 1 – Forms of income diversification in rural areas and main benefits



Source: Sambuichi *et al.* (2014).

Case study: the evolution of Brazilian agricultural concentration

A survey conducted by the authors of this chapter allows us to visualize the evolution of the level of agricultural concentration in Brazil. By establishing, per mesoregion, the percentage of occupation of the three main crops in relation to the total agricultural area, it is possible to observe this phenomenon over time. Figure 2 presents the dynamics of this process geographically and temporally.

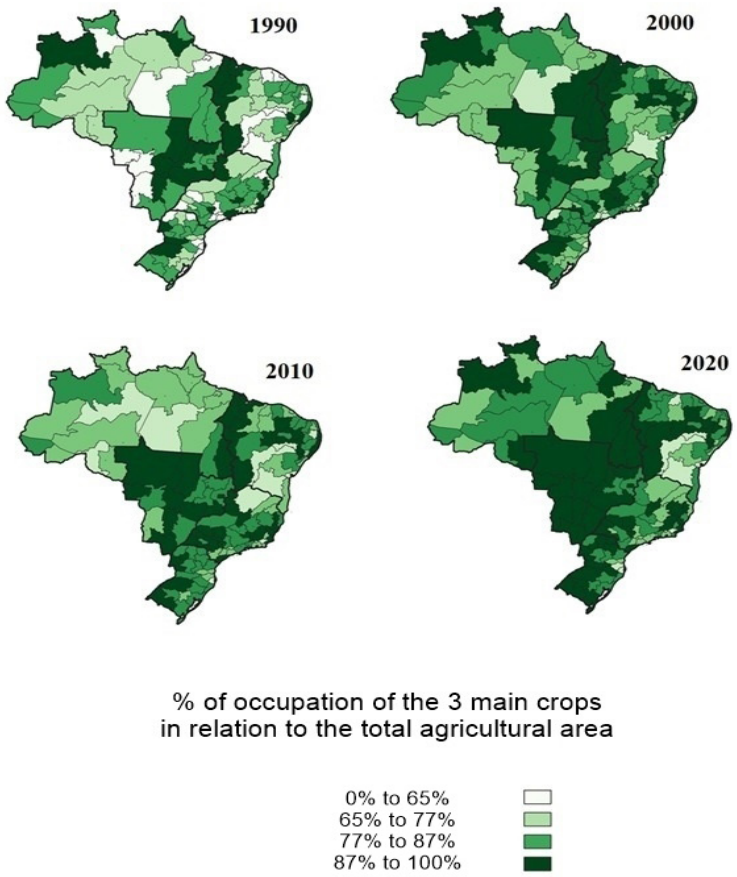
Despite the relative simplicity of measuring the evolution of agricultural concentration in the country over time, and considering the so-called "Triple Threat of the Anthropocene to Humanity," the following questions are posed to the reader:

a) What are the consequences of the evolution of agricultural concentration for the climate?

b) What are the consequences of the evolution of agricultural concentration for biodiversity?

c) What are the consequences of the evolution of agricultural concentration for food security?

Figure 2 – Evolution of agricultural concentration in Brazil, by Mesoregion



Source: Elaborated by the authors (2024).

Final considerations

The challenges and opportunities of agricultural diversification are diverse, but the literature converges on the idea that this is one of the strategies to promote sustainable development.

From a productive perspective, diversification is considered negative because it does not maximize returns. However, in a multidimensional analysis of sustainability, other factors must be considered. Here comes the social, economic, and environmental tripod. Obviously, no rural producer wants to give up the gains from their production, but it is necessary to think in the long term. Thus, agricultural diversification becomes advantageous and considers factors that purely economic logic disregards, such as food security, subsistence, and resilience. The latter is especially increasingly relevant concerning existing threats and those that may arise.

Finally, it is perceived that agricultural diversification, based on literature and UN policy, allows progress towards what is sought with item 2.4 of SDG 2. Thus, agricultural systems can increase their resilience, becoming more capable of adapting to natural and anthropogenic events, besides being able to positively impact food security.

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Chapter 8

Marketing strategies of family farmers operating in short food supply chains: cases in regions of Rio Grande do Sul

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Introduction

The commercialization of products and services plays a relevant role in the economy, integrating different social actors by linking the production of goods or services with consumers. The organization of this process allows consumer agents (at different levels of the distribution channel) to receive products and services according to the expected characteristics. According to Mendes and Padilha Junior (2007), understanding the functioning of the supply chain allows for improving the decision-making process by helping to understand the variables that form and affect this chain.

The interaction between relevant social actors (buyers and sellers) involved in the transaction process of some service/product will characterize the formation of a market. According to McMillan (2004), the market can be considered a mechanism used by societies to coordinate the production, distribution, and transactions of all types of products and services. Proudhon, cited by Braudel (1996), stated that working and eating would be the only apparent purposes of man, but between these two universes, "narrow but lively like a river: exchange or, if you prefer, the market economy - imperfect, discontinuous, but already coercive during the centuries and surely revolutionary" (Braudel, 1996, p. 11). Thus, the market can be defined as a meeting point (physical or virtual environment) conducive to the conditions of the exchange of goods (products and services).

Under these conditions, resource allocation occurs in a decentralized manner, through the interaction between economic actors (suppliers, distributors, consumers), each making decisions according to their interests. In the case of food, the way the consumer will have access to it: choice, acquisition, and distribution, has led organizations to review their relationship strategies, including the way food reaches the final consumer.

According to Pigatto and Alcântara (2007), changes observed in consumer behavior and the strategies of other actors (suppliers and distributors) have promoted important changes in the structure of many distribution channels. The development of commercial relationships

between the actors that form and operate in the distribution channels can be described, according to Abosag and Lee (2013), as a process of establishing, creating, developing, and maintaining relationships, where satisfaction, trust, and commitment are important elements for the result of the organizations that operate in the distribution channel.

New distribution channels are created in the face of consumer attitude changes, such as fairer markets, and short circuits, with the approach of consumers and producers, without the intermediation and dependence on programs and government policies (Ueno *et al.*, 2016). In this sense, direct marketing presents itself as an alternative for the distribution of agricultural products, through various channels, providing an improvement in the local economy and generating a relationship of trust between producer and consumer (Huygens *et al.*, 2010).

Local food systems, or short circuits, involving direct sales already existed at the beginning of agriculture, where farmers sold their food to consumers at the production site itself or made exchanges in nearby places. After World War II, these direct sales systems began to disappear with the emergence of mechanization, productive intensification, and the addition of chemical products. From 1950, with the opening of the first self-service stores (supermarkets), food began to be packaged, standardized, labeled, and often processed. Thus, they were sold at low prices and bought from farmers located in remote regions, changing the production methods and sales channels (Kapala, 2022).

From 1990, in the face of questions related to food systems, the reduction in prices of some products, and environmental problems, due to the intensive mode of food production, some farmers opted for alternative modes of production and marketing (Lamine *et al.*, 2012; Renting; Marsden; Banks, 2003). Simultaneously, there was a behavioral change in consumers regarding their eating habits, seeking healthier foods and differentiated qualities (Abatekassa; Peterson, 2011; Ilbery; Maye, 2005).

Thus, Short Food Supply Chains (SFSC) emerged as opposed to the standardized and industrial mode, as well as farmers who wish to meet the demands of new consumption patterns, with the main objectives being

cost reduction and value addition to the product (Belletti; Marescotti, 2020; Renting; Marsden; Banks, 2003).

SFSC or short food chains consist of the approximation between producer and consumer. This approximation can be understood through the reduction of the physical distance between producers and consumers, being geographically close; the reduction of the number of intermediaries connecting producers and consumers; and the reduction of the cultural and social distance between them. For example, even if consumers are geographically distant from farmers, by viewing the labels and information present on the products, they share the same values, associated with the quality of the offered item, with the production methods, or with the territory and people involved (Ilbery; Maye, 2005; Kneafsey *et al.*, 2013). Thus, product differentiation is related to transparency in market relations, where these quality definitions are transmitted among all involved parties and communicated to the consumer, in a way that makes them aware of paying the premium price (Renting; Marsden; Banks, 2003).

In Brazil, there is a highlight for rural producers located in the state of Rio Grande do Sul, in its rural areas, there is an extensive diversity of natural resources, landscapes, and the organization of productive structures (Conterato; Strate, 2019). Of all rural establishments in the state, 80% are family farmers (IBGE, 2017).

These farmers receive government incentives that seek to increase the participation of farmers operating in direct sales, seeking an approach with the consumer, and intending to add value to production (Schneider; Buzatto, 2023). Thus, this chapter presents some marketing strategies used by family farmers, located in the state of Rio Grande do Sul, who operate in Short Food Supply Chains, with an emphasis on adding value to their products and services.

It is important to emphasize that SFSC contributes to achieving some Sustainable Development Goals (SDGs), such as SDG 2, in helping to end hunger and promote sustainable agriculture, by providing the sale of safe, nutritious foods, with agricultural methods that help preserve ecosystems (such as organic), from local production, contributing to the

productivity and income of family farmers. In this way, it contributes to SDG 10, regarding the reduction of inequalities, by including family farmers in alternative markets. SFSC also supports SDG 12, regarding responsible consumption and production, by reducing food losses, as some sales are direct and producers are located geographically close to their consumers, avoiding possible losses during long journeys and in long distribution chains. SDG 12 also affirms the implementation of tools that develop sustainable tourism, by generating jobs and promoting culture, based on local products. Thus, one of the marketing strategies of SFSC involves rural tourism, including multiple functions and services developed by farmers, allowing the addition of value to local agricultural products, and promoting local culture, in a way that generates jobs for farmers, their families, and the community (United Nations Brazil, 2023).

Distribution channels and the emergence of short food supply chains

There is a great variety of formats of market distribution channels, depending on the number of participating agents involved and the different roles that intermediaries play in the distribution of products or services (Betancour *et al.*, 2016; Coughlan *et al.*, 2002). For Coughlan *et al.* (2002), Rosenbloom (2002), Stern, El-Ansary, and Coughlan (1996), there are different definitions of distribution channels, but these authors converge on the description as being groups of interdependent companies responsible for making a product available on the market for use or consumption.

This characteristic suggests that the distribution channel should be seen in an inter-organizational way, that is, managed by more than one company, which necessarily means that there is a direct relationship between agents or external partners to the organization (Lin; Chen, 2008; Rosenbloom, 2002).

According to Pigatto and Alcântara (2007), the most appropriate channel structure for the organization will depend on the strategies adopted

to better attract final customers in the target segments of each organization. For this, the success of the channel strategy and the structure that supports it is directly dependent on how people from various organizations relate to each other in the performance of their activities (Rosenbloom, 2002).

The main members of the distribution channel are formed by producers (farmers, processors, and manufacturers), intermediaries (wholesalers, retailers, and specialists), and end users (business customers or individual consumers). The relationship between these actors does not occur in only one direction, but it is bidirectional, starting from the farmer and reaching the final consumer, being able to travel this path directly, or passing through several agents, and the choice will depend on the company's need in distribution (Deimiling *et al*., 2015).

Regarding economic literature, direct sales to consumers are related to the symbolic value of food products (local, conventional, etc.), including the choice of where to buy, and, on the other hand, farmers choose the best marketing channel (Corsi; Novelli; Pettenati, 2014).

The presence or absence of a particular member in the channel is determined by its ability to perform the necessary flows and allow value to be added to the end users (Coughlan *et al*., 2002). Thus, the farmer can define whether he has the necessary capabilities and if, by himself, he performs all the channel flows, being an indispensable characteristic to sell directly to the final consumer. Direct sales channels, in addition to strengthening the relationship between producer and consumer, represent extremely dynamic and diversified markets, not failing to reveal an intense and complex distribution system.

Thus, before discussing SFSC, it is necessary to contextualize and understand their historical precepts. In the face of the green revolution, there was an increase in food production and investments to improve agricultural production. This modernization began in the 1960s, with the emergence of the first pesticides used to combat unexpected problems by farmers. Thus, the first insecticides appeared and, from the 1970s, synthetic fungicides and herbicides were created. In the 1980s, the use of early fertilization, the density, and higher quantity of seeding, among

others. These products were created to maximize production and income (Lamine *et al.*, 2012).

While these technological change processes were taking place, especially at the level of agriculture, there was also a transformation in the food processing and distribution sectors. For example, the establishment of industries, with intensive management strategies in harvesting, ultra-processing, as well as standardization and mass delivery of products (Lamine *et al.*, 2012; Levidow; Sansolo; Schiavinatto, 2021).

In this type of agro-industrial system, the productive structure is often directed towards a competitive advantage in distant and anonymous markets. Many farmers who tried to follow this model could have easy access to credit (by investing in technology and waiting for payments for the harvest) but faced structural disadvantages by competing on the terms stipulated in long chains, resulting in the loss of added value. This loss was also related to profit margins directed to intermediaries. Some farmers, realizing that they were in long-term debt, had to abandon agriculture (Levidow; Sansolo; Schiavinatto, 2021).

Simultaneously, from 1990, there were some questions related to food systems, such as while the prices of some products, such as cereals, were decreasing, environmental problems were increasing (Lamine *et al.*, 2012). Intensive food production can be related to changes in land areas, such as loss of biodiversity, erosion, deforestation, pollution, desertification, freshwater scarcity, among others (Maren, 2019). These environmental factors, combined with the price decrease, where producers were not receiving the desired profits, led some of them to change their practices, with the main objectives being cost reduction and environmental and ethical issues (Lamine *et al.*, 2012; Renting; Marsden; Banks, 2003).

The conventional forms of agriculture were increasingly limited for farmers to remain in the field. Thus, new promising responses emerged for them to increase their incomes, for example, the diversification of new activities, through rural tourism, as well as the increase of the added value of agricultural products, such as quality production and direct sales (Renting; Marsden; Banks, 2003).

These new forms of farmer operation allow understanding the emergence of Alternative Food Networks (AFN) (Renting; Marsden; Banks, 2003). Thus, AFN was developed as a different way of providing and consuming food (Pinna, 2017). The potential of AFN is to promote sustainable food systems, through ecologically healthy productive forms and the reduction of physical and social distance between producers and consumers, promoting positive socioeconomic results (Zollet; Maharjan, 2021). AFN is considered a cultural transition, involving scaling down, shortening distances, commitment to local actors, and productive ways organically and sustainably (Jarosz, 2008; Sellitto, Vial; Viegas, 2018).

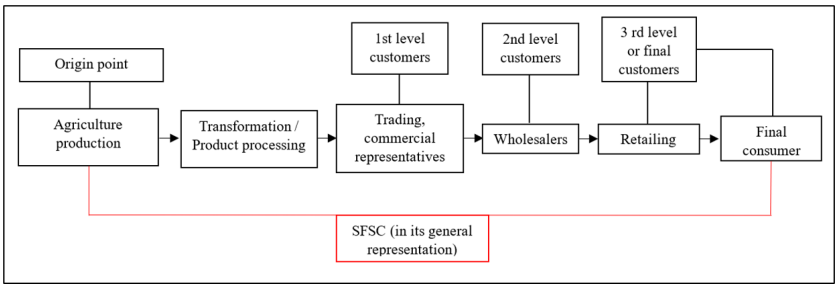
For this reason, Chiffoleau and Dourian (2020) mention that SFSC is one of the many forms of AFN, where ethical, social, and environmental values motivate producers to participate in alternative markets. Similarly, other scholars characterize AFN and SFSC as presenting structures that allow direct contact between producers and consumers (Zoll; Specht; Siebert, 2021). However, there are conceptual differences between AFN and SFSC. While AFN encompasses new emerging networks of producers, consumers, or other actors adopting alternative ways in the food supply chain, in opposition to the standardized and industrial mode, SFSC encompasses producers and consumers. Producers, who in addition to cultivating food in the field, process and distribute it directly to consumption, demonstrate an interrelationship between producers and consumers (Renting; Marsden; Banks, 2003). Thus, SFSC seeks to redefine the relationship between producer and consumer, by shortening the distances between them, building value and meaning in this interaction, so that the price of products relates to the criteria and constructions of this model of supply and demand (Marsden; Banks; Bristow, 2000).

Short food supply chains

While the conventional food supply chain has as its main characteristics an intensive production mode of standardized and ultra-processed products, going through various levels of suppliers and,

subsequently, intermediaries until the product reaches the consumer, SFSC involves an approach between producers and consumers, establishing direct relationships between them (Chaffote; Chiffoleau, 2007; Maren, 2019), as exemplified in Figure 1.

Figure 1 – Conventional food supply chain versus SFSC



Source: Adapted from Lambert, Cooper (2000), Belletti and Marescotti (2020).

It is important to emphasize that, in SFSCs, the form of connection between producer and consumer is not related to the number of times the product was intermediated, or the distance traveled to the final consumer, but the fact of presenting a product with incorporated information. This information can be communicated through packaging and/or information expressed on the products, such as Geographical Indication seals, or even through sales that present interactions between producer and consumer, where the farmer himself communicates about his product. From these communications, the consumer can often create connections and attribute value to the product based on the production location and, potentially, with the values of the people involved, such as the involvement of farmers, their families, the promotion of local jobs, production methods, among others (Abatekassa; Peterson, 2011; Marsden; Banks; Bristow, 2000).

Commonly, in the literature, three positions of SFSCs are recognized, with their respective market operation models (Ilbery; Maye, 2005; Marsden; Banks; Bristow, 2000; Renting; Marsden; Banks, 2003):

- Face-to-face, where consumers buy products directly from producers, presenting personal interactions between agents and, often, generating a relationship of trust, their models involve on-farm sales, Pick-Your-Own, and farmers' markets, among others.
- Spatial proximity, where products, in addition to being produced and resold in the specific production region (or local), consumers are informed about the origin and nature of the product at the point of sale. This category overlaps with face-to-face, by including the same locations mentioned in the previous item. In addition, it includes specialized retailers selling local products, such as grocery stores, local shops, tourist companies dedicated to retail, and sales to institutions, such as hotels, hospitals, schools, and even supermarkets selling locally sourced food.
- Extended spatiality, where products are sold to consumers located outside the local area (from where the products were produced), but there is information on the product about the production method, region, or producer. This model involves products with certification labels or reputation effects, such as fair trade, and Geographical Indication seals, among others.

Besides these categories, SFSCs can also be interpreted according to three perspectives: reduction of physical distance between producers and consumers (being identified through geographical or local proximity); reduction of the number of intermediaries connecting producers and consumers (where the number of intermediaries between producers and consumers can be minimal, or ideally none); the increase of cultural and social proximity between producers and consumers (products present value information to the consumer, for example, by communicating on the packaging the place and production methods, allowing the consumer, even geographically distant, to associate the product with the place, space, people, and their involved production methods) (Ilbery; Maye, 2005; Kneafsey *et al.*, 2013).

SFSCs and adding value to products

According to Renting, Marsden, and Banks (2003), SFSCs are also related to the definitions and conventions of quality. For example, product differentiation is related to transparency in market relations, where these quality definitions are transmitted among all involved parties and communicated to the consumer, to make them aware of paying the premium price (Renting; Marsden; Banks, 2003; Sacchi *et al.*, 2018).

Thus, there are two categories of SFSCs related to the quality convention, presented by Renting, Marsden, and Banks (2003). The first consists of the relationship between product quality attributes and the place of origin, where the product was produced, or information about the producer, and the second is about the production method, especially organically.

Regarding the first category, the specific characteristics of the production location involve natural factors, cultural factors, and gastronomic traditions, among others. These are parameters that define the product quality, often generating a typical result, unique in appearance or taste, like those that express the artisanal nature of the production process, the producer's skills in knowing how to do it, carrying their cultural heritage. Similarly, consumers attribute the quality of SFSCs by accessing a fair market, considering ethical and justice parameters, especially for farmers.

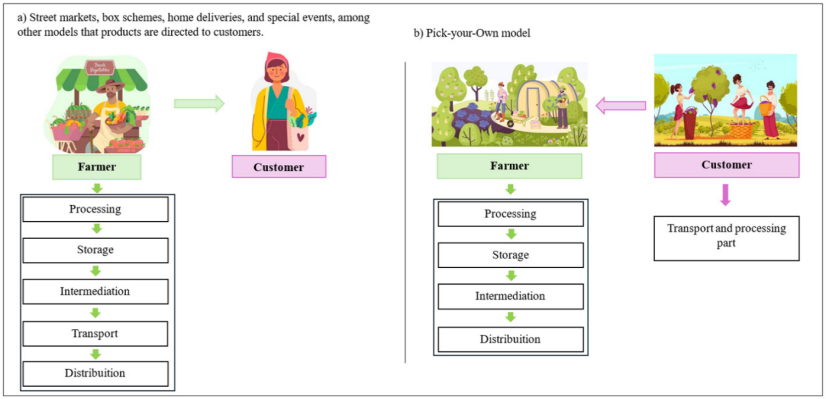
The second category defines the quality of SFSCs by relating the food production method and environmentally friendly production methods, such as integrated production, organic production, genetically modified organism-free foods, and lower use of chemical additives, among others. There is a diversity of products that can present packaging with information about natural aspects, as well as be based on romantic images of agriculture, by communicating a valuation of multifunctional agricultural forms, such as agritourism options that contribute to nature by maintaining rural landscapes and animal welfare.

According to Belletti and Marescotti (2020) and Renting, Marsden, and Banks (2003), farmers engaged in SFSCs aim primarily to reduce costs and add value to the product. The most appropriate distribution method for each type of producer can change according to labor availability, infrastructure, and the organization of the production system (Rocchi *et al*., 2020). For example, there are SFSC models that present interactions between farmers and consumers that include both face-to-face (producers' store, Pick-Your-Own, multifunctional rural companies, etc.) and spatial proximity (thematic routes, events, among others). Thus, through this direct contact between them, the main potential value added to products is related to providing more detailed information about production methods, seasonality, food freshness, and territory, among others. According to Pinna (2017), one of the factors that most generate trust in the relationship between producer and consumer is the producer's ability to tell stories about the product and its origin, including the description of their territory. The author states that this is one of the best ways for consumers to evaluate food quality, which is strongly related to the local and regional identity of a territory.

Multifunctional rural companies offering agritourism options, besides offering fresh agricultural products, have other direct sales opportunities that add value to the products, such as offering services related to their agricultural products and territory, including tastings, gastronomic routes, and providing labor experiences in their production methods (Belletti; Marescotti, 2020).

According to Belletti and Marescotti (2020), transforming distribution chains involving long and standardized systems into SFSCs leads to the elimination of various functions that were performed by actors removed from these chains. These functions are taken over, at least in part, by actors within the SFSC chains, namely, farmers and consumers. This is the case, for example, with Pick-Your-Own, as shown in Figure 2.

Figure 2 – Functions of producers and consumers in some SFSC



Source: Authors adapted from Belletti and Marescotti (2020), Freepik (2023).

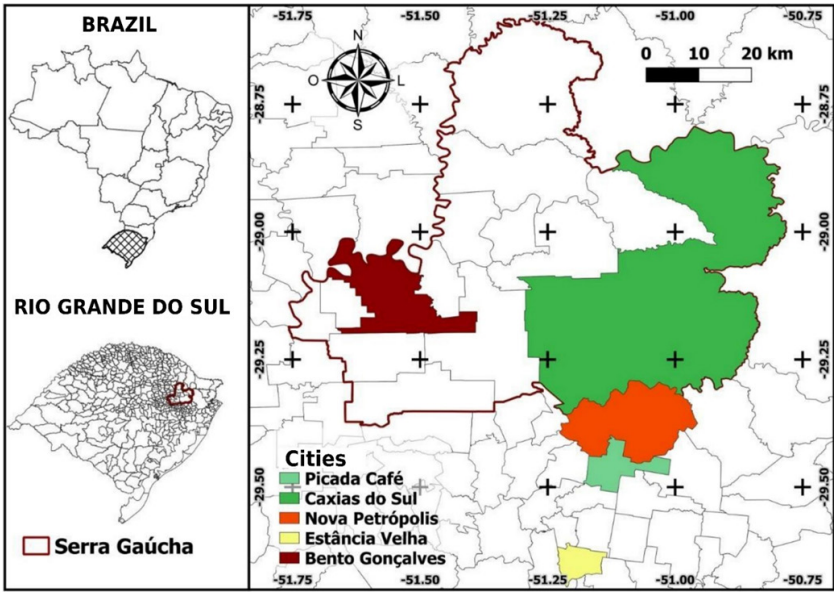
Commonly, in conventional chains or some SFSC chains like farmers' markets, box deliveries, and others, consumers do not play an active role, as they only place their orders and receive them at home or sales locations. In the case of some distribution forms through SFSC, such as Pick-Your-Own, consumers travel to the production site and take part in one or more of the production processes, such as harvesting.

In this context, where consumers are part of the production process, field labor activities create experiences for consumers, allowing farmers to add value to products through various marketing opportunities.

Cases of Family Farmers from Rio Grande do Sul

The farmers who were part of this study are in different municipalities in Rio Grande do Sul, as shown in Figure 3.

Figure 3 – Location of the studied cases



Source: Prepared by the authors, based on the research data (2024).

It is important to highlight that some municipalities like Bento Gonçalves and Caxias do Sul are part of the Serra Gaúcha region, characterized by grape cultivation and wine production. This territory, being a mountainous region, provides enchanting landscapes that attract tourists, fostering other economic activities in the cities and region, such as the establishment of hotel networks, gastronomy, leisure options, and events that express the local culture, like Italian immigration (Dinis *et al.*, 2022; Fertenseifer, 2007; PPGQ, 2023).

Similarly, other cities like Nova Petrópolis, Picada Café, and Estância Velha, besides being located close to this region, are part of the state's Romantic Route. This Route is a tourist path formed by 14 municipalities, including Gramado and Canela, where tourists can drive, appreciating nature along the roads lined with plane trees and highlighting the cultural value related to the preservation of German culture inherited

by immigrants. Thus, there are gardens, half-timbered houses[3], traditional German festivals, colonial fairs, typical bands, and other attractions (Rotas e Roteiros, 2023). Therefore, the roads that are part of the Romantic Route allow farmers to also benefit from the landscapes surrounding their rural properties. Regarding the main products, only one case (B) does not process its products, producing and marketing Fruits, Vegetables, and Greens (FLV).

Concerning this research, it is important to note that, firstly, a key agent from the Federation of Agricultural Workers in Rio Grande do Sul (FETAG) was contacted and, subsequently, based on the contacts provided by this agent, communication with family farmers was made through the social network WhatsApp, informing them about the research objectives, and as per the interest and availability of the farmers, a face-to-face visit was scheduled. Thus, data were collected through semi-structured interviews with open-ended questions and observation of the visited properties, totaling responses from six family farmers.

Of the farmers who responded to the research, half are female (A, D, F) and 67% of them (A, D, E, F) are between 40 and 45 years old, 33% (B, C) are between 50 and 55. When asked about their level of education, half responded that they studied up to high school (C, D, E), two up to elementary school (A, B), and one has completed higher education in viticulture (F). All respondents have a Declaration of Aptitude to Pronaf (DAP) and are aware of the change from DAP to CAF (Family Agriculture Registry). This result indicates that all surveyed farmers are informed about the concept of Family Farming, as per Law No. 11.326, of 2006, and the access to credit from the National Program for Strengthening Family Agriculture (PRONAF).

Regarding property data, 50% (A, C, D) started their agribusiness activities between 2010 and 2013, 33% (B, E) between 2000 and 2003,

[3] The houses feature a construction technique that uses articulated woods, fitted together in horizontal and vertical positions, forming a structure that later has the spaces filled with other materials, which can vary between stone, brick, wattle and daub, among others, leaving these woods visible on the façades, providing a contrast between colors and materials (Priberam Dicionário, 2023; Wittmann, 2016).

and 17% (F) were founded in 1970. Thus, most started their activities from the 2000s onwards, as observed in Box 1.

Box 1 – Characterization of the properties

Case	Main product offered	Year of foundation	Productive area (hectares)	Gross monthly revenue (thousands - R$)	Number of family members contributing
A	Tea	2013	Between 1 and 10	Not informed	3
B	Fruits, vegetables, and greens (FLV)	2003	Between 1 and 10	Between 11 and 20	4
C	Jam	2011	Between 1 and 10	Above 50	3
D	Dairy products	2010	Between 21 and 30	Between 11 and 20	3
E	Cookies	2000	Between 1 and 10	Between 31 and 40	3
F	Wine	1970	Between 1 and 10	Between 21 and 30	3

Source: Prepared by the authors, based on the research results (2024).

Regarding the productive area, most (83%, A, B, C, E, F) have an extension between 1 and 10 hectares, and 17% (D) between 21 and 30. This result is not directly related to the revenue level of the properties, as establishments that showed higher revenue, such as those above R$50 thousand (C) or between R$31 and R$40 thousand (E), have an area between 1 and 10 hectares. According to one of the interviewees (D), the family farmer does not need to buy extensive land areas but, as per his statement, "make the most of what they have." This yield, for the farmer, is related to the strategy of differentiation and adding value to the product, mentioning that consumers are willing to pay a higher price for a quality product. Furthermore, the farmer mentioned that they do not only sell products but also the story of their lives, the products, contributing to the environment and consumers' health. This result can be explained by Bazzani and Canavari (2017), who cited that the cultural and social approach promoted by SFSCs is not only based on products recognized for

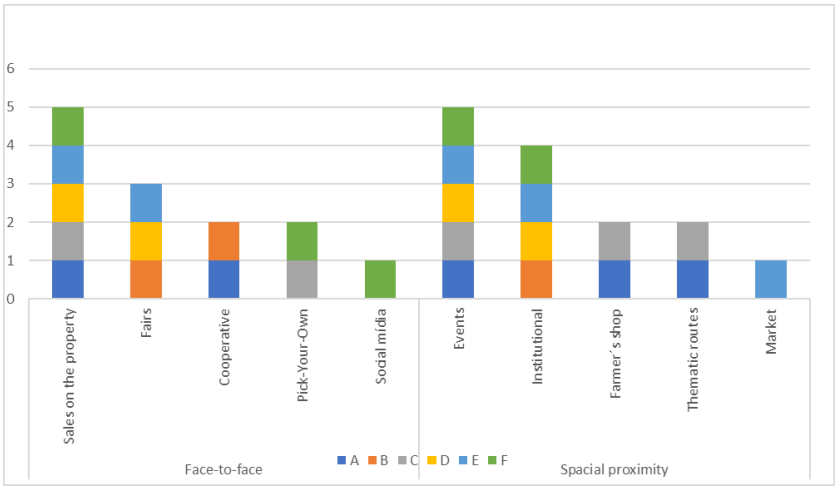
their production location but also on consumers' interest in the cultural and symbolic value of the offered product.

All farmers receive labor contributions from three to four family members, being family agriculture composed of husband, wife, children, and/or in-laws. In two cases (A, B), the children are teenagers and, in addition to their studies, play an active role in the family rural enterprises, such as creating products, assisting in sales involving consumer interactions, such as events and fairs, and changes in packaging. In one case (A), the daughter implemented the idea of printing QR Codes on labels, allowing consumers easy access to product and enterprise information, including the family history and product catalog. Additionally, some children take technology-oriented courses to expand sales through online resources. This result indicates stimuli for income generation, increased autonomy, and rural succession, as presented by Conterato and Strate (2019).

Regarding the marketing channels, it was identified that all use the categories identified as face-to-face and/or spatial proximity, as observed in Figure 4.

The main models used in the face-to-face category were sales on the properties (83%, A, C, D, E, F), and fairs (50%, B, D, E). Sales on the properties include those with stores (A, C, F), displaying both products produced on the property and those from the local region. Case F, for example, sells sausages from the city and region of Bento Gonçalves, as well as using these products for consumers to taste with wines, making various pairings. The farmer, when displaying his drinks, maintains partnerships with other farmers in reselling regional products, contributing to local development.

Figure 4 – Marketing models used by farmers



Source: Prepared by the authors, based on the research data (2024).

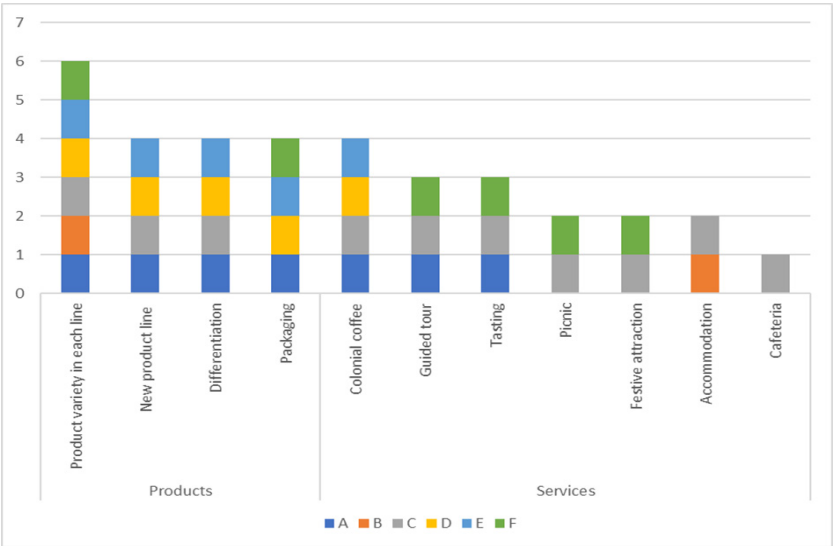
Regarding the marketing models in the spatial proximity category, the main ones were participation in events (83%, A, C, D, E, F) and institutional sales (50%, B, D, E). The events are trade fairs that include family farming, such as Expodireto, Fenadoce, and Expointer. The latter, most cited among the respondents, corresponds to a traditional agricultural fair in the state of Rio Grande do Sul, starting in 1900 and, according to one of the farmers (A), is the most anticipated event due to the number of visitors and sales. Between 2022 and 2023, for example, there was a 6% increase in the number of visitors and a 12% increase in business volume (Rio Grande do Sul, 2023).

Although some farmers do not participate in free fairs (A, C, F), they direct their efforts to participate in events like these to increase the visibility of their brand, considering it a showcase for their products and often aiming to foster business, seeking resellers from other states. As for institutional sales, these include sales to schools (B, D, E), social assistance institutions (E), and restaurants (B, E, F). In sales that include schools and social assistance, farmers participate in the National School Feeding Program (PNAE) and the Food Acquisition Program (PAA). Sales to schools

caused some cases (D, E) to differentiate their products, as nutritionists demanded products with lower sugar content, but without losing the quality of aroma and flavor. These items also began to be marketed to other consumers, especially those concerned about health.

Regarding ways to add value to products and services, it was identified that all cases invested in product variety in each line, as observed in Figure 5. For example, in case F, there is the production of only one product line, being wine, but there is a variety of them, such as fine wines, smooth, red, and white.

Figure 5 – Ways to add value to the products and services offered



Source: Prepared by the authors, based on the research data (2024).

Next, 67% (A, C, D, E) invested in new product lines, differentiation (67%, A, C, D, E), packaging improvements (67%, A, D, E, F), and added value with service offerings, the main ones being colonial café (50%, A, D, E) and tasting of agricultural products (50%, A, C, F). Except for cases B and F, besides the main products, there is the production and trade of other product lines, such as jams, dried fruits, cookies (A), grape juices (C), yogurts, kinds of butter, cheeses (D), and pasta, such as noodles and agnolini

(E). The fact that farmers invest in new product lines is related to economies of scope, which, according to Mendes (2004), is when the same industrial plant produces several products simultaneously, or not, enabling advantages related to the unit cost of the product through a combination of factors, such as machinery usage, facilities, marketing, and administration. Thus, the production of one or more (different) products comes from using the same facilities and labor, reducing unit production costs.

In addition to reducing unit costs, farmers increased their negotiation capacity by producing and offering other product lines, meeting different consumer demands, to remain competitive in the market. For example, case E bought a more modern machine for cookie production and uses it, in different shifts, for pasta production, especially agnolini. The same applies to case C, where the farmer identified losses during juice production. Thus, he chose to expand his production to jams to utilize the excess grapes. In this case, there was also an increase in product variety, related to the marketing model. Through Pick-Your-Own, by expanding their plantations to raspberries, strawberries, blueberries, physalis, among others, the farmer uses these fruits to produce different jam flavors, including combinations, such as red fruits and purple fruits. These products are marketed as gourmet, with a higher price compared to single-fruit jams.

Regarding product differentiation, some farmers offer foods with organic certification, whole products, diet, gluten-free, and lactose-free (A), lower sugar content (D, E), and free of sucrose and preservatives (C). Thus, besides the products presenting traditional aspects in their production, the differentiations are related to consumer health. Organic foods, for example, when presenting certifications, are aligned with Scalco (2019), explaining that products with seals differentiate from conventional ones by following rules and norms determined by entities that regulate and certify these products, ensuring that the manufacturing processes preserve the health of consumers and workers.

In this context, it is important to note that, except for case B, all have packaging, labels with the enterprise's logo, and the Selo Sabor Gaúcho (Gaúcho Flavor Seal). According to the Secretariat of Rural Development,

Fisheries, and Cooperatives (2023) of the state of Rio Grande do Sul, this Seal emerged due to the need to create a product origin designation, based on the artisanal origin of family agroindustry, in compliance with sanitary, environmental, and social responsibility requirements. Thus, according to Abatekassa and Peterson (2011), origin and provenance information can be communicated through packaging, and information on labels, such as the use of seals. The Selo Sabor Gaúcho allows farmers to add value to their products by informing consumers of the origin, being in the state of Rio Grande do Sul, artisanal production through agriculture involving families in the field, and safe food for consumption, meeting sanitary and environmental requirements.

Farmers also added value to products through packaging investments, such as Drip Tea (A), enabling tea consumption anywhere and anytime without losing product quality. In case D, the yogurt presentation switched to a transparent pot, highlighting the fruit pieces, and the cheeses, previously wrapped in plastic film, are now vacuum-sealed, contributing to product quality, and maintaining the properties and flavor of the food. There were changes in labels (E, F), where product names, shapes, and colors of logos started representing the culture and descent of the family, which is Italian. Thus, they included in their brand's visual identity the colors of the Italian flag.

Marketing models involving product displays, such as on-property stores, fairs, social networks, local stores, and events, even if farmers interact with consumers, invested in adding value to products, enabling sales through appearance and other visual aspects, according to a farmer's statement: "first, you have to sell a product with your eyes. So, we also sought to differentiate our packaging for people to see our product" (Interviewee D).

Regarding ways to add value to services, all are related to multifunctional rural enterprises, which, according to Belletti and Marescotti (2020), besides offering fresh agricultural products, provide services related to these products and the territory. Thus, most offer services that add value to their products, such as colonial café (50% A, D, E), guided tours, and tastings (50% A, C, F).

The cases presented peculiarities in serving colonial cafés on their properties, depending on the space, each adds value differently, as represented in Figure 6.

Figure 6 – Colonial café served on rural properties, according to local structure, allowing different experiences

Source: 8photo (2023) and Vecstock (2023).

In case A, the café can be served in an indoor area, made of wood, near the fireplace and/or on an outdoor deck, overlooking the surrounding landscapes. Thus, depending on the weather, the consumer can choose between these two options. In case D, the space is an annex to the farmer's house, being a wooden kitchen, with a wood stove, wooden tables and benches, and decorative items from the farm itself, such as kettles and iron pots, presenting a more rustic characteristic. On property E, the products are displayed on a long table in a covered area outside the agroindustry, with pallet furniture, where the cushions are in Italian colors, and the farmers approach the consumers to enjoy the nature of the place and appreciate stories of generations and culture, through the offer of their products.

In all three cases (A, D, E), there is an offer of food that brings cultural revival, with fresh products, such as dulce de leche, corn cake, cream cookies, stuffed cucas, cheese bread, traditional sausage, among others that indicate homemade food. This result aligns with Renting, Marsden, and Banks (2003) by explaining that SFSCs are related to the

quality convention, in which one of the categories is related to the quality attributes of the product and the place of origin, indicating where the product was produced, or information about the producer, involving cultural aspects and gastronomic traditions. Thus, consumers can attribute quality to the offered product and service based on the product quality, relating it to the productive location and information about the producer, encompassing cultural and traditional aspects.

The same cases that offer guided tours also provide tasting (A, C, F). Case C, for example, has a partnership with tourism companies in some tourist cities in the region, such as Canela and Gramado. These companies organize groups of tourists who wish to visit the property, and the starting point is hotels and/or other locations. The guided tour also offers consumption experiences; in case F, consumers need to schedule the visit in advance and are guided by the owner, an oenologist, who explains and answers various questions about the product manufacturing. On some occasions, she recommends consumers perform the sabrage[4]. The visit includes viewing the barrels and the cellar where the wines are stored, with low lighting, allowing for original photos, with the company logo in evidence, and includes consumer participation in production processes, such as assisting in label sticking.

A few cases (equal to or below 33%, two) offer other services that require infrastructure investments, such as accommodation and café, or the disposition of time and/or hiring labor to carry out picnics and festive attractions. Case C, for example, identified a labor problem by offering picnic service, especially for serving people, and implemented a system similar to that used in food courts of shopping centers. The consumer goes to the place to place their order and is given a digital device, through which the consumer is notified, employing vibration and lighting of the device, that their order is ready. Thus, people move to the delivery point and collect their purchase, with a basket of products, as shown in Figure 7.

[4] Technique for opening sparkling wine bottles using a saber (a curved-blade sword), but the bottle can also be opened with a sommelier's sword or a spoon. In this way, by sliding the saber along the tip of the bottle's neck, at a 45º position, the cork is removed (Yanomany, 2023).

Figure 7 – Picnic basket like what the surveyed farmers offer

Source: Vwalakte (2023).

Cases C and F offer consumers a picnic service, carried out under the vines, with the provision of tables and red checkered tablecloths. The location of the tables allows the appreciation of the nature view, contemplating the surrounding landscape, with a nearby playground option for children. In both cases, there are festive attractions, such as the grape stomping festival, during harvest times, promoting unique experiences for consumers.

Regarding accommodation, there is an offer between cases B and C, but with different proposals. Case B offers lodging on-site, adapting to the family residence, with the addition of rooms in its structure, for tourist groups to stay and eat. Case C, on the other hand, built wooden chalets, with fireplaces, bathtubs, and private open-air decks, and, because the property is located on one of the region's Germanic Paths, offers accommodations with panoramic and scenic views. This accommodation allows guests to walk through private gardens, and pick fruits directly from the tree through the Pick-Your-Own system, among other attractions provided by the farmers.

Final considerations

The SFSCs emerged as an alternative to the standardized and industrial mode of the food system, leading farmers to seek alternative marketing models. In parallel, due to new consumption patterns related to ethical, cultural, and environmental values, farmers sought to meet this new demand, with the main objectives of cost reduction and adding value to the product.

Thus, through this chapter, some marketing strategies used by family farmers in the state of Rio Grande do Sul, who operate in the Short Food Supply Chain, adding value to their products and services, were exposed.

Adding value to products is related to marketing channels that involve the display of offered items, such as events, and shops on properties, among others. In parallel to the interaction between farmers and consumers, products are sold through their visual aspects, such as the presence of seals and certification, indicating differentiation, investments in packaging, involving logo and label, and the diversity of the product line, to meet different consumer preferences.

As for ways to add value to services, all are related to multifunctional rural businesses, which, in addition to offering fresh agricultural products, farmers offer services related to these products and the territory, such as colonial café, guided tour, picnic, festive attraction, among others that promote unique experiences for consumers, in contact with nature.

These ways of adding value to products and services, through SFSCs, contribute to income generation, improved living conditions for farmers and their families, rural succession, due to autonomy, and local and territorial development, by attracting tourists and assigning value to origins and regional culture, as well as helping to maintain and preserve landscapes and other natural resources in the regions where rural properties are located.

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8PHOTO. *Algumas sobremesas turcas com copos de chá e bule em uma mesa com a vila no fundo, vista lateral.* Freepik. 2023. 1 fotografia. Disponível em: https://br.freepik.com/fotos-gratis/algumas-sobremesas-turcas-com-copos-de-cha-e-bule-em-uma-mesa-com-a-vila-no-fundo-vista-lateral_7757646.htm. Acesso em: 12 set. 2023.

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Chapter 9

Relationship between technological innovation infrastructure and productivity in peanut cultivation

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Introduction

Peanut (*Arachis hypogaea* L.) is an herbaceous plant, whose seeds contain around 25% protein and 50% edible oil. The grain is considered one of the most nutritious and energetic foods, being used in the food industry as raw material to produce oil and confections (Gerico *et al*., 2020).

In 2020, the world's largest peanut producers were China, India, Nigeria, USA, Sudan, Argentina, and Brazil, respectively, with China responsible for producing approximately 17.5 million tons. Also in 2020, the largest importers of shelled peanuts were the Netherlands, Indonesia, China, Russia, and Germany, respectively (FAO, 2023). In the same year, the volume of shelled peanut imports was approximately USD 3.3 billion, and peanut oil was almost USD 440 million in the world market, of which Brazil had a 7% and 13% share, respectively (Trade Map, 2022).

With exponential growth of 100% in the last decade, peanut production in Brazil reached almost 700 thousand tons in the 2021/22 harvest (CONAB, 2022b). This increase is due to the adoption of new technologies in the production segment, with new more adaptable, resistant, and productive cultivars, with the introduction of mechanized harvesting, and with the institutional changes that have occurred since the development of standards and production rules aimed at ensuring product health (Akram *et al*., 2022).

The peanut crop is highly relevant to the agribusiness of the state of São Paulo, which is the largest producer in the country, being responsible for producing 561.6 thousand tons in the 2021/22 harvest, representing almost 90% of national production (CONAB, 2022a).

The main peanut-producing regions within the state of São Paulo are Alta Mogiana, where production is mainly concentrated in the municipalities of Ribeirão Preto, Dumont, Jaboticabal, and Sertãozinho; and Alta Paulista, where production is more representative in the municipalities of Tupã and Marília (Sampaio; Fredo, 2021). Additionally, it is estimated that 80% of the reformed sugarcane areas in the state are occupied by the peanut crop

(Sampaio, 2016). Therefore, the inclusion of this crop in areas of sugarcane renewal is making it increasingly competitive in the country.

Although peanut cultivation has been explored in the state of São Paulo since the 1940s, gathering more than 80 species, there is a need for more investments in infrastructure, machinery, technology, and personnel to generate innovations capable of achieving higher productivity, profitability, and competitiveness (Sampaio; Fredo, 2021).

According to Martins and Vicente (2010), the capacity to innovate and adapt to market requirements and demands depends largely on strategies, adoption, and development of new technologies. Therefore, there must be "[...] the maximization and creation of synergies among the parties involved in the production chain to meet consumer needs more efficiently and effectively, with lower costs" (Armelin; Silva; Colucci, 2016, p. 80).

Indeed, technological changes in peanut production and processing and institutional transitions are directly linked to the current production scenario of the crop, meaning they impact the production volume, product quality and competitiveness, and more effective participation in meeting domestic and foreign market demands (EMBRAPA, 2014). In this sense, Information Technology has become increasingly relevant to agribusiness, contributing to innovation in food production and food security.

Agriculture 4.0 consists of a set of integrated digital technologies (systems, applications, and machines) developed to optimize agricultural production in all its stages, from planting to harvesting (Silva *et al.*, 2019). Therefore, the combined use of precision agriculture, big data, and the internet of things can lead to greater efficiency in management and agricultural production, as these technologies have been used in the planning and control of various crops (Braun; Colangelo; Steckel, 2018); in the intelligent use of data collected through advanced technologies (Mancini; Frontoni; Zingiarettie, 2019); as well as in sustainable practices (Symeonaki; Arvanitis; Piromalis, 2020).

Agriculture 4.0 tools generate and analyze a large amount of data, integrating management and production processes and ensuring the

professionalization of activities and sustainability in production processes. They facilitate decision-making, providing cost reduction and higher productivity and profitability (Silva *et al*., 2019). Therefore, understanding the association between the use of new technologies and the effect of this use on peanut productivity enables the establishment of scenarios that will assist in decision-making regarding the improvement of the dynamics and competitiveness of the production chain.

This chapter presents the technological infrastructure, based on Agriculture 4.0, related to machines and equipment, inputs, storage, and management used by peanut producers in the West Paulista region. Specifically, it makes an association of this infrastructure with the productivity of the said crop to verify the implication of using these technological innovation items on productivity.

The concept of technological innovation is associated with the emergence of unprecedented technologies generated in a scientific research environment that provide higher quality and productivity, an essential factor for the development of peanut production, similar to other crops and economic sectors (Sharif, 2012). In this sense, the world is becoming "dramatically more interconnected, interdependent, and competitive, where fostering innovation has emerged as the main strategy for socioeconomic prosperity" (Sharif, 2012, p. 599).

Given this context, the theme addressed in this chapter aligns with the Sustainable Development Goals (SDGs) in terms of the following targets:

> Target 9.5 Strengthen scientific research, improve the technological capabilities of industrial sectors in all countries, particularly developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per million people and public and private spending on research and development. Target 9.b Support domestic technology development, research, and innovation in developing countries, including ensuring a conducive policy environment for, among other things, industrial diversification and value addition to commodities (GT AGENDA 2030, 2022).

The theme and objectives of this work are interrelated with the areas of Administration, Agronomy, Statistics, Information Systems, Economics, among others. Therefore, given the multidisciplinary scope of the related areas, it is considered that the results of this research contribute to the Competitiveness of Agribusiness Systems line of the PGAD by providing important information on the advantages of using certain technologies in agricultural activities for cleaner and more sustainable production.

A form with multiple-choice questions was used as a data collection instrument. This form was applied to a random sample of 29 peanut producers from the West Paulista region (which includes the Alta Paulista region) who used conventional and conservationist systems during the second semester of 2022 (harvest 2022/23).

The surveyed producers are in the main peanut-producing municipalities of the West Paulista region, namely, Adamantina, Arco-Íris, Bastos, Getulina, Guaimbé, Herculândia, Iacri, Marília, Martinópolis, Nantes, Parapuã, Presidente Prudente, Quatá, Quintana, Rancharia, Sagres, and Tupã. The number of surveyed farmers corresponds to 20% of the total planted area in the West Paulista region, representing a significant segment of the peanut-producing region.

The form's questions concern the type of farmer (family or non-family), planted area, production destination, and peanut productivity, as well as the adoption of technological innovation items (in the 2022/23 harvest) related to:

- Machines and equipment: Self-propelled sprayer; Harvesters; Global Positioning System (GPS); Light bar; Section cut on the sprayer; Autopilot; GPS signal correction; Variable rate fertilizer; Applications using Unmanned Aerial Vehicles (Drones); and Telemetry system.
- Inputs: Annual soil analysis; Application of macrobiologicals; Integrated Pest Management (IPM); and Integrated Disease Management (IDM).
- Type of storage: Dryer; and Warehouse.

- Management: Agronomic assistance from the cooperative/ reseller; Own agronomic assistance; Agribusiness-oriented applications; Business management software; Trained operators; Business management by a professional; and Quality certificate

The data obtained were analyzed using descriptive statistics (graphs and percentages), and then G independence tests were applied. The G test is a non-parametric test, similar in all aspects to the chi-square test (χ^2), used to verify the association between two qualitative variables, arranged in contingency tables or double-entry tables, specifically when the sample size is less than 40 and expected frequencies are less than '5' (Fávero; Belfiore, 2017). In this chapter, contingency tables are shown geometrically, i.e., summarized through graphs.

Non-parametric tests are recommended for formulating hypotheses about certain qualitative characteristics of a population and can be applied to qualitative data, on a nominal or ordinal scale (Fávero; Belfiore, 2017). Thus, for a significance probability obtained from the data (p-value) less than or equal to the 5% significance level established for the test, the null hypothesis Ho of independence between the variables productivity and a given item of technological innovation was rejected, concluding that there is a significant association between the two variables analyzed (Martins, 2005).

Profile of rural producers, planted area, production destination, and peanut productivity in the West Paulista region

According to the research data, 35% of the surveyed producers can be characterized as family farmers, according to Federal Law No. 11.326, of July 24, 2006 – which establishes the guidelines for Family Agriculture and Rural Family Enterprises in Brazil (Antunes, 2011; Brasil, 2006).

Sales of 83% of rural producers' production are exclusively to the domestic market. Of the remaining 17%, 7% are family farmers, with cultivation ranging from 242 to 605 hectares, who have quality certification

from the Brazilian Association of Chocolate, Peanut, and Candy Industry (ABICAB) and supply the product to domestic and international markets. The other 10% exclusively sell their products to the international market, with 3% of these producers having production of up to 1,815 hectares and 7% around 2,420 hectares. Of these 10%, about 70% of producers have quality certification.

As for export destinations, a significant portion of the peanuts produced by the surveyed producers goes to the following markets: Russia, Algeria, Ukraine, European Union (14 countries), Dubai, Morocco, and Colombia.

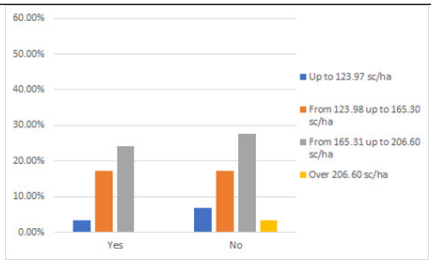
Additionally, about 56% of rural producers had productivity above 165.30 bags per hectare (sc/ha) in the 2022/23 harvest, i.e., above 4,132.5 kilograms per hectare (kg/ha). It is noteworthy that, in the same harvest, the average peanut productivity in the state of São Paulo was 3,848.0 kg/ha, or equivalently, 153.92 sc/ha (CONAB, 2022a), which highlights the representativeness of the West Paulista region in the state's peanut production scenario.

Relationship between technological innovation infrastructure and peanut productivity

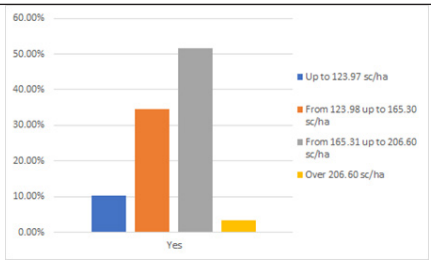
As for technological innovation infrastructure, Figure 1 shows the existing structure in terms of machines and equipment used by rural producers in peanut production.

It is observed that all surveyed producers have harvesters (Figure 1.b), and a significant percentage of producers have self-propelled sprayers (Figure 1.a), use GPS (Figure 1.c), and cut sections on the sprayer (Figure 1.e). A less significant percentage use autopilot (Figure 1.f) and GPS signal correction (Figure 1.g). On the other hand, most producers do not apply variable rate fertilizer (Figure 1.h) or use drones (Figure 1.i) for such applications, nor do they use a telemetry system (Figure 1.j) or light bar (Figure 1.d).

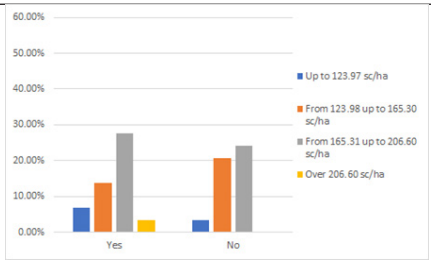
Figure 1 – Machines and equipment used by rural producers versus productivity (sc/ha)



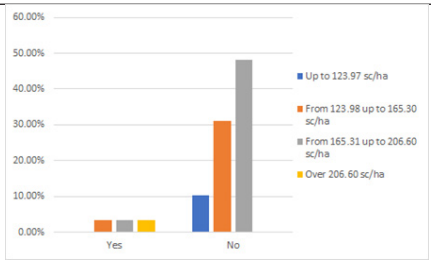
Self-propelled sprayer
G = 1.4819; degrees of freedom = 3; p-value = 0.6865



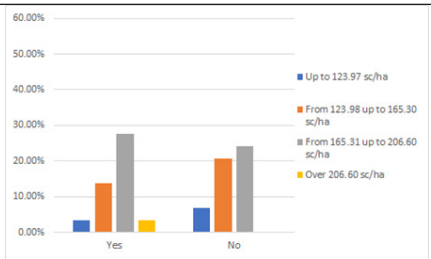
Harvesters



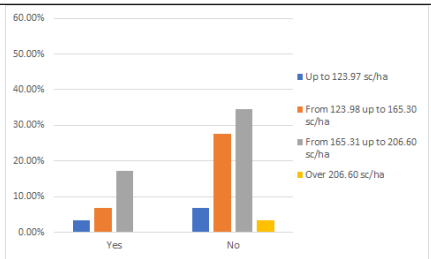
GPS
G = 2.1610; degrees of freedom = 3; p-value = 0.5397



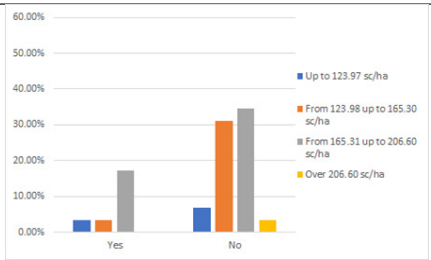
Light bar
G = 5.4409; degrees of freedom = 3; p-value = 0.1422



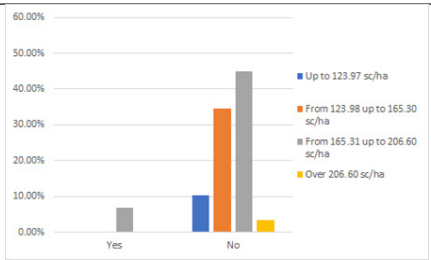
Section cut on the sprayer
G = 2.1610; degrees of freedom = 3; p-value = 0.5397



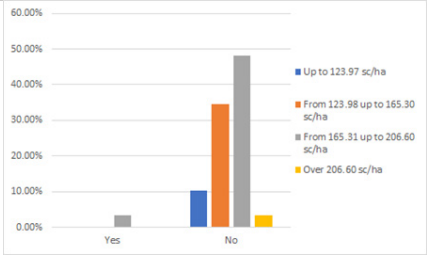
Autopilot
G = 1.2396; degrees of freedom = 3; p-value = 0.7435



GPS signal correction
G = 2.6384; degrees of freedom = 3; p-value = 0.4508

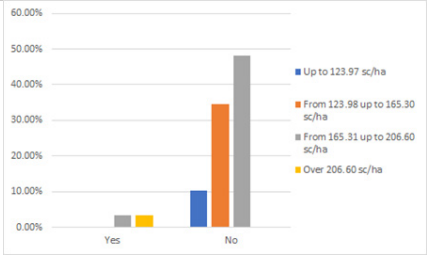


Variable rate fertilizer
G = 2.7751; degrees of freedom = 3; p-value = 0.4276



Applications using Drone

G = 1.3518; degrees of freedom = 3; p-value = 0.7169



Telemetry system

G = 7.2075; degrees of freedom = 3; p-value = 0.0656

Source: Prepared by the authors from the research data (2022). *Significant at 5%, indicating that the variables are associated.

The Global Positioning System or GPS is the equipment used for navigation, communication, measurement, and area delimitation, providing a reduction in the risk of losses. As for the autopilot systems in tractors, harvesters, and other agricultural machines, these work through an antenna installed on the machines' roofs that receive satellite signals from the GPS, allowing the vehicle to be guided automatically, without operator interference (Silva *et al.*, 2019). Unmanned Aerial Vehicles or drones are instruments that can be used to analyze areas, check for pest or disease attacks, and investigate planting failures. Telemetry, in turn, is a system that collects and shares data about machines, equipment, and vehicles remotely, monitoring routes, fuel consumption, and refueling, among other purposes (Silva *et al.*, 2019). The light bar is the equipment used to guide a vehicle in adjacent strips to obtain more precision and uniformity in the distribution of soil amendments and fertilizers. Variable rate fertilizer application is a resource that allows the application of different fertilizer rates in each part of the soil, according to its characteristics and planned yield (Armelin; Silva; Colucci, 2016).

Figure 1 also shows the p-values of the G tests applied to verify the independence between each of the machines and equipment items used (or not) by rural producers and productivity. It was observed that no item is significantly associated with productivity, according to statistical tests. Indeed, the data show that the Agriculture 4.0 infrastructure in terms

of machines and equipment in the West Paulista region is still incipient among the surveyed producers.

In this sense, Silva, Oliveira, and Loureiro Junior (2019) emphasized that there is little investment in research on the use of technologies in peanut cultivation, including regarding the mechanized harvesting process compared to other crops. However, technologies have significant potential for improving the harvesting process of this crop, highlighting the use of autopilot, yield mapping, telemetry, and computer vision.

Figure 2 shows the second group of technological adoption items related to inputs, which can be used to improve the soil and combat the main pests and diseases affecting peanut production, with "black spot" (which appears associated with other diseases) and the "redneck caterpillar" pest being the most observed in the West Paulista region. Regarding weeds, there is a higher incidence of "indigo" and "morning glory" in this region.

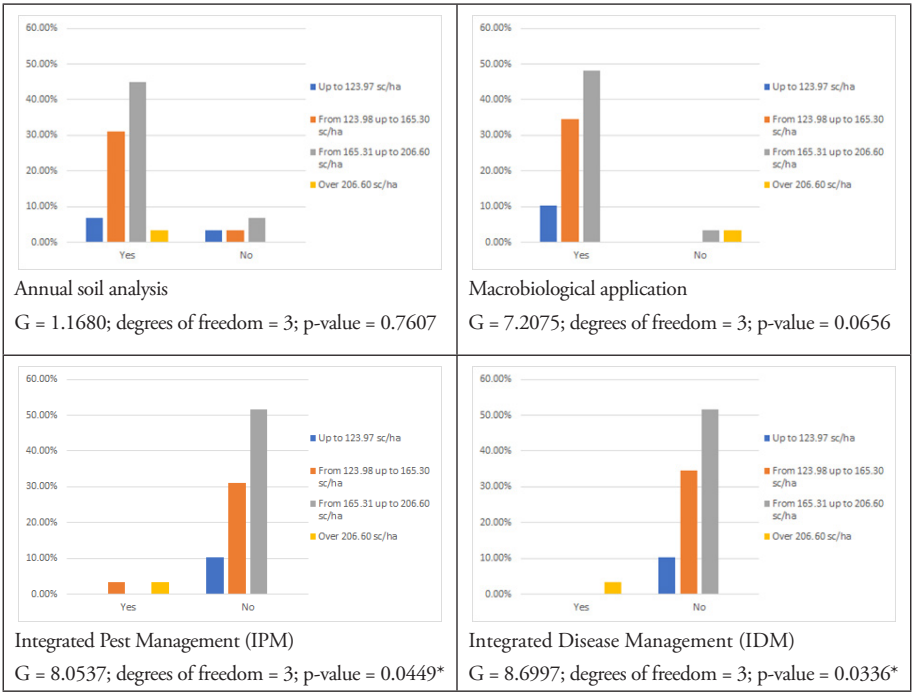
It is found that most surveyed producers take care of the soil, with more than 90% of them conducting annual soil analysis (Figure 2.a) and investing in macrobiological application (Figure 2.b), which is a pest and disease management procedure that uses living organisms (natural enemies) to control them. However, IPM and IDM have much less adherence among peanut producers in this region (Figures 2.c and 2.d).

As for the p-values of the G tests applied to verify the independence between each of the input items used (or not) by rural producers and productivity, Figures 2.c and 2.d indicate that two of them are significantly associated with productivity, namely, IPM and IDM. According to the data, about 80% of producers do not practice IPM or IDM but are concentrated in the two central productivity ranges (between 123.98 sc/ha and 206.60 sc/ha). However, producers who practice IPM and IDM are in the highest productivity range, above 206.60 sc/ha.

Integrated Pest and Disease Management is a control procedure that aims to preserve natural mortality factors through the integrated use of combat techniques selected based on economic, ecological, and sociological parameters. Thus, by effectively combating existing pests and diseases in the crop, this type of management leads to reduced use of

agricultural pesticides and, consequently, production costs, contributing to environmental balance and increased productivity and profitability of the crop (Norlia *et al.*, 2018).

Figure 2 – Inputs used by rural producers versus productivity (sc/ha)



Annual soil analysis

G = 1.1680; degrees of freedom = 3; p-value = 0.7607

Macrobiological application

G = 7.2075; degrees of freedom = 3; p-value = 0.0656

Integrated Pest Management (IPM)

G = 8.0537; degrees of freedom = 3; p-value = 0.0449*

Integrated Disease Management (IDM)

G = 8.6997; degrees of freedom = 3; p-value = 0.0336*

Source: Prepared by the authors from the research data (2022). *Significant at 5%, indicating that the variables are associated.

Figure 3 provides information on the types of storage used by surveyed producers after peanut harvesting. Such care is essential for maintaining the product, which requires specific conditions for drying, conditioning, transportation, and storage to avoid contamination by Aflatoxin, heavy metals, and other pathogens (Yang *et al.*, 2020).

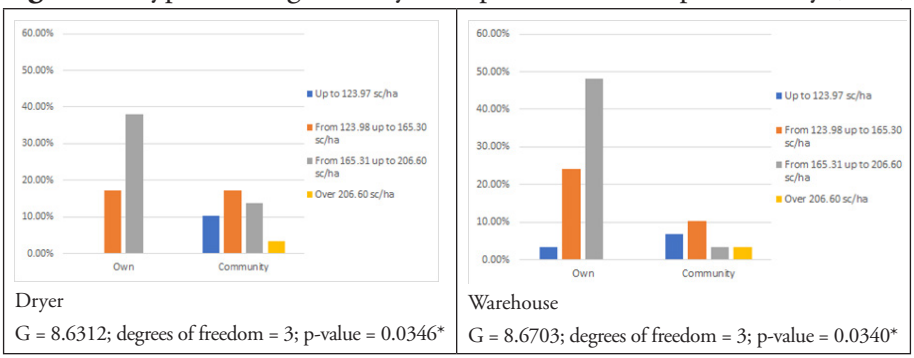
Notably, investments in technology and drying and storage equipment with humidity control enable the producer to have greater control over the procedures and lower risk of contamination by contact

with peanuts from other sources, in addition to strategic positioning with reduced external logistical costs, increased efficiency in logistical flow, and lower risk of product deterioration (Batalha, 2007; Norlia *et al.*, 2018).

According to Figure 3, all surveyed producers use dryers and warehouses for peanut maintenance, with over half of rural producers using their own dryers (Figure 3.a) and nearly 75% having their own warehouses (Figure 3.b). Additionally, the p-values of the G tests applied to verify the independence between each type of storage used (or not) by rural producers and productivity show that both (type of dryer and type of warehouse) are significantly associated with productivity.

In this sense, it was observed that rural producers who have their own dryers and warehouses are mostly concentrated in the productivity range between 165.31 sc/ha and 206.60 sc/ha, one of the highest. Indeed, this allows producers to have greater control over the moisture rate and risks related mainly to the Aflatoxin index, reflecting increased productivity.

Figure 3 – Type of storage used by rural producers versus productivity (sc/ha)



Dryer

G = 8.6312; degrees of freedom = 3; p-value = 0.0346*

Warehouse

G = 8.6703; degrees of freedom = 3; p-value = 0.0340*

Source: Prepared by the authors from the research data (2022). *Significant at 5%, indicating that the variables are associated.

Figure 4 shows the production management structure employed by the surveyed producers. It is observed that technologies in production management have been used by producers in the West Paulista region

in some ways to assist in planting planning and execution to improve efficiency, increase productivity, and ensure profitability.

According to Figures 4.e and 4.a, all surveyed producers have business management carried out by a professional (they hire managers and professional technicians) and have agronomic assistance provided by cooperatives/resellers (they rely on technical competence in assistance, guidance, and care in agricultural production procedures). Additionally, about 25% of them also have agronomists on their teams.

On the other hand, it is observed that technologies associated with business management software (Figure 4.c), trained operators (Figure 4.d), and certification (Figure 4.f) have lower adoption percentages. Business management software aims to provide technological management with more accurate control and information, enabling more assertive decision-making (Hermans *et al.*, 2019). In this sense, the rural producer needs to have a team of operators qualified to use this software and agribusiness-oriented applications so that these technologies can improve production results (Rodrigues *et al.*, 2020). Product quality certification (Pró-Amendoim-ABICAB or others), in turn, allows the producer to gain competitiveness through differentiation and strategic positioning (ABICAB, 2022; Nico *et al.*, 2016).

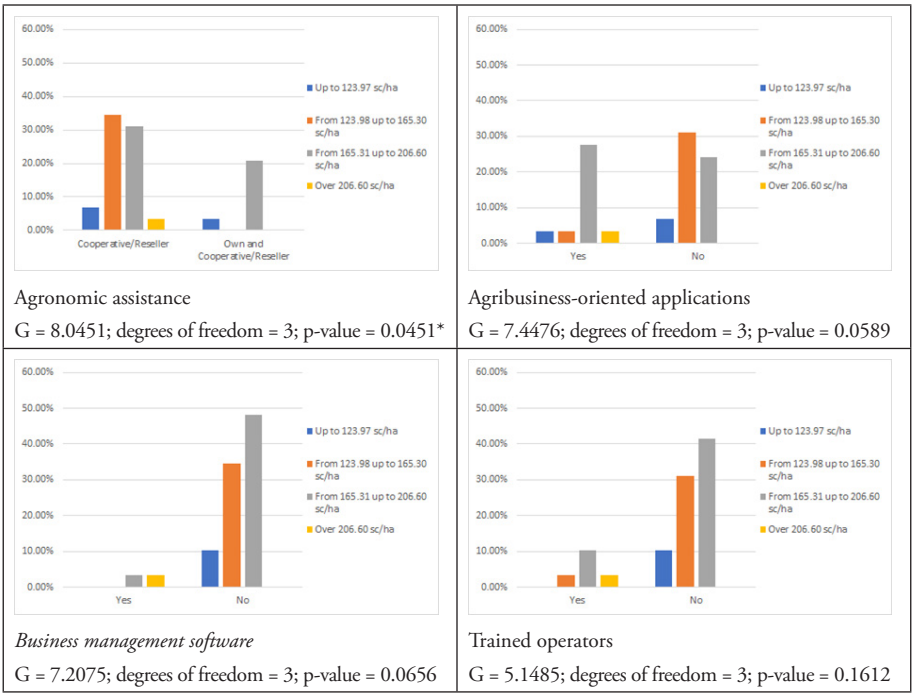
Agribusiness-oriented applications are used by more than 30% of the surveyed rural producers (Figure 4.b). These technological resources are employed to achieve better results, minimizing losses, damage, and/or impacts (Silva *et al.*, 2020).

Using business management software and applications in peanut agriculture, when applied in an integrated and well-planned manner, can offer several benefits. These tools help farmers optimize the planting process, monitor plant growth, manage fertilizer and pesticide applications more efficiently, and assist in pest and disease control. Software and applications also allow for recording and analyzing data on weather conditions, soil management, and other relevant factors for peanut cultivation. Based on this information, farmers can make more informed and precise decisions,

which can lead to higher productivity and profitability with the help of these management tools (Lima *et al.*, 2020).

Additionally, using these technologies in peanut agriculture contributes to sustainability and environmental preservation by allowing more rational use of natural resources and reducing waste of inputs. Overall, they can boost the agricultural sector, making it more efficient, competitive, and sustainable (Almeida; Buainain, 2016).

Figure 4 – Management tools employed by rural producers versus productivity (sc/ha)

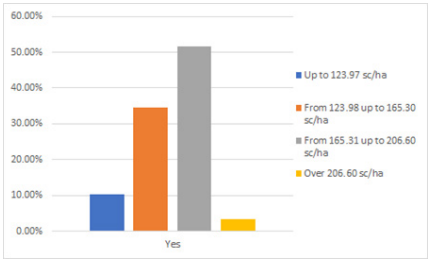


Agronomic assistance
G = 8.0451; degrees of freedom = 3; p-value = 0.0451*

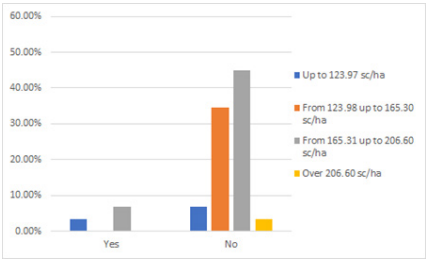
Agribusiness-oriented applications
G = 7.4476; degrees of freedom = 3; p-value = 0.0589

Business management software
G = 7.2075; degrees of freedom = 3; p-value = 0.0656

Trained operators
G = 5.1485; degrees of freedom = 3; p-value = 0.1612



Business management carried out by a professional



Quality certification

G = 3.6911; degrees of freedom = 3; p-value = 0.2968

Source: Prepared by the authors from the research data (2022). *Significant at 5%, indicating that the variables are associated.

As for the p-values of the G tests applied to verify the independence between each management tool used (or not) by rural producers and productivity, only agronomic assistance is significantly associated with productivity. In this sense, it was observed that almost 70% of the surveyed producers who use only agronomic assistance from the cooperative/reseller had productivity above 123.98 sc/ha, showing that this type of assistance has been effective in peanut production management in the studied region.

Sampaio (2016) points out that one of the challenges of peanut production lies in the relationship this crop has with sugarcane production, highlighting the importance of studies that show the performance and feasibility of production technologies in the Alta Mogiana and Alta Paulista regions, and whether these technologies are truly adapted to the different conditions required by sugarcane renewal areas. The author also emphasizes the need for improving machines, implements, and equipment for planting and harvesting in peanut production systems, corroborating the results obtained in this research.

Final considerations

The research results highlight the technological infrastructure based on Agriculture 4.0 for peanut production by rural producers in the West Paulista region and its relationship with crop productivity.

As for technologies in machines and equipment, it was observed that the surveyed producers have directed their investments towards implementing harvesters, self-propelled sprayers, GPS, and section cutting on the sprayer. However, adherence to other technologies is much less effective. In this sense, statistical tests did not show a significant association between the use of these technologies and productivity increases.

Regarding inputs, it was observed that most rural producers conduct annual soil analysis and apply macrobiologicals. Integrated pest and disease management, however, is rarely practiced, even though statistically, there is a significant relationship between these technologies and productivity.

For storage technologies, statistical tests showed that rural producers who have their own dryers and warehouses tend to have a significant productivity gain, as they have greater control over procedures and, consequently, face lower risks of contamination and product deterioration.

As for management technologies, there is greater adherence by rural producers to professionalized management, agronomic assistance, and agribusiness-oriented applications. In this sense, statistical tests showed a significant association between agronomic assistance and productivity, indicating that producers who use this type of assistance tend to achieve higher productivity.

The evidence presented in this work indicates the incipience of Agriculture 4.0 technologies in peanut farms in the state of São Paulo. In addition to effective business management, storage, and agricultural input tools, this paradigm foresees the extensive use of digital technologies, including geographic information systems, GPS, yield monitors, precision soil sampling, proximal and remote spectroscopic sensing, unmanned aerial vehicles, self-guided and directed equipment, and variable rate technologies (Kovács; Husti, 2018).

The main limitation of this work is the research sample, restricted to rural producers in the West Paulista region. However, considering the exploratory nature of the research, it is expected that this work can contribute to the literature by presenting a preliminary scenario regarding

the implementation of Agriculture 4.0 technologies in peanut cultivation and their impacts on agricultural productivity.

Acknowledgments

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Chapter 10

The digital transformation of agricultural fairs in Brazil: an analysis from the perspective of their organizers

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Introduction

The Covid-19 pandemic has challenged all sectors, which needed to reinvent themselves to minimize the damage caused by the disease. Since the SARS-Cov-2/Covid-19 registration in China in December 2019, humanity has been facing a serious global health crisis (Aquino *et al.*, 2020; Souza *et al.*, 2020).

With face-to-face activities suspended, one of the sectors affected by the pandemic was agricultural events. In March 2020, the cancellation or postponement of 13 agricultural events in the country until the end of May (including agricultural exhibitions, workshops, ceremonies, forums, and pre-events) impacted this market by R$ 10.8 billion, based on the amounts moved in 2019 (Soares, 2020).

Even with difficulties, some companies and organizations implemented actions aimed at overcoming such a situation. With the aid and use of technologies, innovation, and creativity, the agricultural fairs and events sector has continued activities by digital platforms (ABMRA, 2021).

Some agribusiness fairs have reinvented themselves and adopted Internet technological tools to make their events viable and generate business, taking advantage of the greater public reach, without the barrier of physical distance (ABMRA, 2021). Thus, the need to maintain social relations and economic activities led to greater use of digital communication tools during the pandemic period, breaking current societal stereotypes (Ricarte, 2020).

For this chapter, we are particularly interested in the Digital Transformation (TD) triggered during the Covid-19 pandemic in the rural environment, especially agricultural fairs. Recognizing that the TD process, in this case, was not initiated and conducted strategically but as a reaction and adjustment to the situation caused by the pandemic, the organizing and exhibiting companies relied on digital technologies to transform their offers and manage various structural and cultural changes and barriers.

In this context, this chapter aims to verify the emergency adaptation of agricultural fairs to the virtual environment, by identifying the strategies and challenges of agricultural events due to the pandemic period and verifying the benefits and disadvantages of this emergency adaptation.

The theme presented in this chapter contributes to scientific knowledge around sustainable development, which is in line with the objectives of the Postgraduate Program in Agribusiness and Development (PGAD) at Unesp, Campus de Tupã. In this sense, it contributes to discussions within the scope of the eighth Sustainable Development Goal (SDG), which aims to "promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all" (United Nations Brazil, 2021). More specifically, it addresses sub-item 8.2 of the SDG, which aims to "achieve higher levels of economic productivity through diversification, technological upgrading, and innovation, including through a focus on high-value-added sectors and labor-intensive sectors" (United Nations Brazil, 2021).

Agricultural fairs and events

Agricultural fairs are events where information about techniques, machinery, and other innovations are presented to the public. They are configured as spaces for the exhibition and presentation of information related to agricultural activities, to meet the informational needs of rural producers, as well as to move the business of exhibiting companies (Savran *et al*., 2018).

Considered the showcase of agribusiness in Brazil, agricultural fairs are present in the event calendars of states and municipalities and are relevant for covering information related to the most diverse agents in the agricultural chain. Zanella (2006) describes them as meetings between people or entities, held on specific dates and aimed at providing an environment for business, social, and scientific activities.

Agricultural fairs occur throughout Brazil and move billions of reais with the sale of machinery, agricultural implements, inputs, and animals. According to Soares (2020), the number of events in the area, which between 1990 and 2000 approached 500, currently only the most structured ones remain on the market, which today are national references (about 300 fairs). Such events constitute an important channel for scientific research to capture the demands of rural producers and collaborate in solving field problems. Held at the municipal or regional level, agricultural fairs are organized by associations, cooperatives, sector institutions, companies, and public bodies. They are characterized as a showcase of technologies and services aimed at agribusiness (Brannstrom; Brandão, 2012; Vieira, 2017). In addition to presenting their launches to rural producers, exhibiting companies use the fair space as an important marketing strategy, carrying out activities that connect a large volume of customers with potential buyers; space for product promotion; strengthening the relationship with rural producer customers; collecting information about competitors; conducting market research and opportunity to improve corporate image (Situma, 2012).

Rzemieniak (2017) and Souza (2018) describe that fairs provide spaces for content exposure to bring new strategies to the field to producers. Each agricultural event has a strategy, ranging from business realization; dissemination and implementation of the latest market technologies; exhibition and sale of animals (Brannstrom; Brandão, 2012), often accompanied by scientific dissemination and technical assistance and rural extension. According to Melo (2020), the 17 main fairs in Brazil together earned R$16.9 billion in 2019. Box 1 presents a list of 13 of these events canceled and/or postponed since the beginning of the quarantine, and the financial amount moved by each in 2019.

Box 1 – Agricultural exhibitions postponed or canceled between March and May 2020 and amounts moved in the face-to-face editions in 2019

Event	Location	Financial movement (in R$)
TecnoShow Comigo	Rio Verde – Goiás (GO)	3.4 billion
Agrishow	Ribeirão Preto – São Paulo (SP)	2.9 billion
AgroBrasília	Brasília – Distrito Federal (DF)	1.2 billion
Norte Show	Sinop (MT)	1 billion
Rondônia Rural Show	Ji-Paraná (RO)	703.5 million
ExpoLondrina	Londrina (PR)	615.6 million
Femec	Uberlândia (MG)	420 million
ExpoZebu	Uberaba (MG)	220 million
Parecis SuperAgro	Campo Novo do Parecis (MT)	150 million
ExpoPec	Porangatu (GO)	72 million
ExpoAgro Afubra	Rincão Del Rey (RS)	70.6 million
ExpoGrande	Campo Grande (MS)	26.5 million
ExpoJardimMS	Jardim (MS)	No data

Source: Adapted from Soares (2020).

Fairs like Expodireto Cotrijal, Coopercitrus Expo, Agrishow Experience, Expointer Digital, and Agrotins are examples of agribusiness events in Brazil that adapted their programs to the virtual environment in 2020. Some organizers report that there was already an intention to present digital content during their events and that the pandemic only accelerated this process. Debate rounds, auctions, company stands, equipment exhibitions, and even family farming product fairs were adapted to virtual platforms for the drive-thru format (Agricultural News, 2021; Rural Channel, 2021a; Rural Channel, 2021b).

In 2021, other events announced a new cancellation or postponement of the next edition to 2022, such as Tecnoshow Comigo in Rio Verde-GO, and Norte Show in Sinop-MT. Other events remained with their programming only in digital format, due to the impracticality of the

hybrid format, such as the Paraná Show Rural Coopavel fair in Cascavel (Toledo, 2021).

In this scenario, there are three possible event formats according to Martin and Lisboa (2020), and Rêgo, Barros, and Lanzarini (2021): virtual fair (online), totally web-based, with people interacting isolated at all points of the connection, eliminating crowds and travel, a priority during the pandemic period and, on the other hand, limiting available activities and technologies; hybrid format, which uses digital technologies (such as streaming and the Internet) to complement the participants' experience, who can be present at the event location or connected remotely; face-to-face format, which takes place with all participants present in the same location, and which, considering the pandemic times, depends on new social behavior and health safety protocols.

This new reality of digital events, in addition to demanding new skills and knowledge from organizing professionals, also points to new participant needs. Remotely, events are different when compared to the needs of the face-to-face format, as they require adjustments in dynamics, content, and the choice of platforms and tools, among other actions and suppliers (Events, 2020).

While digital events emerge as a safe alternative, regarding health restrictions during the pandemic period, Rêgo, Barros, and Lanzarini (2021) emphasize that they also modify the culture and behavior of consumers and businesspeople in the sector. The 'virtual wave' that advanced in the pandemic scenario brought a new proposal for many event organizers, although they were already known in the digital environment, and reached the agribusiness sector, becoming an extension of face-to-face activities.

However, although digital events are being considered a temporary alternative, for Rêgo, Barros, and Lanzarini (2021), the infrastructure regarding participants' access to technology is limiting, warning of the possibility of financial results being significantly lower, especially when it comes to agricultural fairs and events.

Digital transformation in the adaptation of agricultural events

According to Vial (2019, p. 118), Digital Transformation (TD) is "a process that aims to improve an entity, triggering significant changes in its properties through combinations of information, computing, communication, and connectivity technologies," which means that it goes beyond organizational boundaries and the workplace, occurring and affecting different spheres of people's lives.

Survival in increasingly competitive environments leads companies to seek waste reduction, limit resource consumption, and produce more efficiently, adding new development technologies to traditional business strategies (Caliskan; Özkan Özen; Ozturkoglu, 2020).

Among the available technologies, Augmented Reality (AR), Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, data analysis, and cybersecurity are digital tools that deeply influence business processes, being able to be applied in different ways as marketing strategies in the search for offer differentiation, delivering a greater experience to the consumer.

Pandey (2021) indicated the need to adopt digital technologies to manage the effects of the pandemic more efficiently, as more and more people are connected due to the lockdowns imposed by governments of different countries. Therefore, the use of digital marketing has been essential to reach consumers, emphasizing the importance of digital marketing communication tools in interactions between companies and customers.

Digital marketing is defined as a tool capable of promoting products or services that reach consumers through digital platforms, enabling them to be retained in more intimate and lasting relationships. In this sense, the digital relationship, which was previously an option, became indispensable during the pandemic, forcing organizations to adapt to Digital Information and Communication Technologies (TDIC) to make the offer of products and services viable to their consumers (Cani *et al.*, 2020).

TDICs are increasingly embedded in society, whether in companies, schools, or homes, providing facilities for the human-information

relationship in daily life. According to Melović *et al.* (2020), TD is an evolutionary process, modifying people's lives and the ways organizations do business, providing technological solutions based on information and technology services.

The employability of TDIC benefited, in addition to urban organizations, rural businesses that use technologies to boost their activities and understand the agricultural sector and its context. Communication is attributed to the advancement of TDIC, which has taken information developed outside the rural sphere to the producer, adding competitiveness to agribusiness in all links of the production chain (Cardoso; Prado, 2008).

The digitalization of agriculture has found fertile ground in Brazil, with 84% of the country's farmers using at least one digital technology during their production process (Bolfe *et al.*, 2020). Other sector data also reflect a positive scenario in this direction, as indicated by the latest national survey conducted by the Brazilian Association of Rural Marketing and Agribusiness (ABMRA) in 2017 on the consumption habits of rural producers, when it was found that some of the interviewed rural producers use Internet resources to carry out purchase activities, mainly seeds (20%), agricultural pesticides (20%), fertilizers (17%), and agricultural equipment (12%). This scenario demonstrates the producer's approach to available communication technologies, although Internet access is still not the majority, as 58% of the interviewees still did not have the technology on their properties (ABMRA, 2017).

The adaptation of the event industry, according to Campillo-Alhama and Herrero-Ruiz (2015), depends on digital communication tools to establish closer interaction ties, creating proximity experiences and increasing the harmony of the company-client relationship. This more direct connection also requires concern with the values and brand image being propagated to customers, ensuring they are consistent with the identity and intention the companies wish to convey.

By developing their marketing tools, companies boost their businesses and survive in the market, transitioning from offline marketing to online marketing through the digitalization of the tools used, taking

advantage of the progress of the digital economy and the mass adoption of smartphones, which have profoundly influenced consumer behavior and lifestyle (Petrů *et al.*, 2020). This includes corporate portals and business platforms in disseminating information.

The marketing strategies of contemporary companies are often associated with the digital relationship with customers through communication tools for brand advertising and sales promotion from websites, social networks, and online conferences. Cyber contact with consumers occurs from the pre-sale phase to post-sale follow-up and generation of potential new business (Labanauskaitė *et al.*, 2020).

According to Kumari *et al.* (2021), the main challenges in adopting digital technologies in rural areas include the lack of technological infrastructure, digital skills, and Internet inaccessibility. In Brazil, it is no different, and to advance in this TD, challenges related to infrastructure and connectivity need to be overcome, with the aggravating factor that, according to the 2017 Agricultural Census, released in 2019 by the Brazilian Institute of Geography and Statistics (IBGE), 71.8% of Brazilian rural properties do not have Internet access.

The next section presents case studies conducted at two events, which were named Event A and Event B.

Case studies - Event A

The first edition of Event A took place in a digital format during the second half of 2020, presenting three days of programming with discussion forums, debates with experts and politicians, cattle auctions, and company stands. The event was organized by an institution in northern Brazil, and therefore, the theme of the virtual meeting was focused on agribusiness in that region. Event A was driven by the moment of diffusion of lives and digital events resulting from the Covid-19 pandemic and the impossibility of holding another traditional agricultural fair in the city in a face-to-face format. The main information collected in the interview can be found in Box 2.

Although the organizers considered the time interval short between the start of site development and the event's realization, the number of registered participants, exhibiting companies, and business volume were considered quite satisfactory by the organizers.

Despite the virtual fair was initially planned with a focus on small rural producers, the event saw participation from farmers of all sizes and areas of activity, as well as other interested parties, such as researchers, politicians, companies in the field, and the press.

Box 2 – Information on Event A

Elements	Event A
Time to organize the virtual fair	3 months
Number of registrants	3.6 thousand people
Organizer's satisfaction with the virtual event	Positive
Programming	Interviews, auctions, and debates with experts from the entire agribusiness chain in response to producers' demand
Target audience	Rural producers and other interested parties
Interaction among participants	No tool was provided by the organization
Exhibitors	About 300 companies
Banking institutions	Participation and offer of special credit lines
Difficulties during the events	Insufficient or non-existent connection, handling of the platform via cell phone, and platform resolution via cell phone
Participants' feedback	90% positive
Scientific dissemination and participation of research institutions	Participation of the Technical Assistance and Rural Extension Company (Emater) and the Brazilian Agricultural Research Corporation (Embrapa)
Business volume	R$ 41 million – including closed contracts and projected for the next 12 months
Benefits of virtual events	Adaptation and investment of agricultural events to the virtual environment
Expectations for future fairs	Continuity and start of a digital transformation

Source: Prepared by the authors (2024)

It is noteworthy that there was no interaction between the audience and the speakers or even among the audience, as there was no space for real-time information exchange. Some participants pointed out this difficulty, and therefore, the organizers intend to provide a chat in the next edition of the event in 2021, according to the organizers' report: "People want this, they want to communicate, right? It is an opportunity to implement it next year, yes" (Organizer A, 2020).

The organizers indicated some challenges and experiences observed regarding the digital format, such as the telecommunication infrastructure (availability and stability of the Internet connection) in the state, considered to be of low quality, constituting one of the factors preventing the participation of several rural producers and other interested parties; the touchscreen functionality in handling the platform and its resolution for those who accessed the event via smartphone, since being a 3D environment, the quality and ease of access were greater via computer. However, the organizers stated that the participants had fewer difficulties than expected.

The negotiations carried out during Event A totaled R$41 million, considering the conversion of transactions in dollars and the projection of exhibitors for the next twelve months in closing contracts resulting from the virtual fair. The organizers emphasized that, in addition to the sales made or planned, the exhibitors promoted their brands (Organizer A, 2020).

The experience in organizing the online fair, according to the organizers of Event A, highlighted an important benefit, as it marked the beginning of a 'turning point' for the digitalization of agribusiness, as emphasized in a section of the interview: "the beginning of a digital transformation (...) those who do not have this mindset, unfortunately, will not continue in the job market in a certain time" (Organizer A, 2020).

At the time of the interview, the organizers considered not yet knowing whether future events would be held only in virtual mode or in a hybrid format, given the possibility of reaching a larger target audience, but there was an understanding that the pandemic contributed to the opportunity for virtual agricultural events with good acceptance by rural

producers. "Virtual is here to stay, that does not mean there will be no face-to-face because even if you can do a lot remotely, people want contact, they want this coexistence" (Organizer A, 2020).

Case studies - Event B

Event B is an international agricultural technology fair held annually since 1994 in a southeastern state of Brazil. It is considered not only the largest agribusiness fair in Brazil but also the largest in Latin America in its segment and is currently organized by a committee of professionals.

The online edition of Event B took place in the second half of 2020 and was the first digital version of this large and traditional Brazilian agribusiness fair. The organization reports that it was an emergency way to keep the fair active, highlighting its name, in addition to minimizing the damages that the cancellation of the face-to-face edition brought to the organizers.

Thus, Event B featured debate rounds with experts, company stands, and a live show closing, during which the audience could follow more than 20 hours of live and recorded content. The main information collected in the interview regarding Event B can be found in Box 3.

The organization time of the virtual experience was four months, from planning to execution, with the number of participants being positively evaluated by the organization, which was satisfied with the results, having fulfilled all its purposes, believing it promoted an unprecedented and innovative experience for Brazilian agribusiness.

Box 3 – Information on Event B

Elements	Event B
Time to organize the virtual fair	4 months
Number of registrants	6 thousand
Organizer's satisfaction with the virtual event	Positive

Programming	Webinars, interviews with experts from the main areas of Brazilian agribusiness, and closing show
Target audience	Rural producers and other professionals in the field
Interaction among participants	Low interaction in chat and networking
Exhibitors	569 participating companies (71% of the face-to-face volume)
Banking institutions	There was no participation
Difficulties during the events	No reports of difficulties in accessing and handling the site
Participants' feedback	90% positive
Scientific dissemination and participation of research institutions	There was none
Business volume	There was no business
Benefits of virtual events	Adaptation and investment of agricultural events to the virtual environment
Expectations for future fairs	Greater investment in technologies for virtual events

Source: Prepared by the authors (2024).

The virtual edition presented the audience with a different perspective from the face-to-face fairs, as the purpose of its realization is the sale and commercialization of the products and services exhibited at the event. However, during the virtual version, no business was closed, but the organizers emphasized that this was not the fair's objective.

> "It was a way for us to keep the fair alive, in action, keeping the fair's name in evidence. To not say the fair ended because it did not end, we were forced not to hold this event, anyway, no major event happened this year, so what we organized was a series of lectures, interviews, and webinars on some topics, it was a totally thematic fair, but without business" (Organizer B, 2020).

The priority of Event B was the interaction between the participating public (on one side rural producers, researchers, and other interested parties,

and on the other, speakers, companies, and professionals from the most varied sectors of the agribusiness production chains). The interaction occurred through a chat on the platform and in a space provided for the public to connect with companies and for personal and professional networking.

Among the exhibitors participating in the online edition of Event B, a large and varied number of companies directly and indirectly linked to agribusiness were verified, from input suppliers, rural producers, the processing industry, and support sectors for these activities. In comparative terms, while the face-to-face event traditionally brings together about 800 exhibiting brands, the virtual version had 569 participating companies, as many did not believe in the realization of the event in the digital format.

An important absence was the financial institutions, as it occurs in the face-to-face version, however, the organization reports that: "in the virtual, there was no time to make an arrangement with the banks, we could not do that (...) most likely next year we will have something more practical in this matter" (Organizer B, 2020).

The organization of Event B highlighted difficulties and positive points for holding the online fair, emphasizing that not holding it would imply contractual damages:

> "The biggest challenge was not holding the face-to-face fair! And if you want to know, not holding a fair is more work than holding it. Because it cost a lot of money, we were with the fair ready (...) so it's like this, the fair was practically set up, the companies mobilizing to make their stands when we were prevented by the pandemic and decrees. And even if the decrees were not in force, it would be very imprudent to hold a fair" (Organizer B, 2020).

There were no reports of difficulties in accessing and navigating the website built for the event, and the organizers' understanding is that the Brazilian farmer is quite virtualized, that is, increasingly using digital channels to seek information and make purchases, a process that accelerated

in 2020 due to the quarantine period and social isolation resulting from the Covid-19 pandemic.

> "It is a young agriculture, we can say that there are many new people in the market. The people who were watching and were willing to buy and need information, the first place they visit is the company's website. If you have an event, they seek information through this event. But the first place they go is the company's website. And during this pandemic period, this grew a lot, especially from the companies' part regarding communication tools" (Organizer B, 2020).

A negative aspect of the event refers to the interactions between rural producers and research institutes, frequently present in the face-to-face editions of the fair, and responsible for the dissemination of the latest research and scientific knowledge. Thus, the virtual event lost this characteristic, presenting itself more commercially to the participating audience.

> "In the face-to-face fair, all research institutes in São Paulo are present at the fair, we have the Fisheries Institute, the Agronomic Institute, the Zootechnics Institute, and the Biological Institute, all are present (...) we also count on Embrapa, presenting the latest research and knowledge. This face-to-face is one thing, and virtually it is very difficult to set this up on a platform" (Organizer B, 2020).

The evaluation of Event B is that since the digital version, it will not be possible to hold an event only in a face-to-face format, requiring new resources to conquer the target audience. Therefore, for the coming years, the organization expects the fair to take place in a hybrid format, with access for visitors and a virtual public.

> "I want you to be able to enter the stand from wherever you are, tour the machine you want, from wherever you are. Part of the public has gotten used to this new virtual reality, and the public will look for activities that offer their products and services in a hybrid

> way (...) people want to see what is happening at the event, like a news system of everything that happens inside the fair, because you call the public to see what is happening at the fair and consequently business happens. This woke us up, we need to invest more and more in technological tools" (Organizer B, 2020).

The organizers' understanding is that investments in tools improve the presentation of the event, reflecting returns and gains since digital technology contributes to the virtualization of agricultural fairs.

Discussion

Online events A and B did not fully achieve the commercial, cultural, social, and scientific contacts that occurred in previous years at face-to-face events. These characteristics are important at an agricultural fair (Zanella, 2006). Even though the proposed virtual scenario and the tools used were adequate for the moment, given the unpredictability of events – considering that events of this size begin to be structured as soon as the previous editions end – Campillo-Alhama and Herrero-Ruiz (2015) highlight the importance of adapting the event industry to intensify the relationship between the event and its audience.

The year 2020 was crucial to accelerate the TD of agricultural fairs and events, which timidly rehearsed an evolution towards the implementation of new communication strategies. Although the gains from this process should make events more attractive to rural producers, in addition to adding gains for the organization and conduct of events, it is evident that the advance was carried out under pressure for results that would minimize the losses from the cancellation of these fairs. Thus, it is understood that the improvement and planning of future editions will bring greater benefits to all involved in their realization.

During the participation of researchers to observe the realization and conduct of virtual fairs, it was verified that Event A invested in an experience closer to face-to-face, with a platform in a three-dimensional

(3D) environment, showing products and animals in virtual auctions, equivalent to what would happen in person at the agricultural fair. Meanwhile, Event B presented itself to the public as a traditional corporate portal, highlighting a program of debates and lectures, concluded by a live show with a musical attraction. Thus, by presenting themselves differently, some comparisons cannot be made between the events but rather highlight the experiences obtained with the proposed digital transformation.

Box 4 contributes to the analysis of the proposed problem, summarizing some aspects observed in the two events, complemented by interviews conducted with their respective organizers.

Although there are simultaneous communication technologies available in the market, in Event A there was no verification of interaction between participants, as there was no specific space (such as a chat) for the audience to communicate among themselves and with exhibitors. With a different purpose, Event B enabled social interaction among participants with areas providing networking and chats. Despite this space, it was observed that the participating public did not receive feedback on the questions raised in the chat, which would likely not occur in person.

Box 4 – Aspects observed at Events A and B

Observation	Event A	Event B
Program including lectures or workshops	Yes	Yes
Interaction between speakers and audience	No	No
Interaction among participants	No	Yes
Availability of chats	No	Yes
Accessible language for all audiences	Yes	Yes
Technical communication	Yes	Yes
Disclosure of services and products	Yes	Yes
Virtual reality technology (3D)	Yes	No
Sales and business	Yes	No
Networking area	No	Yes
Themes related to the rural sector	Yes	Yes
Organization sought feedback from participants	Yes	Yes

Source: Prepared by the authors (2024).

The participants of the online events had access to innovations and technical information in the agricultural sector, however, they could not share their experiences with their peers, as Zhong and Luo (2018) traditionally consider. In this case, the absorption of information that informally circulates in personal contact and is essential in knowledge construction, according to Nonaka and Takeuchi (1997), was impaired in these virtual editions.

It was also observed that the interactions between the public and the event organization were simplified, forgetting that the attention given to the participating public is part of the consumption experience, especially in a digital version of the event, where everything is new. Adding to this the fact that the ease of connecting to one event or another does not depend on travel and accommodation, saving time and money for rural producers, should create a more competitive environment among agricultural fairs, considering a competition for the available resources of the buyer. Therefore, feedback is important and, according to Schermerhorn, Hunt, and Osborn (1999), an essential factor for promoting effective communication.

Zanella (2006) and Soares (2020) reinforce that the objective of events is to generate commercial relationships; however, Event B did not conduct business, despite the presence of exhibitor stands participating in its program. The commercial relevance of events for exhibiting institutions was calculated at R$41 million in Event A, resulting from online negotiations and projected for the 12 months following the event.

Although no business was closed at Event B, the exhibiting brands were present. Martin and Lisboa (2020) and Labanauskaitė *et al.* (2020) highlight the relevance of companies' strategic presence in digital environments, maintaining their commercial relationship where their consumers are inserted. That is why the organizers of Event B considered that the conference's objective was achieved, as it aimed to maintain the fair's liveliness during the pandemic period.

The participation of exhibiting companies in both events was different, reaching 300 companies in Event A and 569 organizations in Event B. The numbers did not reach the results of the face-to-face versions,

as some of the invited companies did not participate because they did not believe in the positive results from the migration of the face-to-face event to the virtual one (Event B) or because they already had their annual order demand complete for 2020 (Event A). These positions are contrary to what Labanauskaitė *et al.* (2020) state about the need for organizational marketing to transpose from the offline to the online environment.

Agricultural fairs are essential events that contribute to the development of rural businesses, becoming important allies in promoting scientific understanding, facilitating the expansion of knowledge and ideas to farmers and ranchers, as Duarte (2004) emphasizes. However, at a time when a lot of technical and managerial information was made available through digital means, such as business lives and webinars, many free, in the form of digital content generation, a low participation of research institutes and universities was observed in these virtual versions of agricultural fairs. On one side, Event A counted on the participation of two research institutes in its program (Embrapa and EMATER), while Event B did not have the participation of these institutions in its virtual version.

After the virtual fairs ended, the organizers of both events collected feedback from participants and exhibitors, having, according to both, reached 90% of positive responses, indicating the event's approval and the desire to participate in future editions.

The Covid-19 pandemic accelerated the TD, forcing different sectors of society to make a significant digital leap in their daily practices, including sectors related to agribusiness, from contract closure to training and education. Quickly, many businesses transitioned from a traditional approach to digitalized and/or remote practices, leaving rural producers to adapt to available technologies, managing and mastering different digital tools.

Final considerations

The reinvention of the rural event market due to the Covid-19 pandemic took place urgently to mitigate the economic damage caused

by the cancellation of the face-to-face editions of these events. To this end, investments were made in digital tools and platforms, so that Events A and B found new opportunities to hold fairs in a virtual format, still guaranteeing partially positive results for those involved, and which should be incorporated and improved for their future editions.

However, it is important to highlight that, despite this TD of agricultural events following a trend of other types of business, there are some obstacles that must be considered and solved over time: digitalization, while integrating and connecting different actors, excludes those who do not have access to TDIC, either due to lack of aptitude for use, technical and educational deficiencies, or even the absence of adequate telecommunication infrastructure for a large portion of rural producers.

This means that the Internet and its resources are essential tools for holding and participating in these events, and while the organizers use the terms 'turning point' and 'digital transformation' to describe the current moment of adaptation, the same does not occur with the infrastructure and connectivity in the field. On one side, technology is positioned as the main strategy used in the articulation and execution of agricultural events, while on the other, the challenges lie in the many rural properties that still do not have Internet connection, lack of technological equipment, and digital skills, imposing a communication barrier. In this sense, adjustments were and still are necessary in all spheres, with companies taking the lead in the process, which is not complete without the participation of rural producers.

In conclusion, there were significant gains with the digital edition of these events, highlighting the convenience and expanded reach. However, it is likely that some particularities of face-to-face agricultural events cannot be completely transferred to the digital format, especially those that promote the exchange of tacit information and generate knowledge, such as more intimate personal interaction, physical contact, or even a conversation and coffee with a technician. This finding points to a balance path, possibly in the format of hybrid events, capable of providing the best of both experiences, as a trend of a new era determinant for Brazilian agribusiness events.

In this context, the reflections and discussions presented in this chapter, regarding SDG 8, encompass the perspective of social development, collaborating with subsidies that can assist research and actions towards fulfilling the 2030 Agenda.

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Part III

Chapter 11

Beyond the Effort of the National School Feeding Program (PNAE) in Public Schools of the Municipality of Tupã (SP) during the Covid-19 Pandemic: Impacts on Achieving the Sustainable Development Goals

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Food and Nutritional Security – A Vision Beyond Combating Hunger and Malnutrition

The theme of Food and Nutritional Security (SAN) encompasses various segments of society, far beyond combating hunger and malnutrition, which is among the Sustainable Development Goals (SDG 2) of the United Nations (UN). Non-communicable Chronic Diseases (NCDs) constitute a group of diseases such as diabetes, hypertension, cardiovascular diseases, cancer, chronic respiratory diseases, among others, and can relate to the debate of SDG 3, Health and Well-being. These diseases are directly associated with several risk factors, but primarily with the consumption of harmful foods over long periods of life. This includes the excessive consumption of ultra-processed foods rich in sugar, saturated fat, and sodium, as well as low intake of fruits, vegetables, fibers, and nutrient-rich foods (De Moraes, 2013; Francischi *et al*., 2000).

Malnutrition (SDG 2) is associated with NCDs (SDG 3), which are responsible for approximately 71% of all deaths worldwide, that is, the death of 41 million people each year, of which 15 million are aged between 30 and 70 years, with half of these, 7.2 million, being from countries with a higher prevalence of Socioeconomic Inequality, hence, poverty in the world (WHO, 2018; PAHO, 2020).

Without the Reduction of Inequality (SDG 10), one cannot combat one of the main causes of global health expenses, where the costs associated with these diseases vary considerably, influenced by factors such as the type and stage of the disease, geographic location, the health system of the country, and access to treatment. The increase in NCDs can lead to poverty due to various factors, disproportionately affecting vulnerable populations. This happens due to the lack of access to health information, quality medical care, and appropriate treatments, resulting in higher healthcare expenses. Moreover, NCDs not only affect the patient but also their families, who often need to take on caregiving roles, reducing their capacity to work and invest in education. This relationship between poverty and NCDs creates a negative cycle, where poor living conditions increase the risk of developing

NCDs, which, in turn, worsen the economic situation of people and, consequently, poverty, perpetuating social inequality worldwide (Brasil, 2021; Colon, 2018; Duarte; Shirassu; Moraes, 2023).

To combat this cycle, it is essential to adopt a comprehensive approach involving public health policies, equitable access to healthcare, education on prevention, measures to reduce social and economic inequalities, and promotion of healthy environments, contributing to the sustainable socioeconomic development of society.

Issues of SAN and healthy eating are themes involving various interconnected factors and an approach that is multi-, trans-, and interdisciplinary. In multidisciplinarity, diverse areas such as nutrition, agriculture, economics, public health, education, sociology, anthropology, and psychology contribute different perspectives on the subject. Interdisciplinarity seeks a greater understanding of the factors affecting SAN and healthy eating, considering aspects such as access to food, public policies, economy, agribusiness, health, education, culture, and others. In transdisciplinarity, connections between these factors are identified, such as agricultural policies influencing the availability of healthy foods or how food education affects food choices (Banerjee; Van Der Heijden, 2023).

The municipality of Tupã, in the state of São Paulo (SP), adopted the practice of healthy eating, which involves educating to promote habits and behaviors for choosing nutritious foods suitable for daily caloric needs, especially in the school environment. It is a city in the Alta Paulista region with about 65,615 inhabitants and 11,921 students enrolled in public schools, with the Municipal Department of Education being one of the main responsible for the policies of the National School Feeding Program (PNAE), including purchases of school meals for students enrolled in the 32 schools in the municipality, with 19 managed by the municipality and 13 by the state. The PNAE is an important government tool for promoting these healthy habits, being one of the largest SAN programs in the world, with significant coverage and impact on agriculture (Rossetti; Da Silva; Winnie, 2016).

Policies related to school feeding and food security have undergone changes throughout the country, and this also happened in Tupã, São Paulo. Exceptionally, during the period of class suspension due to the pandemic, Law No. 13,987 was enacted on April 7, 2020 (Brasil, 2020):

> Authorize, exceptionally, during the period of class suspension due to an emergency or public calamity, the distribution of foodstuffs purchased with resources from the National School Feeding Program to parents or guardians of students in public basic education schools.

That, in June 2009, amended Law No. 11,947 to:

> Provide for the provision of school feeding and the Direct Money Program in Schools to students in basic education (Brasil, 2009).

Thus, it enabled the delivery of school meals directly to the homes of students in public schools, not only to the most vulnerable families covered by Bolsa Família. On this occasion, the surplus produced by family farmers was offered through direct sales or the free market to local community consumers (Valadares *et al.*, 2020).

Kunihiro *et al.* analyzed the performance of PNAE in the municipality of Tupã (SP) according to economic indicators of production related to Family Farming from 2017 to 2021. The study did not cover whether the actions of distributing fresh food products to public school families had any positive impact on combating NCDs, especially on the risk variables of these diseases such as overweight and obesity (Kunihiro; Montefusco Ceschim Silva; Cristina Vieira Gomes, 2023).

PNAE is responsible for directing resources from the National Education Development Fund (FNDE) to states and municipalities, which are used to purchase school food. Federal Law No. 11,947 of 2009 incorporated sustainability and the provision of healthy and adequate food

as an essential part of the program. Therefore, school feeding is seen as a fundamental right that also contributes to the SAN of students (Paetzhold Pauli *et al*., 2018; Rossetti; Da Silva; Winnie, 2016).

PNAE, as a public policy for SAN and the strengthening of Family Farming, also aligns with SDG 2 "Zero Hunger" and SDG 12 "Responsible Consumption and Production". SDG 2 aims to combat malnutrition, increase the agricultural productivity of small producers, and ensure access to safe and nutritious food. SDG 12 focuses on reducing food waste, promoting sustainable public procurement, and supporting sustainable development through local products. Both goals guide policies for sustainable local development, supporting family farming and SAN (IPEA, 2019).

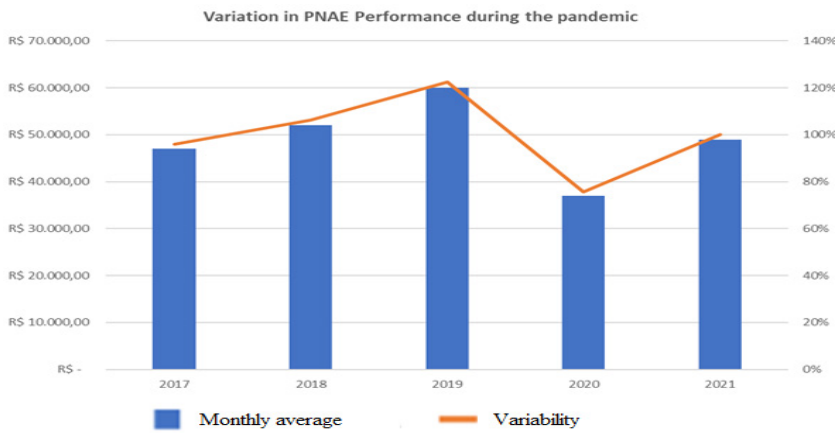
The Covid-19 pandemic affected SAN in Brazil and worldwide. The closure of schools and suspension of classes impacted the food supply by PNAE. Emergency measures were defined in Law No. 13,987 of 2020 and Resolution No. 2 of 2020, but face challenges in implementation due to a lack of effective financial transfers. To support small producers and avoid economic losses, some municipalities, such as the Federal District, used agricultural associations and cooperatives to distribute food. Public policies, such as the Food Acquisition Program (PAA) and PNAE, played an important role in maintaining production, preventing losses, and supporting farmers' income during the pandemic. To ensure the functioning of PNAE, various strategies were adopted, such as distributing food kits, encouraging the purchase of food from family farming, assessing Food Insecurity among students, increasing the per capita transfer in areas of higher Food Insecurity risk, and serving during school vacations and recesses (Alpino *et al*., 2020; Amorim; Ribeiro Junior; Bandoni, 2020; Hossain, 2020; Nogueira; Marcelino, 2021).

The study aimed to analyze the performance of PNAE, under the effect of the Covid-19 pandemic, in combating hunger and ensuring SAN in schools in the municipality of Tupã from 2017 to 2021[7].

[7] This study on the operationalization of the PNAE in Tupã adopted a quantitative and qualitative approach, including bibliographical analysis, documentary research, and data collection through messages on the WhatsApp application for institutional actors. The responses from the participants focused on

The result of PNAE's performance concerning the pandemic showed variations as illustrated in Figure 1. With adjusted values, the values from 2017 and 2021 served as a benchmark for the last 10 years, from 2007 to 2017. Even though in absolute terms, the values are not of great financial value, it was observed that from 2017 to 2019 there was a significant increase in PNAE's performance, reaching its climax during the pandemic. With the suspension of classes during the period of social isolation, instead of interrupting the acquisition of fresh food production, there was a considerable increase in the acquisition of food products from family farmers, thanks to the collaboration between the Municipal Departments of Social Assistance, Environment, Agriculture, and Education, to ensure students' nutrition, even while absent from schools. In 2020, due to institutional bureaucratic issues of the bodies responsible for regulating PNAE, there was a decrease and even temporary interruption of product acquisition, until the return to normality process in mid-2020 to 2021 (Kunihiro; Montefusco Ceschim Silva; Cristina Vieira Gomes, 2023).

Figure 1 – Performance of PNAE in relation to the pandemic



Source: Kunihiro; Montefusco Ceschim Silva; Cristina Vieira Gomes, 2023.

understanding the perceptions and points of convergence or divergence of the interviewees. Confidentiality and secrecy were maintained through the anonymization of the interviewees. In addition, health data were collected through a structured questionnaire and focus groups with various actors, contributing to the analysis of the performance of the PNAE from 2017 to 2021 (Kunihiro; Montefusco Ceschim Silva; Cristina Vieira Gomes, 2023).

Considering the increase in fresh food products in the basic basket of the population assisted by Bolsa Família and the provision of the same products to all families whose children attended public schools, even without being registered in Bolsa Família, the fact is that it allowed the population access to natural foods of high nutritional value during the pandemic. According to the Banana Growers Association, there was a previously unnoticed factor: because it concerns Family Farmers, the added nutritional value of the delivered products had not been attributed until then (Kunihiro; Montefusco Ceschim Silva; Cristina Vieira Gomes, 2023).

Considering that the food did indeed reach the final consumers and that they did indeed consume it, there are still some questions, such as: 1) If they did consume and enjoy it, would they continue consuming the same even without the free supply, i.e., did it help the beneficiaries change their lifestyle? 2) Would there actually be adherence to a healthier lifestyle by the population if there were a public policy that favored better conditions for acquiring healthy foods? 3) What were the most effective strategies to reduce barriers for the population to adhere to a healthier lifestyle? Given these questions, the study continued in search of possible answers or clarifications to these questions.

The Intersectoral Convergence that Enables Meeting the SDGs of the 2030 Agenda

Given the above questions, it was understood that if the implementation of PNAE was effective in the municipality of Tupã, the SDGs, such as 2 (Hunger and Food and Nutritional Security), 3 (Health and Well-being), 10 (Reducing Inequality), and 12 (Sustainable Consumption and Production), should be, even partially, evidenced.

An observational and analytical research[8] was conducted to analyze whether the difficulty in adhering to healthy food consumption was due

[8] The observational study presented some limitations such as selection, sampling and non-response bias. As for selection bias, although there is no intervention or control mechanism, the representation of community health agents refers to 50% of the population of the municipality of Tupã, therefore it does not have full

to economic unviability or the simple choice of individuals or families regarding the consumption of higher or lower nutritional quality foods. The questionnaire, consisting of three questions, was initially answered individually by 21 community health agents from the family health program. The agents were then randomly divided into five groups, where the same content was discussed, seeking the group's perception within the proposed theme. In the third moment, the five groups shared their perceptions on the same theme, with this content being recorded by the interviewer[9].

The first question was whether the distribution of fresh food in the basic basket could help beneficiaries change their lifestyle. Among the responses, the most highlighted change in eating habits was reported by individuals due to the presence of women at home during the pandemic. The responses were as diverse as possible, even somewhat antagonistic. On occasion, because people were forced to stay at home longer, women cooked more, bought, and consumed more fruits and vegetables, and the few who did not return to their activities maintained this habit. With less emphasis but still in focus was the more vulnerable population, where the factor of access to knowledge of other foods, referring to healthier foods, could provoke a possible change if the experience of receiving fresh food for free in the basic basket continued.

At the group level, out of the five groups, four stated that although there was an increase in fresh food consumption during the pandemic, post-pandemic, there was no effective change in eating habits, returning to old eating habits. The group that claimed to have changed attributed it to the fact of cooking more at home and consequently consuming healthier foods. One attributed the lack of access to these foods due to financial subsidy, and three others to the lack of awareness of the need to change eating habits, corroborating individual findings.

representation, except for its coverage area. Regarding sampling bias, in the areas covered by the PSF, there was no population uniformity in the socioeconomic variable item that allows for inferences and application of such knowledge in other realities.

9 Before the activities began, participants were informed about the research and data collection, which was free from any personal or nominal nature, but guaranteed anonymity and that no personal or moral harm would be caused to the participants. Those who felt embarrassed or, for any reason, did not want to participate could abstain or even withdraw, without any loss or embarrassment. Participants were also asked to sign the Informed Consent Form, as well as the Confidentiality Agreement.

In both moments, no one could bring any evidence of effective lifestyle modification as a result of the fresh food increment during the pandemic. Practically in 100% of the group reports, it was not possible to evidence consensus on significant changes.

The second question was whether the population would adhere to a healthier lifestyle if there were a public policy that favored better conditions for acquiring healthy foods.

Individually, 30% admitted that lowering acquisition costs could help but not guarantee adherence to the new lifestyle. Forty percent stressed that efforts should focus on awareness and food education reflecting cultural change within households. The remaining 30% pointed to the application of education, not in traditional forms such as lectures but in hands-on experiences such as community gardens, cooking workshops with tastings, etc.

At the group level, it was consented that the focus was on education for adherence and progressive change to a healthier lifestyle, not on increasing accessibility or reducing the cost of acquiring healthy food.

The third question was about the most effective strategies to reduce barriers for the population to adhere to a healthier lifestyle.

Individually, attention was directed to the more vulnerable population with increased accessibility, awareness, and re-education of society. The most accepted strategy was the community garden. Of the 60%, 35% believed that management should not be the community's responsibility but the municipal management; the other 25% cited that it goes beyond public management but partnerships with suppliers and agricultural technicians. Of the 40% who did not believe in community garden development initiatives as strategies to promote a change in eating habits, they did not believe in the population's engagement in the project due to an ingrained assistance culture that discourages the population's protagonism in achieving a healthier lifestyle.

Collectively, the community garden was cited not only as a place for supply or reducing acquisition costs but as a place transitioning from

an individualistic paradigm to a collective outlook, as an effective strategy for food education and health promotion. The reference for this was the school itself, which weekly informs parents via the WhatsApp application of the menu of healthy food. Concerning school cafeterias, it was mentioned that fried snacks are no longer sold, only baked ones. In higher-income neighborhoods, the gradual elimination of school cafeterias was determined, and in lower-income neighborhoods, the total elimination of school cafeterias.

From the PNAE actions data collected and analyzed in light of the SDGs, the statements of the Community Health Agents (ACS) ensured the promotion of SAN (SDG 2) that PNAE proposed. This was evidenced among many reports about women cooking more at home during the isolation period, leading to greater fruit and vegetable consumption. The repercussion of this result reaches other areas such as promoting healthy living and well-being linked to SDG 3. It was also reported by the ACS that this phenomenon was limited to the isolation period during the Covid-19 pandemic, as returning to professional activities, especially among lower-education and lower-income women, along with the cut of the fresh food increment benefit, tended to revert to pre-pandemic eating habits.

Given the limiting factors of PNAE in promoting a healthy lifestyle, the study showed that emphasis on awareness and food education reflecting cultural change within households is a fundamental strategy for addressing sociocultural inequalities in the barrier to adherence to a healthier lifestyle. Contextualized food education can help bridge the knowledge gap and promote healthier food choices across all socioeconomic groups, thus addressing SDG 10, in reducing inequalities.

Final Considerations

The results of PNAE during the Covid-19 pandemic allowed, albeit partially, to prove the importance of joint intersectoral action as public policy, education, social assistance, health, and agribusiness in combating

major societal challenges such as malnutrition, primarily arising from inequality and social vulnerability.

The report highlighted, above all, the importance of education and awareness as key strategies to promote a healthier lifestyle, aligned with SDG 3 (Health and Well-being), 10 (Reducing Inequalities), and 12 (Responsible Consumption and Production). By addressing these aspects, public policies can play a significant role in combating NCDs, promoting equal access to healthy foods, and encouraging sustainable consumption and production practices.

It is observed that despite the socio-economic non-uniformity of this research, the determining factor in the non-change in food consumption style was evidenced, not by the lack of access to resources for acquiring such foods, but by the lack of a culture of consuming these foods. In the non-response bias, respondents sometimes differed from one another. The point of greatest divergence was regarding the accessibility of healthy products by the vulnerable population due to high costs. While some argue that people would not buy the products, being healthy on their own, even if they were of low acquisition value, but would only consume them if free. Others argue that the more vulnerable population would indeed acquire them if the price were accessible.

It is known that nutritional food education faces great challenges, especially sociocultural elements, in breaking with the culture of attractiveness, ease of preparation and consumption, and low cost developed and offered for decades by agribusiness. Traditional education does not respond, whether to awaken the need for change and/or to effect the change in food consumption style. The focus on non-traditional education, such as community gardens and cooking workshops with tasting, has been widely discussed to promote sustainable production practices to final consumption without waste. Teaching to adopt a responsible lifestyle, from growing their own food, preparing healthy meals, to achieving positive changes in healthy food consumption, aligns with SDGs 3 and 12. Furthermore, raising awareness of the importance of choosing healthy foods promotes more sustainable consumption practices, such as supporting local and seasonal producers and reducing food waste.

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Chapter 12

Contributions and Challenges of the National School Feeding Program (PNAE) in Promoting a Healthy and Adequate School Food Environment

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Food Systems and Their Components

Malnutrition, which encompasses both undernutrition and obesity, is one of the major global health challenges (WHO, 2017; HLPE, 2017). The coexistence of these two extremes, hunger and obesity, represents the phenomenon of the "double burden of malnutrition" (WHO, 2017; Wells *et al*., 2020). In light of the various challenges the world faces, including hunger and obesity, the United Nations (UN) established the 2030 Agenda in 2015, composed of 17 Sustainable Development Goals (SDGs), with the aim of eradicating poverty and promoting global well-being. Among the 17 goals, SDG 2 aligns with the challenge of the double burden of malnutrition, aiming to "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture" (United Nations, 2015, p. 19), highlighting the importance of nutrition in the global agenda (PAHO, 2017).

However, a report by the Food and Agriculture Organization (FAO) (2020) on food security and nutrition emphasizes that achieving the SDG 2 goals requires not only access to sufficient food but also quality food. Diet quality is seen as a vital link in the fight against all forms of malnutrition, including undernutrition and obesity. Furthermore, experts have identified a "Global Syndemic" composed of three major challenges for global public health: obesity, undernutrition, and climate change. These challenges are intrinsically linked to a dominant global food system model that promotes unhealthy diets and perpetuates inequalities in food distribution (Swinburn *et al*., 2019).

In 2017, the FAO presented a theoretical model on food systems developed by a High-Level Panel of Experts. The main objective of this report was to analyze how food systems influence people's eating habits and to highlight how effective programs and policies have the potential to shape food systems, promoting the sustainable production, distribution, and consumption of food, in addition to ensuring the right to food for all (HLPE, 2017).

According to the HLPE report (2017, p. 11), the food system consists of:

> […] the collection of all elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities related to the production, processing, distribution, preparation, and consumption of food, and the outcomes of these activities, including socio-economic and environmental outcomes.

The theoretical model of food systems presented in the FAO High-Level Expert Panel report (HLPE, 2017) consists of three components: food supply chains, food environments, and consumer behavior. These elements are influenced by drivers (factors driving change in the food system), such as: biophysical and environmental factors; innovation, technology, and infrastructure; political and economic factors; socio-cultural factors; and demographic factors.

Biophysical and environmental drivers encompass the available natural resources, essential ecosystem services, and climate change. Meanwhile, political and economic drivers include factors such as leadership, globalization, foreign investment, international trade, food policies, land tenure issues, food price fluctuations, price volatility, conflicts, and humanitarian crises (HLPE, 2017).

In the realm of socio-cultural drivers, elements such as culture, religion, rituals, social traditions, and women's empowerment are highlighted, all exerting significant influence on food systems. Lastly, demographic drivers refer to aspects such as population growth, changes in age distribution, urbanization, migration, and forced displacement, which shape the dynamics of food systems (HLPE, 2017).

Regarding the components that integrate food systems, the food supply chain encompasses a series of activities ranging from food production to final consumption and waste management (HLPE, 2017).

The food environment refers to the "physical, economic, political, and socio-cultural context in which consumers engage with the food system to

make decisions about acquiring, preparing, and consuming food" (HLPE, 2017, p. 28). Therefore, the food environment plays a fundamental role in influencing individuals' food choices. It is important to note that while healthy food environments provide adequate and nutritious food choices, there is currently a significant prevalence of "unhealthy" food environments worldwide that promote less healthy food choices (HLPE, 2017).

Finally, the last component is the consumer, characterized by the choices consumers make regarding the selection, storage, preparation, and consumption of food, either individually or within families. It is important to emphasize that food choices are influenced by personal factors, convenience, cultural aspects, beliefs, and other elements. However, it is crucial to recognize that eating behavior is substantially shaped by the food environment. These three components that comprise food systems (and are influenced by drivers) play a decisive role in the quality of individuals' diets, resulting in consequences for nutrition and health, as well as generating impacts on social, economic, and environmental dimensions (HLPE, 2017).

In the context of the elements that make up food systems, the food environment stands out significantly as it exerts substantial influence on individuals' consumption behavior and, consequently, their diet. In this regard, a highly relevant study was conducted by Glanz *et al.* (2005), who classified the food environment as: organizational, community, consumer, and informational environment.

People interact with various food environments, but it is worth highlighting the school food environment, as many children spend a significant part of their time at school and have their main meals in this environment. One way to ensure that children have access to healthy and adequate food in the school food environment is through public policies, such as the National School Feeding Program (PNAE), a Brazilian government program that aims to provide quality school meals to public elementary school students. The PNAE seeks to promote educational development and contribute to the formation of healthy eating habits. In this context, the present chapter aims to

analyze the challenges and contributions of the PNAE in promoting a healthy and adequate food environment.

For this chapter, it is worth highlighting the organizational food environment, which includes places where people spend a significant part of their time, such as schools, workplaces, and hospitals, for example. The availability of healthy or unhealthy foods in these institutions can significantly influence individuals' food choices. School food policies, for example, can affect the type of food children consume daily (Glanz *et al*., 2005).

Food Security and Nutrition

Food Security and Nutrition (SAN) represents the realization of the universal right of all to the constant availability of high-quality food in adequate quantities, without compromising access to other essential needs. This goal is achieved through dietary practices that promote health, respect cultural diversity, and are socially, economically, and environmentally sustainable (CONSEA, 2004).

Food security is often analyzed under four interdependent dimensions: food availability, food access, food utilization, and food stability. Food availability refers to the quantity of food available in a region or community. Access to food encompasses both economic and physical aspects. Economic accessibility refers to the resources needed for people to acquire quality and nutritious food year-round (Leão, 2013).

Physical accessibility means that food must be accessible to all population groups, from infants to the elderly, as well as individuals with physical disabilities, terminal patients, those facing health challenges, inmates, and others. Additionally, it is crucial to ensure access to food for those living in remote areas, facing natural disasters or armed conflicts, including indigenous peoples and other vulnerable groups (Leão, 2013).

The food and nutrient utilization dimension corresponds to the biological utilization and includes how people use available food to meet

their nutritional needs. It includes knowledge about nutrition, food preparation practices, and eating habits (FAO, 2014). Finally, food stability refers to the consistency of food access over time (Leão, 2013).

Considering this, as stipulated in Decree No. 7,272 of August 25, 2010, which follows the guidelines of the National Food and Nutrition Security System (SISAN), everyone is guaranteed not only the right to food as a mere requirement for survival but also the right to healthy and adequate food that can promote and ensure the health and well-being of individuals. However, to ensure this right, it is essential to develop sustainable food systems to provide everyone with access to healthy, safe, quality food in adequate quantities (GLOPAN, 2016).

Food systems directly influence the SAN framework as they are responsible for the nature of food, its production, and final consumption. Policies, programs, and institutional actions influence food systems to promote SAN, and among the policies that can influence food system components, the PNAE stands out (HLPE, 2017).

The PNAE – National School Feeding Program and Its Challenges

The PNAE aligns with the guidelines of international organizations such as the FAO, which has encouraged actions to ensure SAN in countries, indicating the adoption of public policies that institutionalize the pursuit of SAN. One of the 17 SDGs proposed by the FAO expresses this concern and guides the tasks to be implemented by governments, society, and the production sector so that by 2030 a more sustainable world is achieved, in an attempt to integrate the SDGs with the actions of the countries involved (UN BR, 2021). SDG 2, namely, "zero hunger and sustainable agriculture," focuses on stimulating sustainable agricultural practices through family farming with access to land, technologies, and markets. In this global concern with public policies that ensure adequate food for children, programs like the PNAE are included.

The PNAE is a public policy adopted in Brazil that plays a fundamental role in promoting education and combating hunger and malnutrition

(Abrandh, 2013; Silva; Hespanhol, 2019; Lourenzani; Cardoso, 2020). The program operates through the transfer of financial resources from the federal government to states and municipalities, which are responsible for its implementation. The resources must be used for purchasing food and preparing meals in schools. These foods must be fresh, nutritious, and of high quality, adhering to the principles of healthy eating (FNDE, 2014).

The concern with adequate food has been the subject of public policies in Brazil since the 1950s. This concern has evolved significantly over the years, acquiring national relevance as a public food security policy in Brazil. The construction of the PNAE is in line with constitutional determination and is supported by the Federal Constitution of 1988, which ensures the right to food as one of the fundamental rights. Article 208, item VII, establishes the State's obligation to provide school meals to students in Basic Education, promoting equal opportunities in access to education (Brazil, 1988).

The same Constitution mandated compulsory Basic Education, which led many young people and children to enter the school environment. A great challenge and an opportunity to offer this population a healthy diet, thus necessitating a program to manage school feeding policies and assist states and municipalities, such as the National Education Development Fund (FNDE) (FNDE, 2014). The enactment of Law No. 11,947/2009 mandates that 30% of the amount transferred by the PNAE must be invested in the direct purchase of products from family farming, a measure that stimulates healthy eating for students and economic development and market access for family farming (Brasil, 2009). It was noted that indirectly the law guaranteed rural family farmers participation in the fundamental right to food for elementary school students by ensuring a minimum percentage presence in school meals. This law was of fundamental importance as it established guidelines for the organization and operation of the program, promoting local development and access to fresh and healthy food from local family farming.

The FNDE (2020) is the body responsible for implementing the PNAE. It issues various resolutions detailing procedures, criteria, and standards for the program's operation in partnership with states and

municipalities. Additionally, it defines guidelines in its documents ranging from food procurement to accountability, ensuring transparency and efficiency in the use of public resources.

Although the right to food has been enshrined as a universal human right and despite all the technological and scientific advances that enable abundant food production, FAO data indicates that many people still suffer from hunger worldwide and in Brazil (UN BR, 2014). To address this universe of young people facing food and nutrition insecurity, the PNAE is governed by the principle of universality, meaning it must serve all students enrolled in the public education system, regardless of their socioeconomic status, race, or origin, in compliance with the Federal Constitution, which establishes equal rights for all citizens.

The PNAE also relies on social participation and control, ensuring that the school community and civil society have an active voice in monitoring and overseeing the program's implementation. This is essential to prevent deviations and ensure the quality of school meals (Silva; Hespanhol, 2019).

The PNAE plays a crucial role in promoting the right to adequate food, contributing to the physical and cognitive development of children and adolescents. Additionally, it helps combat school dropout rates, as the provision of attractive meals in schools encourages student attendance. This also contributes to reducing social inequalities, as it primarily serves the most vulnerable population (FNDE, 2014).

Despite its importance, the PNAE faces several challenges. One of them is ensuring food quality, as in many cases, product selection is based on the lowest cost, compromising the provision of healthy meals. Additionally, the infrastructure of schools, such as adequate kitchens, is not always available, making meal preparation difficult. Another challenge is oversight and social control. Society needs to be involved in monitoring the program, ensuring that resources are properly applied and the quality of meals is maintained (Leite, 2022).

Given this, the PNAE is an extremely relevant public policy in the Brazilian context. It plays a vital role in promoting education and ensuring

the right to adequate food. However, it is necessary to overcome existing challenges, ensuring that the program fully achieves its objectives and contributes to building a more just and equal country. Social participation, improving food quality, and adequate school infrastructure are essential steps in this direction (Leite, 2022).

In the next section, the implementation of the PNAE in the municipality of Tupã, located in the interior of the state of São Paulo (SP), will be presented to identify the agents involved in the program, the challenges, and the main points that contribute to fostering family farming and the challenges and contributions of the PNAE related to the school food environment in the municipality.

Implementation of the PNAE in the Municipality of Tupã

Addressing the challenges of implementing healthy public food policies requires specific studies that allow an understanding of the interrelationship between food production, especially family farming, the PNAE, and local program management activities, which can drive such policies.

Leite's (2022) study presents an attempt, through a master's thesis, to contribute to this discussion. The research raises the contributions of an association that supplies family farming food, interfaces with family farmers, observes challenges and impacts on their practice, as well as the role of public managers in articulating public policies that ensure SAN, especially the nutritionists in the municipality's pilot kitchen. Data collection was conducted through open-ended questionnaires, with a direct approach to selected individuals: the Municipal Education Secretary, the nutritionist responsible for the pilot kitchen, the technician responsible for the Banana Growers Association, and selected associated farmers.

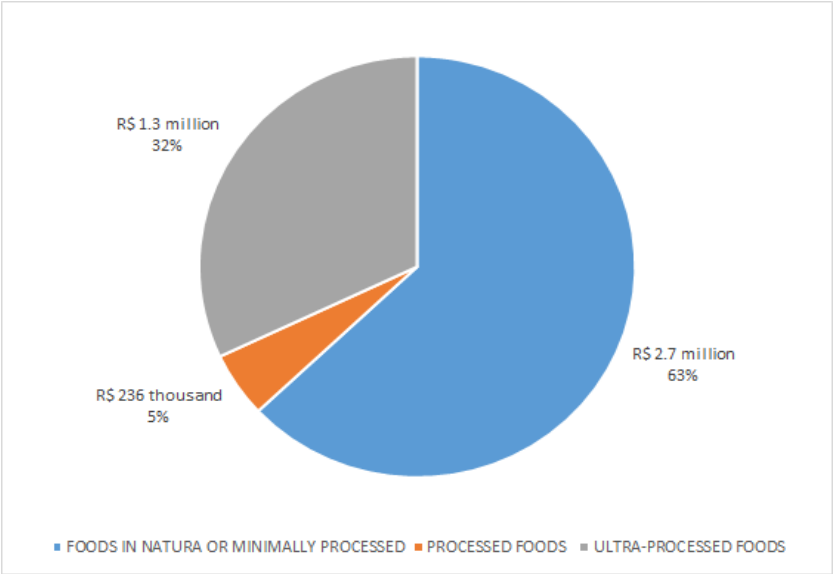
To conduct the interviews, a script was developed to gather the most relevant information for the research objective; the first approach was with the Municipal Manager for his role as Municipal Education Secretary and his decision-making role in the process. An interview was conducted to

map the process and its difficulties. Next, the nutritionist responsible for the pilot kitchen was interviewed to understand her role in the purchasing process and menu development. Subsequently, the person responsible for the contracts of the Banana Growers Association of Tupã was interviewed to understand his role in food procurement in the municipality's public calls. The final stage of interviews was with family farmers supplying the Banana Growers Association.

Ten farmers with active links to the Banana Growers Association were selected based on their availability for interviews, as only these were willing to provide information. The Food Guide for the Brazilian Population was used as an analysis tool to identify whether the items purchased by the PNAE contribute to a school food environment that promotes adequate and healthy eating for students. The reference point for this analysis was the year 2019.

By analyzing all the food purchased in 2019, a significant participation of unprocessed or minimally processed foods (63%) was noted, as well as oils, fats, salt, and sugar, in the menu offered by the Pilot Kitchen, with significant participation of products offered by local family farming through the Banana Growers Association. A higher percentage of ultra-processed foods compared to processed foods was also observed, posing a challenge to improving the school meal menu (Figure 1).

Figure 1 – Proportion of food in 2019 according to the Food Guide, in terms of expenditure (R$)



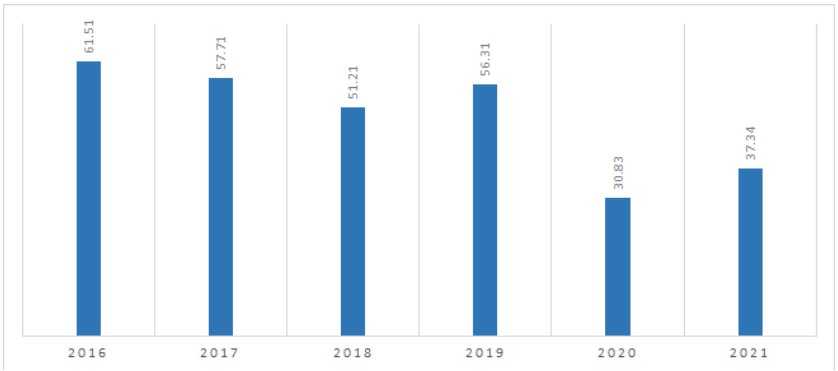
Source: Leite (2022).

Regarding SAN, the nutritionist considers the meals served balanced, striving to vary and adapt the menu to the foods offered by local family farming. Some foods are difficult to incorporate into school meals since children are accustomed to ultra-processed foods at home. Despite the resistance to healthy foods, the nutritionist remains committed to offering them in meals, for example, by finely chopping carrots and green beans with meat, and cabbage with ground beef.

The study highlights the challenges faced by the PNAE in Tupã in promoting healthy eating in the school food environment, due to the persistence of ultra-processed food consumption. Additionally, it emphasizes the importance of family farming as a valuable partner in providing fresh and nutritious food for school meals, benefiting both sides. It becomes evident that a collaborative approach is necessary in implementing public food policies in schools.

The Banana Growers Association works to organize small rural producers, providing support and knowledge transfer so that producers can meet the demands in the municipality of Tupã. However, not all municipalities have this association, necessitating the involvement of all small producers to participate in public calls. Unfortunately, many do not participate because they lack the required documentation for the PNAE. The hypothesis of the Association's strategic role was confirmed in the data collection. The more efficient information management, the more opportunities are generated for producers, overcoming bureaucracy through information transfer by the Association.

Figure 2 – PNAE Transfer Percentage



Source: Leite, 2022.

The study shows that it is possible to meet mandatory percentages to encourage healthy habits and strengthen family farming, a joint effort aimed at ensuring SAN, as observed in Figure 2, which shows the percentage of FNDE resource transfers for the purchase of family farming food from 2016 to 2021.

Final Considerations

The discussion on food systems and food environments is extremely relevant in the current global health context, as it is directly related to the challenges of the double burden of malnutrition, which includes challenges related to undernutrition (low weight and nutrient deficiencies) as well as obesity (overweight).

Based on this scenario, it is important to promote healthy and sustainable food systems. However, it is important to highlight that a healthy food system is not limited to people having access to sufficient food but also to the availability of quality food. Diet quality is essential in the fight against all forms of malnutrition, including undernutrition and obesity. However, the dominant global food system model promotes unhealthy diets and creates inequalities in food distribution.

Food systems are complex and composed of various elements, including the food supply chain, food environments, and consumer behavior. The food environment significantly influences people's consumption behavior and, consequently, their diet. Healthy food environments promote adequate and nutritious food choices, while unhealthy food environments can lead to less healthy choices.

One way to promote food systems and environments that allow people to access healthy and adequate food is through public policies. A relevant example is the school food environment, where public policies, such as the PNAE, play a fundamental role in promoting healthy eating among children. The PNAE acts as an important piece in promoting a healthy food environment in Brazilian schools. This program, aligned with national guidelines and international food and nutrition security orientations, plays a vital role in transforming the school food environment into a conducive space for adequate and healthy food choices.

Observing the implementation of the PNAE in different municipalities, such as the case study in Tupã, it becomes clear that this program is not just an initiative to provide meals, but also an opportunity to influence food choices and, consequently, the quality of students' diets. This is particularly relevant, considering that many children spend

a significant part of their time at school and have crucial meals for their development in this environment.

The association of the PNAE with local family farming is a valuable example of how this program can contribute to a healthier food environment and a more sustainable food system. By encouraging the purchase of fresh and nutritious locally produced food, the PNAE not only provides quality meals but also strengthens local communities and promotes sustainable agricultural practices.

However, the PNAE also faces significant challenges, as observed in the case study, such as students' preference for ultra-processed foods and the need to ensure the quality of purchased foods. Overcoming these challenges requires collaboration among different actors, including the public sector, farmers, associations, and civil society. Thus, it is necessary to establish governance that allows for articulation and alignment among the involved actors so they can address the problem of food and nutrition insecurity and contribute to achieving the goals set in SDG 2.

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Chapter 13

The theme of traditional peoples within the Graduate Program in Agribusiness and Development: possible convergences and important products

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Introduction

The Graduate Program in Agribusiness and Development (PGAD) has a recent trajectory, having been created in 2014, but it faces significant theoretical challenges that shape the debate on socio-environmental sustainability, public policies, and rights, which have been conducted in its research and extension actions, generating very important products.

The PGAD, headquartered at the Faculty of Science and Engineering (FCE) of the São Paulo State University "Júlio de Mesquita Filho" (UNESP), Tupã Campus/São Paulo – SP, was conceived and gradually structured as a training space for masters and doctors who, in their training trajectory, could weave knowledge critically and contextually, beyond agribusiness, within the broad debate about Brazilian rurality, sustainability, culture in rural areas, and the various interfaces – including conflicting and violent ones – present in this scenario.

Emerging from the debates of Line 2 of the PGAD, titled "Development and Environment," Rural Sociology began to be considered fundamental to basic studies, forming an important part of the compulsory annual course Agribusiness Systemic Approach (ASA) for all students. Similarly, the biannual elective course Society and Nature was operationalized, which, despite being optional, took on the responsibility of contributing to the complex and dialectical promotion of knowledge about the relationship between humans and their environment. Additionally, elective courses titled "Ethno development and Public Policies for Indigenous Peoples and Traditional Communities" in 2020, and "Formation and Transformations of Rural Space and Traditional Territories in Brazil" in 2021, had high demand (UNESP, 2023).

In 2015, some faculty members of the graduate program began working with indigenous peoples and traditional communities, including academic and scientific aspects related to Brazilian rurality, specifically with indigenous, quilombola, geraizeiro, riverside, and traditional Latvian communities. They did so in a path that replicates in many other programs,

through research groups and bringing together professors with isolated work in certain areas.

This chapter aims to describe how the PGAD/UNESP Tupã's work with indigenous peoples and traditional communities was structured. Thus, being clear about the qualitative approach and descriptive research type, this research relied on bibliographic and documentary exploration techniques for evidence collection, also using historiography as a research strategy and final technique for analysis and organization of collected evidence (Martins; Theóphilo, 2009).

This chapter of the book dedicated to the 10 years of PGAD narrates descriptively the path that led and continues to lead the graduate program to converge with the demands of indigenous peoples and traditional communities, marking this territory of scientific knowledge production or, in more effusive words from this field, "marking the land," making it a territory of knowledge.

Another central aspect of PGAD's work in general, but presented as a chapter here, specifically, is the convergence with the Sustainable Development Goals (SDGs). The studies on traditional people within PGAD deeply converge with SDG 11 – Sustainable Cities and Communities, as various master's and doctoral works encompass themes that keep sustainability as a backdrop. Other SDGs are referenced in depth, in the specificity of the works, such as SDGs 1, 2, and 11 when studying themes about poverty, hunger, and inequality; SDG 6 when the issue of water access is highlighted, and SDG 4 when basic education is studied, always converging with the field of indigenous peoples and traditional communities.

The socio-environmental challenges of traditional peoples

The Amerindians or Indigenous Peoples of America are descendants of civilizations strongly delineated by the Mayans, Incas, and Aztecs, who, populating the American lands, have been in the current Brazilian territory

for over 10,000 years. The most in-depth archaeological studies in Brazil highlight human presence for many thousands of years in the northeastern hinterlands, the general plateaus, the upper Xingu, and especially in the plains of the Amazon River basin (Neves, 2006).

Generations descended from these peoples would have spread across plateaus and plains, the coast, and the hinterlands of the current Brazilian territory, forming over centuries and millennia, different indigenous peoples. Based on Boas (2004), it is understood that these peoples, given the biological and geographical determinism imposed on their lives, as well as the historical aspects of each community, generated immense cultural diversity and ethnic variety, which includes the linguistic particularities of the more than 300 indigenous ethnic groups described, in past times, by Curt Nimuendajú, Darcy Ribeiro, Florestan Fernandes, and even Marshal Rondon.

Based on the documented notes by Curt Nimuendajú in his important cartographic work titled: "Ethno-Historical Map of Brazil and Adjacent Regions," in its third version, dated 1944, approximately 1,400 indigenous peoples were identified in Brazilian territory. The information refers to 974 bibliographic references (Emmerich; Leite, 1987). From meticulous research, "the map summarizes the bibliography published until 1944" (Zarur, 1987, p. 33).

According to the 2010 Demographic Census data, the diversity of indigenous peoples in Brazil refers to 305 peoples (IBGE, 2012). Currently, this map comprises 1,693,535 Brazilian indigenous people, according to the 2022 Demographic Census (IBGE, 2023). This population data corresponds to 0.83% of the country's total, and compared to the previous Census, an 88.82% increase in the indigenous population was identified (FUNAI, 2023). Science and law converge on the perspective that all indigenous descendants, living on indigenous lands or in cities, are indigenous peoples and, therefore, the original peoples of Brazil.

Anthropology, converging with Sociology, through the work of Carlos Rodrigues Brandão titled "The Traditional Community," published as a book chapter, brings the definition of total culture community and

partial culture community, providing a fundamental notion to the concept of original peoples and traditional communities (Brandão, 2015). On one hand, in light of Ferdinand Tönnies' Theory of Sociability (1855-1936) and Émile Durkheim's Theory of Solidarities (1858-1917), total culture communities are those self-sufficient in seeking the requirements of well-being dimensions (as detailed by Amartya Sen in his work "Development as Freedom"). These communities were not touched by the capitalist mode of production and were self-sufficient, living in a perspective of tribal communism, as described by philosopher Jean-Jacques Rousseau (1712-1778). This was the modus vivendi (way of life) of the original peoples before the colonization process that began in 1500 and is still the way of life of those few isolated indigenous groups (Laraia, 2006).

Still in Brandão (2015), partial culture communities are all those that, touched by the capitalist mode of production, lose their self-sufficiency and enter the perspective of interdependence, profoundly altering their cultures. Numerous interaction processes, filled with friction and violence between peoples oriented by different worldviews and ways of understanding the world and social relations, would be useful here to symbolize this rupture, including the imprisonment of Africans to be enslaved in America, the catechization of indigenous children in Colonial Brazil, or even the expropriation of access by babaçu nut breakers to babaçu zones for collecting fallen fruits.

The social fact here is that total culture communities (self-sufficient for their well-being) moved to the condition of partial culture communities (interdependent for their well-being) and, with this "evolutionary acceleration," began to coexist in a society oriented by the capitalist mode of production, which orients life towards consumption perspectives, individualism, and social fragmentation, usually in urban, condominium, or extreme poverty environments.

However, even when indigenous people cease to have the characteristics of total culture communities, they do not cease to be original peoples. Likewise, when traditional communities are formed through various violent historical paths, they are already characterized as partial culture communities, as they already emerge with dependence on the

capitalist mode of production. Thus, in Brazil, Traditional Communities, besides the indigenous ones, include quilombolas, caiçaras, artisanal fishers, Amazonian riverside dwellers, geraizeiros, pantaneiros, vazanteiros, terreiro people, fundo de pasto people, faxinalenses, and babaçu nut breakers, among others (Brasil, 2007; Vieira, 2014).

It is important to note that all indigenous peoples are original peoples and traditional communities, but traditional communities are not necessarily original peoples (except indigenous in the Brazilian case, or African tribals in African countries, or even the Maori in New Zealand). Finally, the term Traditional Peoples is used to generally designate original peoples (indigenous, in the Brazilian case) and traditional communities (quilombolas, caiçaras, geraizeiros, Amazonian riverside dwellers, among others).

For a better presentation of the quilombola expression in the country, it is important to highlight that, according to the 2022 Demographic Census data, the quilombola population in the national territory totals 1,327,802, representing 0.65% of Brazil's total population, identifying 494 formally recognized quilombola territories. Additionally, only 12.6% of the quilombola population inhabits these demarcated territories (IBGE, 2023).

Besides the international elements enshrined by the United Nations Declaration on the Rights of Indigenous Peoples (UN, 2007) and specific articles contained in Brazil's 1988 Federal Constitution (Brasil, 1988), other important legal markers include, among others, the Indian Statute (Brasil, 1973) and Decree 6040 (Brasil, 2007), which attempt to regulate social relations and the rights of traditional peoples.

After the promulgation of the 1988 Federal Constitution, Brazil's Traditional Peoples experienced alternating moments of better and worse compliance with legal principles, depending on the tone of each federal government but also due to actions taken by local governments (state, district, and municipal). In this sense, transversal to the temporality of governments, some third-sector organizations have conducted excellent monitoring and support work for these peoples, including the Indigenous

Missionary Council (CIMI), which annually publishes its report on Violence Against Indigenous Peoples in Brazil, receiving broad academic support and legitimacy from society, including representative associations of indigenous peoples (CIMI, 2023).

Data presented during the period from 2019 to 2022 indicate that indigenous peoples suffered various forms of violence. Regarding conflicts related to territorial rights, "407 cases were recorded." Concerning "possessory invasions, illegal exploitation of natural resources, and various damages to indigenous heritage, there were 1,133" (CIMI, 2022, p. 13). Regarding crimes against individuals, "795 deaths due to public authority's omission" and "3,552 indigenous children up to four years old died during this period" (CIMI, 2022, p. 13).

CIMI's report indicates that 2022 marked the end of a governmental period characterized by the worsening violence incidence against indigenous communities and territories. During this government, no indigenous land was demarcated (CIMI, 2022).

Indigenous peoples have fought for decades to defend their rights and preserve their cultures and ways of life. "That the new rulers seek to repair the harm, guaranteeing indigenous peoples their fundamental right to land and their ways of being and living in differences" (CIMI, 2022, p. 11). In this context, Bill 490 of 2007, currently being processed as PL 2903 of 2023, addressing the time frame for the demarcation of indigenous lands, represents a setback and infringes on the rights of indigenous peoples in terms of justice, as the 1988 Constitution itself guarantees indigenous peoples the right to land.

Meanwhile, when discussing the socio-environmental challenges faced by traditional peoples, the role and participation of universities in the dialogue and production of knowledge on these precious and delicate topics are questioned. Many challenges are posed, such as affirmative actions and their developments in offering indigenous education that still need improvements, as pointed out by Freitas *et al.* (2022) and Santos and Cristofoli (2022). There is a need to foster "a public policy design that guarantees financial investments in students' permanence in universities,

the preparation of didactic material, and personnel training to deal with great cultural diversity," as cited by Freitas *et al.* (2022). In this context, Santos and Cristofoli (2022) reinforce the need to foster closer relations with indigenous and traditional peoples, considering the policy's purposes and the socio-cultural reality of these communities' plurality.

In this context, the PGAD, through the research line Development and Environment, along with research groups, has been developing studies in the university environment, which will be addressed in the next section.

Trail of studies and research conducted

In 2014, at FCE/UNESP Tupã, two research groups supported and started complementary studies: 1) the Environmental Management and Education Research Group (PGEA)[6], led by Assoc. Prof. Angélica Góis Morales, where the major themes are society's relations with nature; and 2) the Group of Studies in Democracy and Social Management (GEDGS)[7], led by Assoc. Prof. Nelson Russo de Moraes, whose themes include various interfaces of human social relations. Both groups address important arenas for producing academic substrate to address traditional peoples' themes.

In these groups, several undergraduate and high school students joined as fellows of the Institutional Program of Scientific Initiation Scholarships (PIBIC) and University Extension, alongside other academic community members interested in the theme. This information is highly relevant as no course was taught, no orientation conducted, and no research or extension action executed without extensive background work of studies and social and political articulation with environments outside the university.

6 Research group that emerges from the interaction of various researchers and aims to reflect the process of environmental management and education in various contexts, enabling connections, exchanges, planning, and execution of research and extension projects. In this collaborative process, the Sala Verde Rede de Educação Ambiental da Alta Paulista – REAP (UNESP, 2023) stands out.

7 t has an interdisciplinary characteristic, aiming to build contributive knowledge for solving the challenges faced by contemporary society, especially through the promotion of studies, research, and extension aligned with specific themes. Among the important activities of GEDGS, the International Network of Researchers on Indigenous Peoples and Traditional Communities (RedeCT) stands out (UNESP, 2023).

In 2017, the first two master's research projects were initiated within PGAD/UNESP Tupã, under the supervision of Assoc. Prof. Nelson Russo de Moraes, both completed with public dissertation defense in 2019. One of them, titled "Analysis of the social impacts of the transition of agricultural production models in traditional communities: a case study of the geraizeiros community of Matinha (Guaraí/Tocantins - TO)," by Alexandre de Castro Campos, studied the history, characteristics, modus vivendi, and social relations of that community, articulating it with the legitimizing elements of the "geraizeiro world" (Dayrell, 1998; Nogueira, 2009; Ribeiro, 2015). Campos' dissertation (2019) was based on sociologist Ferdinand Tönnies' theory and focused on sociability and the transition from traditional agricultural models to agroecology, exploring these theoretical concepts. Campos (2019) discusses the socio-economic and environmental context of traditional Brazilian communities, emphasizing agroecology as a sustainable alternative to intensive agriculture.

The other research, titled "Brazilian indigenist public policy: analysis of transformations based on the case study of the indigenous village Vanuíre (Arco Íris/SP)," conducted by Ariane Taísa de Lima, revisited the transformations of indigenist public policies in Brazil from colonial times to contemporary times, culminating in describing how state services are provided in the Indigenous Land Vanuíre, where mainly Kaingang, Krenak, and Terena indigenous people coexist, in the areas of education, health, social assistance, and land rights (Lima, 2019; Ribeiro, 1979). Highlighting the present challenges, Lima (2019) concludes that it is urgent for policies to promote the rights and sustainable development of indigenous communities, respecting their unique cultures and identities.

Also under the supervision of Assoc. Prof. Nelson Russo de Moraes, in 2018, Cláudio Antônio Tavares began his master's research titled "Cooperativism as an organizational model and income generation instrument for traditional communities," defended publicly in 2020. The work was dedicated to studying the legally available organizational models in Brazil and their proximity to the political representation needs of residents and better market competitiveness of the products from the Traditional Leta Community of Varpa District in Tupã/SP

(Pinho, 2003; Tavares, 2020). Tavares (2020) investigated associativism and cooperativism as organizational models already experienced by the mentioned traditional community, examining the challenges, benefits, and distinctive characteristics of this organizational model.

From 2018 to 2020, under the same professor's supervision, Valdemir Garcia Neto Melo's master's research titled "From global to traditional: the use of water for human consumption in a traditional Amazonian community" took PGAD once again to the Brazilian Legal Amazon, specifically to the Traditional Riverside Community of Senhor do Bonfim, located on the banks of the Piranha River, Araguaia river basin, in Araguacema/TO. The works started with the international marker of human rights to potable water – Guidelines for Drinking Water Quality (GDWQ) – to which Brazil is a signatory and reproduces the right through its Federal Constitution. In the field, the research conducted interviews, photographic data collection, and two analyses of the water distributed and consumed by the community's residents. The work's results scientifically indicated the low quality of the water, especially due to the abrupt oscillation of chlorine (directly released into collective water tanks) and the presence of various natural sediments. Finally, as usual in works of this alignment, the dissertation presented the set of historical and social characteristics that make Senhor do Bonfim (of Araguacema/TO) a traditional riverside community (Brasil, 2007; Melo, 2020; WHO, 2017). Given these conditions, Melo (2020) highlights the need for investment in water supply and sanitation systems for traditional peoples to improve public health.

In 2019, four new master's research projects on traditional peoples were initiated. Assoc. Prof. Renato Dias Baptista supervised Laís de Carvalho Pechula's work titled "Conflicts in indigenous territories: an analysis based on the transformations of indigenous territorial rights," defended publicly in 2021. Through an interdisciplinary lens between Social and Legal areas, it presented the practical conflictuality and the developments of legal pacification for the issue of indigenous lands in Brazil (Brasil, 1988; FUNAI, 2013; Pechula, 2022). Pechula (2021) analyzes indigenous territorial rights in Brazil from their historical transformations, applicability,

and associated conflicts. To this end, qualitative methods and various data sources are used to analyze the transformations and conflicts around such rights, aiming to promote peace, justice, and sustainable development. Pechula discusses the construction of indigenous ethnic identity and the importance of constitutional guarantees considering increasing violence, especially regarding the demarcation and protection of indigenous lands threatened by Bill No. 490/2007 (current Bill No. 2903) and its impact on indigenous territorial rights, particularly regarding the "time frame" theory, contrary to the 1988 Constitution (Pechula, 2021). Pechula concludes by evoking the role of the National Indian Foundation (FUNAI) and the Public Prosecutor's Office for the need for effective measures to preserve and fully apply constitutional rights to ensure the integrity of indigenous lands and the well-being of indigenous communities (Pechula, 2021).

Assoc. Prof. Angélica Góis Morales supervised the then master's student Valquíria Cristina Martins in her research "Knowledge and socio-environmental practices in the Indigenous Land Vanuíre: understanding the ethnoknowledge of the Kaingang and Krenak Groups," which deals with a comprehensive analysis of the cultural practices and socio-environmental knowledge of the Kaingang and Krenak indigenous groups in the Indigenous Land Vanuíre, focusing on agriculture, cuisine, and crafts. Martins (2021) explores the history, migration, and coexistence of these peoples in the same territory, highlighting the importance of preserving indigenous culture and their rights in the face of challenges such as colonization, forced displacement, and the Covid-19 pandemic. To do so, theoretical concepts about multiculturalism, interculturality, and the role of cultural institutions in promoting cultural and environmental preservation are used.

The study highlights the crucial role of ethnoknowledge and sustainable practices in these communities' relationship with the environment and biodiversity preservation, discussing the difficulties faced by communities in preserving their traditions. Martins (2021) considers that in an increasingly globalized world, intercultural dialogue and the appreciation of indigenous knowledge are increasingly important for promoting sustainability and cultural diversity.

The then master's student Karen Cristina Andrade Pereira, under the supervision of Assoc. Prof. Andréa Rossi Scalco, conducted the research "Influence of the food environment on eating habits: analysis contribution to indigenous peoples in Brazil." Pereira (2021) highlights that food decisions are complex, and influenced by social, cultural, economic, and psychological factors, which are important in promoting healthy eating habits. The analysis focuses on various aspects of the food environment, including the availability of healthy options, prices, promotions, nutritional information, and their relationship with eating behavior. It also includes the domestic, work, and school contexts and their influence on food choices. For Pereira (2021), understanding these aspects is important for addressing the double burden of malnutrition and obesity, centered on life trajectories and individual experiences in forming dietary patterns.

The study emphasizes the need for public policies that promote healthy and accessible food environments for indigenous communities, recognizing the challenges these populations face in seeking a nutritious and culturally appropriate diet, considering that such policies have significant implications for promoting public health and addressing food insecurity (Pereira, 2021).

During this same period, Assoc. Prof. Nelson Russo de Moraes supervised Cristiane Teixeira Bazílio Marchetti in her research titled "Public education policies for indigenous peoples in Brazil: conceptual and legal transformations." Marchetti (2021) studied indigenous education in the Brazilian context, examining its historical transformation, challenges, and advances. To do so, it uses sociological, anthropological, and philosophical contributions, such as those of Marx, Weber, and Freire, which inform a critical understanding of the challenges and processes involved in indigenous education. Marchetti outlines the transition from assimilationist and exploitative approaches during the colonial period to a more positive recognition of indigenous peoples' rights and autonomy in the 1988 Constitution. The legal frameworks and public policies that influenced indigenous education include the creation of Ethnoeducational Territories and the challenges faced by indigenous schools in terms of recognition, resources, and infrastructure; the need to respect indigenous

dietary practices in school feeding programs; and the recognition and respect for indigenous cultures and languages as an integral part of Brazilian identity. From such a perspective, different cultural views within indigenous cultures and the fundamental role of indigenous peoples' participation and autonomy in educational decisions can indeed be included.

It is important to highlight that these works, initiated in 2019, and others that concluded by 2023, were severely impacted by the Covid-19 pandemic, including the infeasibility of entering traditional territories, conducting in-person research, and having dialogues that, under better circumstances, would have been conducted via telephone or internet.

In this pandemic period, Fernando da Cruz Souza, under the supervision of Assoc. Prof. Nelson Russo de Moraes, conducted research titled "Babaçu nut breakers: human well-being in the Bico do Papagaio region, Tocantins." Souza (2023) identified various dimensions of human well-being in rural and traditional scenarios in traditional babaçu nut breaker communities in the Bico do Papagaio region, TO. Based on Amartya Sen's capabilities approach (2010) and the intersectionality of social relations, the author emphasizes the interconnection of social, economic, and environmental factors and their impact on the lives of vulnerable populations. The historical context of the formation of rural and traditional communities, often rooted in resource exploitation, as well as contemporary challenges posed by climate change and deforestation, are discussed (Souza, 2023).

Among the deprivations faced by the researched communities are limited access to education, land ownership, and basic services, while highlighting the collective resistance produced by women who, through social capital, support each other in their quest for well-being. Moreover, traditional knowledge and collective representation in these communities are critical factors in maintaining cultural identities and advocating for social and environmental justice for nut breakers. Given such a reality, this research emphasizes the need for targeted policies and interventions that recognize the unique dimensions of well-being in rural and traditional contexts (Souza, 2023).

Finally, within the pandemic's historical context, the then master's student Isaltina Santos da Costa Oliveira, also under the supervision of Prof. Nelson Moraes, conducted research titled: "Studies on the Origin and Current Social and Geographic Landscape of Indigenous Peoples of Amazon Tocantins." Oliveira (2023) addresses the complex issues faced by indigenous communities in the region, including a violent historical process. The author points out the growth and devastating impact of conflicts in rural areas due to agribusiness, mining, and latifundia formation, which occur at the expense of the essentiality of the territory for indigenous cultures, which do not see it merely as a basis for their cultural, environmental, social, and economic continuity but also as a fundamental element of their identities. The study also highlights deforestation, colonization, and tragic extermination tactics employed against indigenous communities and the profound historical repercussions of such acts as persistent barriers for indigenous peoples in securing their land rights, including the complex demarcation processes. It indicates the need for more precise research and more accurate narratives for a better understanding of the history of the formation of current indigenous peoples and cultures in central Brazil (Oliveira, 2023).

In 2021, the first two doctoral research projects on indigenous peoples and traditional communities were initiated, one within a geraizeiro community and another within a quilombola community, both from the Brazilian Legal Amazon. The first is Alexandre de Castro Campos' doctoral research (still ongoing, under the supervision of Assoc. Prof. Angélica Góis Morales, with defense expected in 2025), titled "Analysis of the modus vivendi and sociability of traditional communities in the face of the impacts of global climate change: a case study of the traditional geraizeiro community of Matinha (Guaraí/TO)." The second is Ana Maria Barbosa Quiqueto's research (ongoing, under the supervision of Assoc. Prof. Nelson Russo de Moraes, with defense expected in 2025), titled "Quilombola school education in the face of public educational policies: challenges and impasses in the rural environment," based on a study in the Lajeado/TO community.

The study of violent colonization processes in the United States and Brazil from two classic works is Luis Guilherme Costa Berti's master's

research (initiated in 2022, under the supervision of Assoc. Prof. Nelson Russo de Moraes), titled: "The communication of the struggle for Pachamama among the original peoples and the colonizers of America: analysis of the works 'The Indians and Civilization' (Darcy Ribeiro, 1979) and 'Bury My Heart at Wounded Knee' (Dee Brown, 2003)."

In 2023, two new doctoral students began their research, contributing to consolidating the field of studies within PGAD/UNESP Tupã. Isaltina Santos da Costa Oliveira conducts, under the supervision of Assoc. Prof. Nelson Russo de Moraes, the research "Museums and indigenous people: The importance of the Índia Vanuíre Museum in the historical and cultural communication of indigenous peoples of Western Paulista" and Valquíria Cristina Martins, under the supervision of Prof. Angélica Morales, conducts the research "Understanding the ethnoknowledge of the Kaingang and Terena groups: Icatu Indigenous Land - Braúna/SP."

It is important to highlight that the robustness of the field being built within PGAD/UNESP Tupã had repercussions on other collateral orientations in other programs, by their faculty's participation in other graduate programs. Thus, under the supervision, co-supervision, or collaboration of Assoc. Prof. Nelson Russo de Moraes, Bruno Ricardo Carvalho Pires produced the dissertation "Digital media and the communicational perspective of orality for the production and reproduction of traditional knowledge in a quilombola community: a study of the traditional quilombola community of Lajeado – Dianópolis – TO"; Marciley Alves Dias the dissertation "The influence of radio journalism in quilombola communities" and Laurenita Gualberto Pereira Alves produced "Brincadequê: toys and games in the Lajeado Quilombo," all from the Federal University of Tocantins (UFT).

Important products produced

The first product is, in truth, composed of various scientific communications. All research developed within PGAD is officially linked

to its students' formative path, whether master's or doctoral. Thus, each master's research (there have not yet been doctoral conclusions with this theme by the end of 2023) generated a dissertation that, besides achieving its objectives and answering the central problem, presents a chapter entirely dedicated to the characteristics of the studied community, serving as an instrument legitimizing that the community is traditional.

This chapter or dissertation section generally provides a good presentation of the geographical location, a detailed historical description of the community's formation, with dates and accounts. It also includes characteristics of the culture and modus vivendi and checks these items against requirements usually set out in legislation and the theoretical state of the art as legitimators of traditional peoples.

An important product of this PGAD work segment was partnerships with institutions and communities. In this sense, there was a concrete rapprochement between FCE/Tupã and traditional peoples in general, and particularly with the indigenous communities of Vanuíre, Icatu, and Araribá, as well as the traditional quilombola community of Lajeado, the geraizeiro community of Matinha, the riverside community of Senhor do Bonfim, the leta community of Varpa, among others. This rapprochement was made possible largely by the essential partnership of researchers with the Índia Vanuíre Historical and Pedagogical Museum (Tupã/SP), which has always maintained a strong interest in the success of the works.

In the field of scientific communications, articles and book chapters with partial research cuts are produced, resulting in more objective scientific documents with more practical answers to the guiding questions of the research or the challenges posed by the communities.

With the increase in the number of works and the theoretical deepening of this movement, some partnerships were structured for committee composition and examination boards, dialogue about methods, and a better understanding of specific flows with the Human Research Ethics Committee (CEPP) and FUNAI, among other demands. In this context, works conducted by the GEDGS and PGEA research groups, among others, by PGAD/UNESP Tupã faculty were structured in the

understanding that many researchers, faculty, students, and isolated groups in their faculties were dedicated to this theme.

From this need, the GEDGS research group planned and created the International Network of Researchers on Original Peoples and Traditional Communities - RedeCT, officially presented to the public on 05/22/2018, at the Federal University of Cariri, in Juazeiro do Norte – Ceará (CE), during the X National Meeting of Researchers in Social Management – ENAPEGS.

RedeCT, currently with over 150 associates from Brazil and other countries, aims to promote cooperation among researchers, professors, students, and academic groups on research, teaching, and extension about traditional peoples. Concrete results include the creation and maintenance of a series of books by the Federal University of Roraima (UFRR) and Fi Publisher, with 11 volumes published and 125 chapters for free access (Fi Publisher, 2023). It created and maintained the Permanent Webinar of RedeCT, where researchers, extensionists, and authors are invited to dialogue and disseminate their works.

In 2020, RedeCT created the annual Scientific International Congress – CCI, which has already counted over 3,000 participants, besides publishing the documents Proceedings of each congress. It is noteworthy that the 2020 CCI was held from UNESP Tupã; in 2021 from Palmas/TO (UFT and Federal University of Northern Tocantins – UFNT); in 2022 from the Intercultural Indigenous Faculty of the State University of Mato Grosso (UNEMAT) in Barra do Bugres/Mato Grosso – MT. In November 2023, it will be held at the University of the Amazon (UNAMA) (Belém/Pará – PA) and in 2024 at the Faculty of Architecture, Arts, Communication and Design – FAAC/UNESP Bauru.

Final considerations

The production of a field of studies, research, and extension within a specific line of a graduate program is not something accomplished

without the continued effort of the involved individuals. The good theoretical debate, reflecting practical societal phenomena, encourages the epistemological and causal deepening of the theme and strengthens the collaborative work of the more critical research groups.

The developments of the interdisciplinary research described above generated direct interlocution with the complex circumscribed theme with UNESP, opening a new field within the program. The courageous students (and their supervisors) who believed in this research area, especially linked to PGAD's Line 2, producing knowledge in the service of traditional peoples, are remembered here historiographically.

The challenges posed by the Sustainable Development Goals (SDGs) find, in this repertoire of research presented in this chapter, valuable subsidies for thematic deepening, with the complete versions of dissertations available in the university repository, with free and open access.

In response to so many societal demands in general and specifically traditional peoples, PGAD (UNESP/Tupã) has consolidated the demarcation of the territory for producing specific knowledge about the history, culture, worldview, rights, and public policies of indigenous, quilombola, geraizeiro, babaçu nut breaker, terreiro people, Amazonian riverside people, among others.

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Chapter 14

Extension Practices Associated with Research and Teaching: Experience Report of the Kamby Group

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Contextualization

According to the National University Extension Plan (Brazil, 2018 p.1), university extension is understood as "an educational, cultural, and scientific process that inseparably articulates Teaching and Research and enables the transformative relationship between the university and society." Its execution occurs through extension activities developed in the modalities of programs, projects, courses, events, and service provision, inserted in thematic areas and conducted with society (UNESP, 2022).

Higher Education Extension in Brazil is integrated into the curriculum matrix and the research organization, constituting an interdisciplinary, political-educational, cultural, scientific, and technological process (Brasil, 2018). Thus, university extension can promote mutual benefits for the local society and the universities, in such a way that extension is socially important by acting directly in assisting groups that need knowledge (Deslandes; Arantes, 2017).

At the postgraduate level, according to Moita and de Andrade (2009), extension "ends up being relegated to a secondary place, (...) contributing to research and teaching practices dissociated from reality." Perpetuating this dissociated model of teaching, research, and extension results in the loss of a strategic space for generating knowledge, which favors multidisciplinarity, the development of citizen and human awareness, as well as the formation of people capable of being proactive agents of change in society with an active and critical posture (Castro, 2004).

The Postgraduate Program in Agribusiness and Development (PGAD), since 2014, within its dynamic interdisciplinary performance, linked to its central research object, agribusiness, has been a conducive and encouraging means for researchers to act in extension in an associated manner to teaching and research.

In this scenario, this chapter aims to bring an experience report of extension activities associated with research and teaching developed by the Kamby Research and Extension Program (Kamby Group). The Kamby Group has been acting since 2015 alongside the dairy production

chain, developing the teaching-research-extension triad in the search for improving the quality and quantity of milk produced in the Alta Paulista region, driving innovation and social transformation.

Extension Activities and Their Approaches

University extension presents itself as an indispensable tool for bringing the general population closer to universities, as it facilitates transformative interaction between the university and sectors of society through the inseparability between teaching, research, and extension (Forproex, 2012). It is considered the main way to mitigate the vision that access to a university or college is something distant and restricted to the economic elite (Pinheiro; Narciso, 2022).

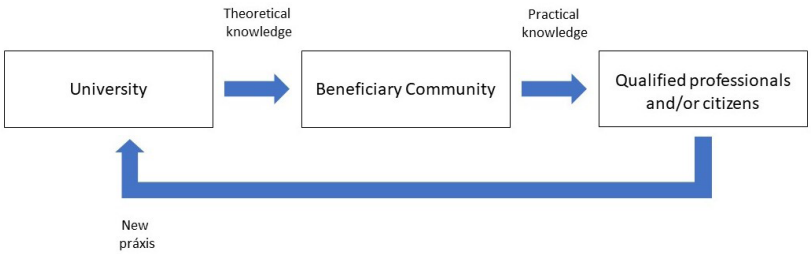
Its historical construction, in terms of applying the concept of university extension, has traversed four paths over time. At first, an extension was the process of transmitting knowledge from the university to society, making the university the sole holder of knowledge. In the second phase, scientific knowledge generated in association with local culture was presented beyond the university walls, serving as a means of transforming society. Regressing, in the third phase, the university resumes a conservative and anti-dialogical vision, turning extension into an assistentialist role. Finally, in its current phase, the university, supported by guidelines, recognizes the inseparability between teaching, research, and extension, and its execution is based on the exchange of knowledge, enveloped in dialogue between academics and society, enabling the praxis of knowledge (Bolzan, 2023).

In its current vision, extension activities at the university are characterized by their educational nature, making people capable of using knowledge in their own life situations (Unesp, 2022). Furthermore, it has an interdisciplinary, political, and academic purpose by promoting interaction between the university and social sectors (Forproex, 2012).

Thus, university extension plays an important role in the learning process of students and society. This cyclical learning process (Figure 1)

occurs through the transmission of theoretical knowledge (praxis) from the university, through its students and faculty, to the community it is inserted in (beneficiary community). The transmission of theoretical knowledge explains everyday situations and phenomena to the population, disseminating academic knowledge. The combination of theoretical knowledge with the practical (empirical) knowledge of society results in the complete qualification of citizens (Pinheiro; Narciso, 2022).

Figure 1 – Cyclical Learning Process through University Extension



Source: Adapted from Pinheiro and Narciso (2022).

The process of transmitting this theoretical knowledge from the university to society, whether public or private sectors, occurs through extension activities (Box 1) developed in the forms of programs, projects, courses, events, and service provision (Brasil, 2018).

Box 1 – Types of Extension Activities and Their Definitions Extension

Extension Activity	Definition
Program	Characterized by integrated scientific-academic actions, carried out within a determined time frame, inseparable from teaching and research, aiming at the production and dialogical sharing of knowledge and wisdom that involve problems and/or demands of society.
Projects	Offered to the external community, aimed at the socialization of academic knowledge, enhancing the interaction process between the University and other sectors of society, through the execution of its own schedule and program content.

Extension Activity	Definition
Courses	Characterized by the primary articulation with other sectors of Society and can be carried out in the form of exhibitions, meetings, symposiums, workshops, congresses, conferences, or cycles of conferences, seminars, forums, debates or cycles of debates, technical meetings, concerts, festivals, artistic and cultural manifestations, ateliers, exhibitions, and similar activities, directed at specific audiences.
Events	Activity of delivering innovative solutions and exchanging experiences with society from the intangible heritage of the university - understood as an inseparable set of practices, expressions, knowledge, and techniques that contemplate the dialogical dimension of University Teaching, Research, and Extension.
Service Provision	Characterized by integrated scientific-academic actions, carried out within a determined time frame, inseparable from teaching and research, aiming at the production and dialogical sharing of knowledge and wisdom that involve problems and/or demands of society.

Source: Adapted from Unesp (2022).

The Kamby Extension Program and Its Research and Teaching Actions: The Origin

The Kamby extension program was created in 2015 at the Faculty of Sciences and Engineering of the São Paulo State University "Júlio de Mesquita Filho" (UNESP), Tupã Campus. In that year, the extension project Kamby "Keeping an Eye on Milk" began its activities with the aim of integrating university students, technicians, and dairy producers in the Tupã region through the exchange of technical and practical knowledge, seeking to improve the dairy production in the region in terms of both quality and quantity of milk produced.

The motivating factor for its creation was the negative impact caused by the closure of the local cooperative, which caused instability among dairy producers in the region, characterized mainly by family production profiles, who found themselves unsupported regarding the future of their livestock activities.

Located in the Alta Paulista, a region of strong indigenous influence in the state of São Paulo, the term Kamby was chosen to honor the local

native peoples, considering that the term kamby originates from the Tupi-Guarani dialect, translated as milk from the breast.

In its first year, the focus of the activities was on extension activities, mapping and characterizing the dairy producers in the region and subsequently bringing technical information about dairy farming.

In 2016, the extension project gained new activities with the inclusion of research activities at the undergraduate level (through scientific initiation) and linking with teaching activities in the Biosystems Engineering bachelor's course.

The complexity of the problems identified in extension activities promoted in 2017 the inclusion of postgraduate research, linking the Kamby extension project to the Agribusiness and Development Postgraduate Program (PGAD) of the same institution.

In 2020, supported by the maturation of the extension project, which then conducted teaching and research activities at the undergraduate, master's, and doctoral levels, culminated in the formalization before the National Council for Scientific and Technological Development (CNPq) of the Kamby Research Group – GPKamby – Good Practices in Dairy Farming (CNPQ, 2023).

The GPKamby is formed by three Research Lines (LP), which are:

- LP 1 – Good manufacturing practices and milk quality: aims to study the means of milk and its derivatives manufacturing so that they can be improved through good sanitary and management practices techniques. Additionally, it aims to evaluate the quality of milk from small, medium, and large producers in Tupã and the region and associate the improvements of good manufacturing practices with quality improvement according to the production and quality standards of the Ministry of Agriculture and Livestock.
- LP 2 – Ambience and dairy farming 4.0: aims to study the effect of the environment on dairy herds in Tupã and the region and develop new technologies for improving the environment for

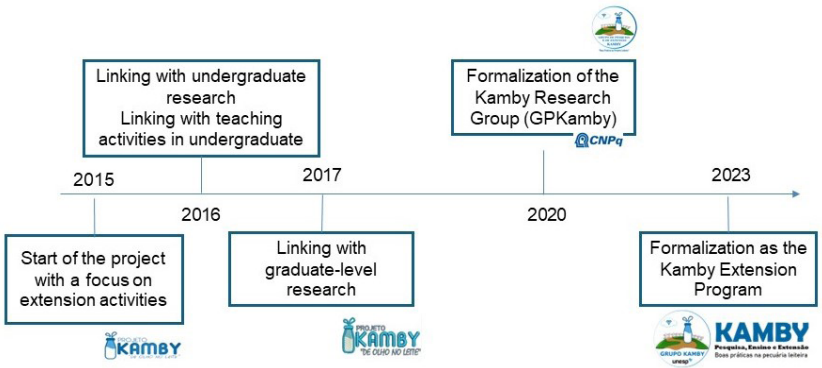
animals and workers in the dairy sector. Maintaining thermal comfort and studying animal behavior, physiological, and immunological variables are tools that will assist in decision-making on the property and in designing technological innovations for the sector

- LP 3 – Management of the dairy production chain: aims to study the management of the dairy supply chain. It includes aspects of planning and managing activities involved in supply and delivery. It works on studies of coordination and collaboration with channel partners (suppliers, intermediaries, third-party service providers, and customers), manufacturing operations, process coordination, and activities through marketing, sales, product design, finance, and information technology.

The conception of GPKamby's research lines aims to align with the activities conducted by the extension project, allowing the analysis of advances in the production chain, milk quality requirements, dairy chain management, regional, national, and global production chain growth, the organization of producers and other chain links, as well as the needs of animals, producers, and the market regarding sanitary aspects, good practices, and the application of new technologies for improving this agricultural sector.

Consolidated by the extension activities carried out, and which are articulated inseparably with teaching and research, in 2022 the extension project coordinators submitted a proposal to change the status, formalizing in 2023 the Kamby Extension Program "Good Practices in Dairy Farming" (Figure 2).

Figura 2 – Timeline of the Kamby Extension Program "Good Practices in Dairy Farming"



Source: Prepared by the authors (2024).

Thus, in 2023, reaffirming its purpose, the Kamby extension program reestablished its objective, which is "to improve dairy production in the Tupã region, both quantitatively and qualitatively of the milk produced, through the dissemination of knowledge and exchange of experiences among its target audience."

Through its knowledge dissemination extension activities, the program contributes to the policy proposed by the United Nations Sustainable Development Goals (SDGs). This policy was constituted by 17 Sustainable Development Goals (SDGs), which together form a framework to guide the actions of governments, international bodies, civil society, and other institutions over the next 15 years to promote sustainable agriculture, eradicate extreme poverty and hunger (FAO, 2015).

The Kamby extension program in its extension activities promotes advances towards sustainable development, as it directly assists in meeting the SDGs. With emphasis on SDG 2, which addresses combating hunger and planning sustainable agriculture, SDG 8, which talks about decent work conditions and regional and national economic growth, and SDG 12, which discusses responsible consumption and production to ensure sustainable production and consumption standards of food (FAO, 2015).

The Kamby Extension Program and Its Goals

The actions promoted by the Kamby program are planned for the quadrennium 2023-2026 and have eight achievement goals:

1. Partner with associations, city halls, agricultural houses, schools, other extension projects and programs, and other entities related to dairy production.
2. Map dairy producers and dairy industries located in the Alta Paulista region.
3. Disseminate knowledge to rural producers, extension workers, and dairy industries through workshops, field days, and technical meetings, through face-to-face and online events, aligned with previously raised technical, management, basic knowledge difficulties, and milk consumption.
4. Increase knowledge dissemination through social media reaching the target audience directly and indirectly involved in the program's actions (@kamby.unesp).
5. Promote integration among the various agents in the dairy production chain.
6. Promote integration with the external community not directly linked to the dairy production chain, such as high school students, the elderly, and children, and schools in the region.
7. Participate and support fairs, agricultural exhibitions, dairy tournaments involving the different links of the dairy production chain.
8. Reconcile the extension program with research projects of the unit (GPKamby and others).

Meeting the goals set for the quadrennium in question includes the continuity of mapping dairy producers in the Alta Paulista region, establishing partnerships with associations, city halls, agricultural houses,

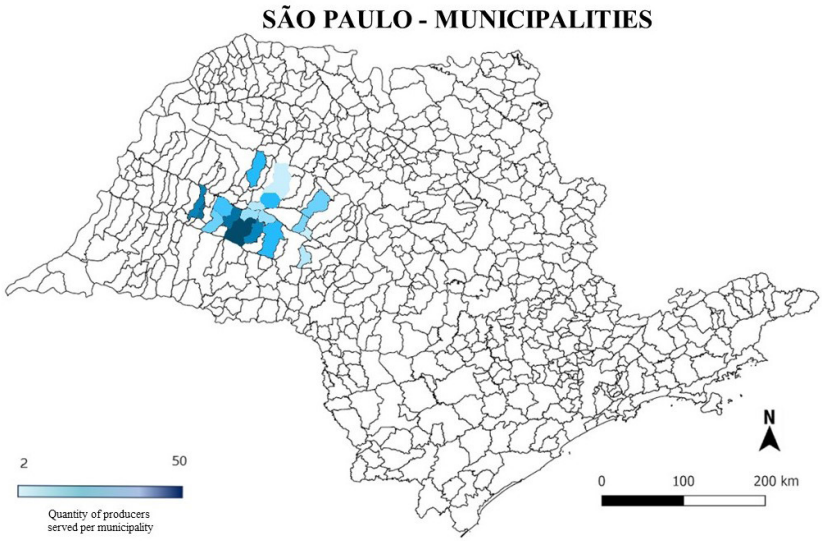
schools, extension projects and programs, and other entities related to dairy production, disseminating knowledge to rural producers, extension workers, and dairy industries through workshops, field days, and technical meetings, both face-to-face and online, and preparing support materials.

All these goals are aligned with the technical, management, and basic knowledge of handling, and sanitary difficulties, as well as milk consumption, which were previously raised and aligned with the extension program by the research projects carried out at the Unit by researchers from the Kamby Research Group.

The Kamby Extension Program Depicted in Numbers and Images

In its 8 years of operation, the Kamby program has helped more than 180 dairy producers distributed in 19 municipalities around the Alta Paulista region (Figure 3).

Figure 3 – Municipalities of Dairy Producers Served by the Kamby Program

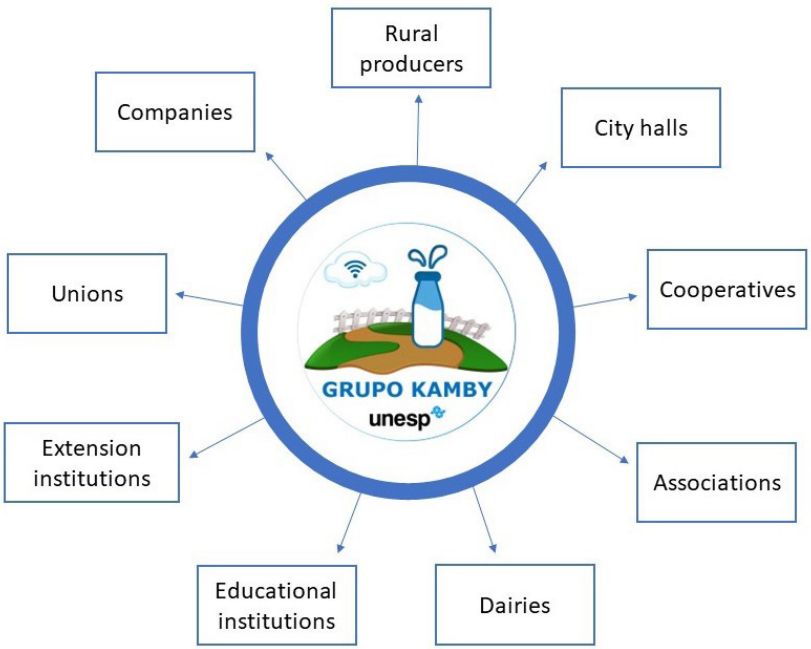


Source: Prepared by the authors (2024).

To foster the various extension activities proposed by the Kamby program, the participation of various agents is necessary, acting as partners. For this, the Kamby program constantly relies on partnerships with public and private entities that add technical support and knowledge (Figure 4).

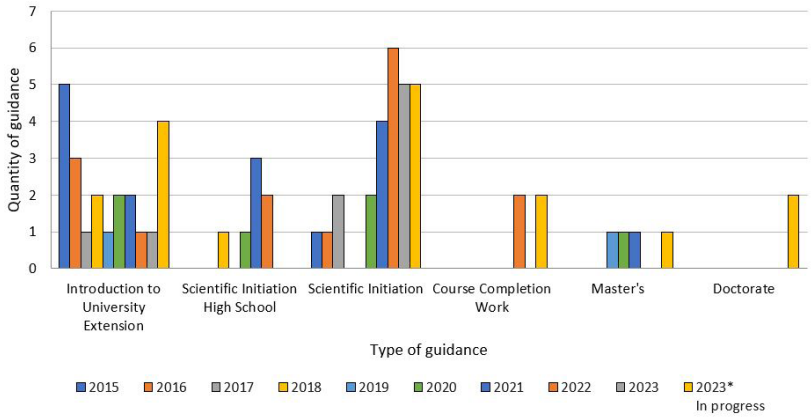
The extension and research activities are conducted by students regularly enrolled in undergraduate and postgraduate courses, supported by the Kamby program coordinators, who play an advisory role. Over these 9 years, 65 students have been guided, sometimes with research and extension scholarships from funding agencies and the University (Figure 5). The PGAD stands out in this scenario as a propellant of teaching-research-extension actions, acting in a two-way street at times, by generating research themes that are solved with the support of extension and teaching, and by being the scientific means for solving problems identified through extension activities.

Figure 4 – Agents Participating in the Kamby Program



Source: Prepared by the authors (2024).

Figure 5 – Number of Undergraduate and Postgraduate Students Guided in the Kamby Group



Source: Prepared by the authors (2024)

Extension Activities Conducted by the Kamby Group

The Kamby Group is formed by members active in the research group (GPKamby) and/or in the Kamby extension program. This group includes undergraduate students from the Biosystems Engineering and Administration courses and postgraduate researchers linked to PGAD, who together conduct extension activities with specific objectives, reaching various target audiences, as depicted in Box 2.

Box 2 – Extension Activities Conducted by the Kamby Group, Their Objectives, and Target Audience

Extension Activity	Objective	Target Audience
Field Protagonists	Focused on the female target audience, it brings the dissemination of knowledge and exchange of experiences with women who stand out in their activities in the field.	University students, professors, technicians, extension workers, milk producers, dairy industry, and the general population.

Extension Activity	Objective	Target Audience
Tupã Dairy Tournament	Milk tournament, focused on dairy producers in the program's area of operation, and aims to reward producers who stand out through the analysis of milk quality.	Milk producers
Good Practices Meeting in Dairy Farming	Annual meeting promoted by GPE Kamby since 2016, which aims to bring knowledge to the dairy production chain in the program's area of operation through lectures.	University students, professors, technicians, extension workers, milk producers, and the general female population.
Activities with Elementary Education Schools	Dissemination of knowledge to elementary school children about the origin of milk, as well as its main derivatives, and presenting a dairy farm in loco.	Children in elementary education
Activities with the Elderly	Dissemination of knowledge to the elderly about the origin of milk, as well as its main derivatives, and presenting a dairy farm in loco.	Extension programs that serve the elderly, milk and cheese producers
Activities with Rural Producers to Improve Properties	Dissemination of knowledge on good practices in dairy farming, which can have different approaches, such as sanitary, feeding, milking management, to meet specific demands.	University students, technicians, extension workers, milk producers, and the general population.
Dissemination of Material in Apps and Social Media	Dissemination of content related to dairy farming in apps and social media to provide knowledge updates.	University students, technicians, extension workers, milk producers, and the general population.
Conducting "Lives" to Meet Producers' Demands	Conducting live sessions on social media with agents from the dairy chain addressing dairy farming content to provide knowledge updates.	University students, technicians, extension workers, milk producers, and the general population.
Distribution of the Good Practices Handbook in Dairy Farming	Distribution to dairy producers of a handbook with the main guidelines on the process of good milking practices in dairy farming.	Milk producers

Extension Activity	Objective	Target Audience
Kamby Extension Program	Improve dairy production in the Tupã region, both in quantitative and qualitative aspects of the produced milk, through the dissemination of knowledge and exchange of experiences with the target audience	Rural producers, municipalities, companies, unions, Higher Education Institutions, Elementary Schools, dairy industry, associations, cooperatives, extension institutions
Management of Reproductive Indicators – Kamby: Disseminating Data and Knowledge	Carry out data management and knowledge dissemination actions with dairy producers in the Tupã region, served by the +Pecuária Brasil Program, aiming to improve reproductive indices on the property and assist in decision making	Milk producers

Source: Prepared by the authors (2024).

The extension activities conducted by the Kamby Group, directly and indirectly, impact the various agents operating in the dairy production chain. This aspect is favored by the diversity of the proposed extension activities' profiles. Box 3 presents the relationships for each extension activity, along with the classification by type and the involved participating agents.

Box 3 – Extension Activities and Their Classification by Type and Participating Agents

Extension Activity	Type of Extension Activity				Involved Agent Participants									
	Event	Course	Program	Project	Rural Producer (PR)	City Hall (P)	Company (E)	Union (S)	Higher Education Inst. (IES)	Elem. Ed. Inst. (EEI)	Dairy Industry (L)	Associations (A)	Cooperatives (C)	Extension Inst. (IE)
Kamby Extension Program			x		x	x	x	x	x	x	x	x	x	x

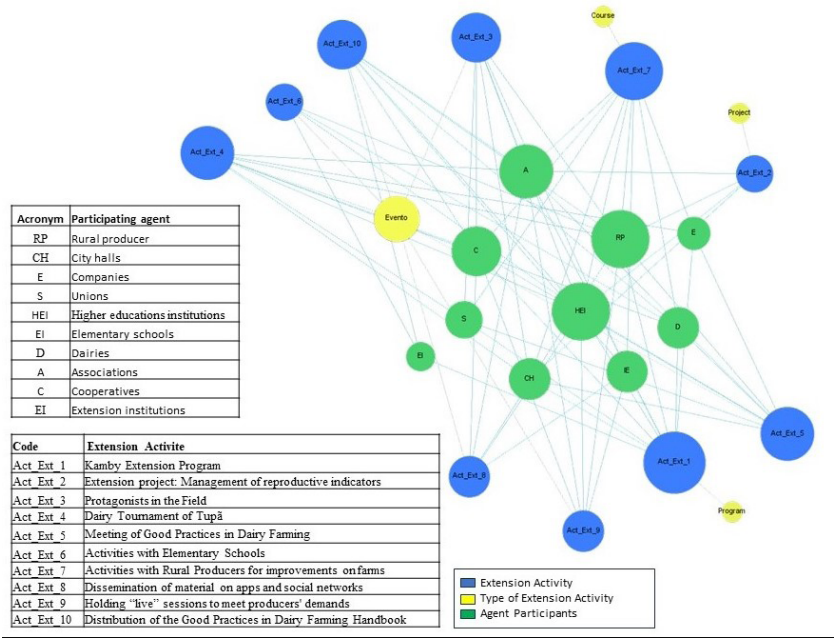
Management of reproductive indicators – Kamby: disseminating data and knowledge				x	x	x			x			x		
Field Protagonists	x				x	x		x	x			x	x	x
Tupã Dairy Tournament	x				x	x	x	x	x		x	x	x	
Meeting of Best Practices in Dairy Farming	x				x	x	x	x	x		x	x	x	
Activities with Elementary Education Schools	x				x				x	x	x			
Activities with Rural Producers for property improvements		x			x	x	x	x	x		x	x	x	x
Dissemination of material in apps and social media	x				x				x			x	x	x
Conducting "lives" to meet producer demand	x				x				x			x	x	x
Distribution of the Best Practices in Dairy Farming Handbook	x				x				x	x	x	x	x	x

Source: Prepared by the authors (2024).

To illustrate the relationships between extension activities, the type of extension activity, and the participating agents, the theory of networks, derived from Social Network Analysis (ARS), was employed. ARS is a research method in the field of applied social sciences that aims to understand the relationships between various interconnected or intra-connected actors (Mollo Neto, 2015). The construction of networks was conducted using Gephi® software version 0.10.0.

Thus, Figure 6 presents the relationships between extension activities (in blue), the type of extension activity (in yellow), and the participating agents (in green). The size of the node (circle) represents the level of interaction, with larger nodes indicating greater representativeness (Maciel, 2018).

Figure 6 – Relationship of Extension Activities Conducted by the Kamby Group, Type, and Participating Agents



Acronym	Participating agent
RP	Rural producer
CH	City halls
E	Companies
S	Unions
HEI	Higher educations institutions
EI	Elementary schools
D	Dairies
A	Associations
C	Cooperatives
EI	Extension institutions

Code	Extension Activite
Act_Ext_1	Kamby Extension Program
Act_Ext_2	Extension project: Management of reproductive indicators
Act_Ext_3	Protagonists in the Field
Act_Ext_4	Dairy Tournament of Tupã
Act_Ext_5	Meeting of Good Practices in Dairy Farming
Act_Ext_6	Activities with Elementary Schools
Act_Ext_7	Activities with Rural Producers for improvements on farms
Act_Ext_8	Dissemination of material on apps and social networks
Act_Ext_9	Holding "live" sessions to meet producers' demands
Act_Ext_10	Distribution of the Good Practices in Dairy Farming Handbook

Source: Prepared by the authors (2024).

In observation of Figure 6, it is noted that extension activities present themselves in four types: program, event, course, and project. The nature of Kamby's history made it evolve into a program, advocating long-term actions in the dairy production chain. Although not visible due to the theoretical classification of extension activities, the extension activities conducted derive from the Kamby Group, which serves as the guiding line of extension activities. Thus, extension activities of event (70%), course (10%), and project (10%) profiles are conducted.

All these activities impact all agents involved in the dairy production chain, with rural milk producers (the main subject of the activities) and university students being 100% involved in extension activities. It is noteworthy that students are active agents of transformation, planning, organizing, and executing extension activities, allowing the

Kamby Group to contribute to the curricularization of extension, which became mandatory for undergraduate courses starting in 2023 (Brasil, 2018). Other significant agents in the conducted extension activities are cooperatives (90%), associations (80%), and dairy industries (60%), which present themselves as the main beneficiaries of the product generated by producers. The relationship between these links is important, as the legislation IN 76 and 77 (Mapa, 2018a, 2018b), which came into force in May 2019, introduced changes regarding the minimum quality standards required and the establishment of penalties in case of non-compliance. At this point, fostering relationships between these agents is essential for the competitiveness of the chain.

Agents such as city halls and extension institutions enhance the conducted extension activities, mainly by sometimes playing the role of a motivational link between the rural producer and the proposed activities. Partnerships between the government and extension projects are an option in seeking sustainable solutions for local and regional problems and reducing socio-economic inequalities (Lopes *et al*., 2013). Finally, elementary schools are an important means to demonstrate the importance of the chain and demystify false concepts attributed to milk.

Science has in its essence the search for solving a problem, often carried out through the systematization of knowledge, which is observed, identified, categorized, explained, and then theories are formulated for explanation and solution. In this scenario, sometimes dairy producers, associations, cooperatives, city halls, and extension institutions contacted the Kamby Group to present problems and request support in finding a solution.

The problems brought by these dairy chain agents are real problems arising from society that motivate research in seeking a solution. It is interesting to note that sometimes the solution to the problem does not only go through the theoretical solution but through conducting a set of actions, which sometimes involve various extension activities. Box 4 presents the relationship between extension activities, research lines, the level of research developed, and whether there is also a relationship with teaching.

Box 4 – Extension Activities and Their Relationships with Research Lines, Level of Research Developed, and Teaching

Extension Activity	Research Link			Teaching Link	Research Line		
	G	M	D		LP 1	LP 2	LP 3
Kamby Extension Program	x	x	x	x	x	x	x
Management of reproductive indicators - Kamby: disseminating data and knowledge	x	x	x	x	x	x	x
Protagonists in the Field					x		x
Dairy Tournament of Tupã					x		x
Meeting of Good Practices in Dairy Farming				x	x	x	x
Activities with Elementary Schools	x			x	x	x	x
Activities with Rural Producers for improvements on farms	x			x	x	x	
Dissemination of material on apps and social networks		x	x	x	x	x	x
Holding "live" sessions to meet producers' demands		x	x	x	x	x	x
Distribution of the Good Practices in Dairy Farming Handbook		x		x	x	x	x

Source: Prepared by the authors (2024). Legend: G – undergraduate, M – master's, D – doctorate, LP – Research Line

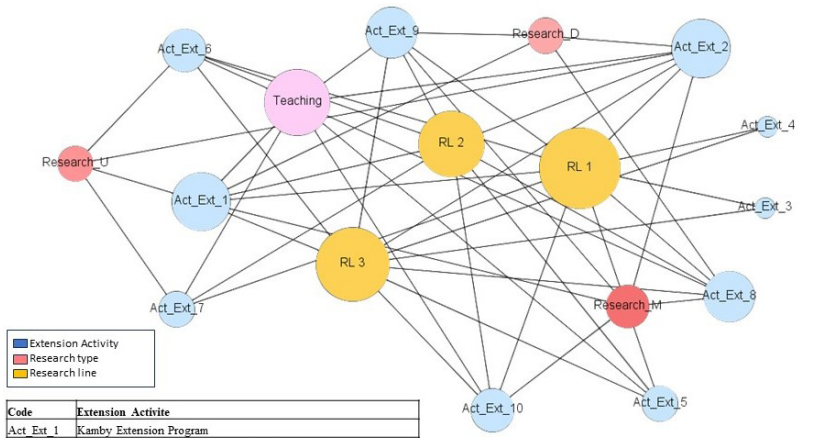
In this context, Figure 7 depicts the network of extension activities conducted by the Kamby Group, relating to research lines (in yellow), research level developed (in red), and teaching (in pink). The size of the node (circle) represents the level of interaction, with larger nodes indicating greater representativeness (Maciel, 2018).

It is observed in Figure 7 that the research actions conducted by the Kamby Group involve its three research lines. Research Line 1, good manufacturing practices and milk quality, stands out for having repercussions in all extension activities, while Research Line 3, dairy production chain management, and Research Line 2, ambience, and dairy farming 4.0, have repercussions in 90% and 80% respectively. This fact demonstrates an appropriate alignment of extension activities to face and solve problems identified in society.

The research development occurs at various levels proposed by the University, with research at the undergraduate level (scientific initiation), master's, and doctorate levels.

Sometimes, the problems for their solution do not only require research and the action of the researcher but teaching how to act and creating a culture towards the problem so that it does not happen again. Therefore, teaching has significant importance among the extension activities conducted by the Kamby Group, linked to 80% of activities and resulting in the inseparable teaching-research-extension triad.

Figure 7 – Relationship Between Extension Activities of the Kamby Group with Research Lines, Research Level, and Teaching



Code	Extension Activite
Act_Ext_1	Kamby Extension Program
Act_Ext_2	Extension project: Management of reproductive indicators
Act_Ext_3	Protagonists in the Field
Act_Ext_4	Dairy Tournament of Tupã
Act_Ext_5	Meeting of Good Practices in Dairy Farming
Act_Ext_6	Activities with Elementary Schools
Act_Ext_7	Activities with Rural Producers for improvements on farms
Act_Ext_8	Dissemination of material on apps and social networks
Act_Ext_9	Holding "live" sessions to meet producers' demands
Act_Ext_10	Distribution of the Good Practices in Dairy Farming Handbook

Acronym	Meaning
LP 1	Research line 1 – Good manufacturing practices and milk quality
LP 2	Research line 2 – Dairy farming 4.0
LP 3	Research line 3 – Management of the dairy production chain
Research_U	Undergraduate research
Research_M	Master's research
Research_D	Doctorate research

Source: Prepared by the authors (2024).

Thus, every extension activity conducted generates an impact on society, whether in isolation or when linked to the research or teaching tripod. Box 5 presents how extension activities relate to the impacts generated for society.

Box 5 – Extension Activities and the Type of Impact Generated for Society

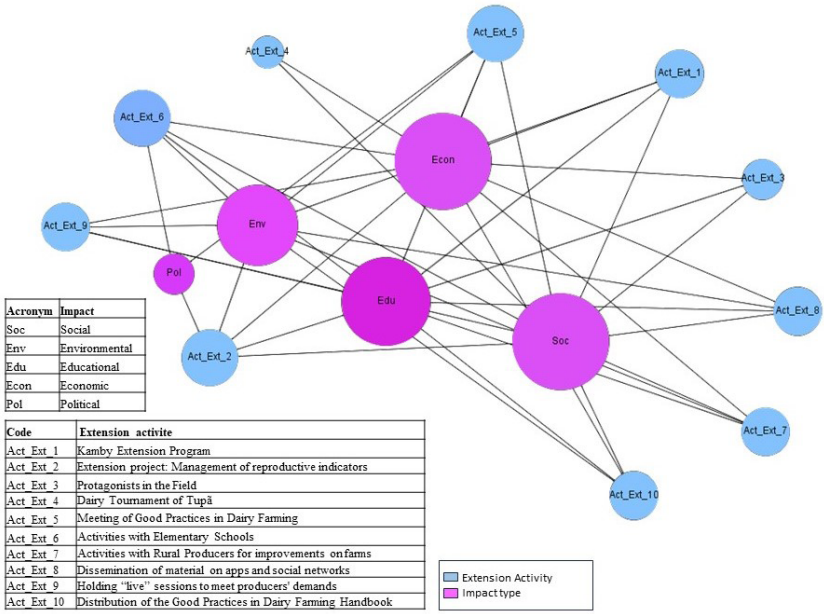
Extension Activity	Type of Impact				
	Social	Environmental	Economic	Political	Educational
Kamby Extension Program	x	x	x		x
Reproductive Indicators Management – Kamby: Disseminating Data and Knowledge	x	x	x	x	x
Protagonists in the Field	x		x		x
Tupã Dairy Tournament	x		x		
Good Practices in Dairy Farming Meeting	x	x	x	x	x
Activities with Elementary Schools	x	x	x	x	x
Activities with Rural Producers for Property Improvements	x	x	x		x
Dissemination of Material in Apps and Social Media	x	x	x		x
Conducting "Lives" to Meet Producer Demand	x	x	x		x
Delivery of the Good Practices in Dairy Farming Handbook	x	x	x		x

Source: Prepared by the authors (2024).

Figure 8 illustrates through the network how extension activities (in blue) act on various types of impact (in purple). The size of the node (circle) represents the level of interaction, with larger nodes indicating greater representativeness (Maciel, 2018).

It is noted that the economic impact has the greatest representativeness, followed by the social and educational impact. The representativeness of these impacts is explained by the nature of the Kamby Group, which seeks to improve the quality and quantity of milk produced. Quality improvement is directly associated with the social and educational aspect, while quantity concerns the economic aspect. Along with this, there is an awareness of the environmental impacts of activities and the political actions that are developed.

Figure 8 – Extension Activities of the Kamby Group and Types of Impact



Acronym	Impact
Soc	Social
Env	Environmental
Edu	Educational
Econ	Economic
Pol	Political

Code	Extension activite
Act_Ext_1	Kamby Extension Program
Act_Ext_2	Extension project: Management of reproductive indicators
Act_Ext_3	Protagonists in the Field
Act_Ext_4	Dairy Tournament of Tupã
Act_Ext_5	Meeting of Good Practices in Dairy Farming
Act_Ext_6	Activities with Elementary Schools
Act_Ext_7	Activities with Rural Producers for improvements on farms
Act_Ext_8	Dissemination of material on apps and social networks
Act_Ext_9	Holding "live" sessions to meet producers' demands
Act_Ext_10	Distribution of the Good Practices in Dairy Farming Handbook

Source: Prepared by the authors (2024).

Finally, as previously described, the Kamby Group acts towards SDGs 2, 8, and 12. The extension activities promoted by the Kamby Group relate to these SDGs, generating a positive impact on society. Box 6 depicts how extension activities relate to the SDGs.

Box 6 – Relationship of Extension Activities to the SDGs of Kamby Group's Operation

Extension Activity	SDG 2	SDG 8	SDG 12
Kamby Extension Program	x	x	x
Reproductive Indicators Management – Kamby: Disseminating Data and Knowledge	x	x	
Protagonists in the Field		x	
Tupã Dairy Tournament	x	x	
Good Practices in Dairy Farming Meeting	x	x	x

Activities with Elementary Schools			x
Activities with Rural Producers for Property Improvements	x	x	x
Dissemination of Material in Apps and Social Media	x	x	x
Conducting "Lives" to Meet Producer Demand	x	x	x
Delivery of the Good Practices in Dairy Farming Handbook	x	x	x

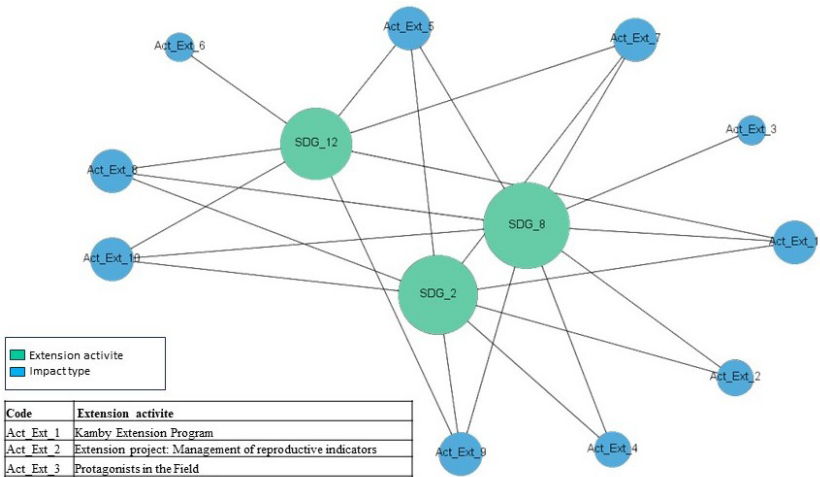
Source: Prepared by the authors (2024).

Figure 9 illustrates through the network the extension activities of the Kamby Group (in blue) and the SDGs (in green). The size of the node (circle) represents the level of interaction, with larger nodes indicating greater representativeness (Maciel, 2018).

It is observed through Figure 9 that the achievement of the SDGs is carried out in various ways through extension activities, with a slight superiority in the representativeness of SDG 8 (responsible consumption and production) over SDG 2 (zero hunger and sustainable agriculture) and SDG 12 (decent work and economic growth).

When confronted with the SDGs developed by PGAD, there is synergy with those conducted by the Kamby group. PGAD has a high performance in SDGs 2 and 12, with SDG 2 also having synergy with SDG 8 (PGAD, 2023). This aspect demonstrates the strategic alignment of the proposed actions between the Kamby group and PGAD.

Figure 9 – Extension Activities of the Kamby Group and Their Relationship with the SDGs



Code	Extension activite
Act_Ext_1	Kamby Extension Program
Act_Ext_2	Extension project: Management of reproductive indicators
Act_Ext_3	Protagonists in the Field
Act_Ext_4	Dairy Tournament of Tupã
Act_Ext_5	Meeting of Good Practices in Dairy Farming
Act_Ext_6	Activities with Elementary Schools
Act_Ext_7	Activities with Rural Producers for improvements on farms
Act_Ext_8	Dissemination of material on apps and social networks
Act_Ext_9	Holding "live" sessions to meet producers' demands
Act_Ext_10	Distribution of the Good Practices in Dairy Farming Handbook

Acronym	Sustainable Development Goal
SDG 2	Zero hunger and sustainable agriculture
SDG 8	Decent work and economic growth
SDG 12	Responsible consumption and production

Source: Prepared by the authors (2024).

Final Considerations

The Kamby Group, in its years of operation, is relevant in generating and disseminating knowledge to rural producers, technicians, researchers, undergraduate and postgraduate students, technical courses, elementary education, and the elderly.

The extension activities conducted allow the target audience to enhance their knowledge of the dairy production chain, aiming to instigate knowledge so that they are also actors in disseminating what they have learned.

Conducting extension at the university is advocated by the inseparability of research and teaching, as demonstrated in this chapter, sometimes the interaction with society is the catalyst for identifying

research problems, and teaching is one of the pillars for disseminating knowledge.

At the postgraduate level, the Kamby Research and Extension Program stands out for inseparably conducting its activities concerning teaching-research-extension. This collective construction is complex and involves the employment of various areas of knowledge and wisdom, in an interdisciplinary process that promotes results directly impacting society, specifically the agents operating in the dairy production chain.

Thus, conducting extensions related to the Kamby Group helps overcome problems arising from society and positively impacts economic, social, educational, environmental, and political aspects.

Finally, the contribution to society reflected by the Kamby Group with the United Nations Sustainable Development Goals is highlighted, promoting extension activities aligned with research and teaching for responsible consumption and production (SDG 8), achieving zero hunger and sustainable agriculture (SDG 2), and decent work and economic growth (SDG 12).

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Chapter 15

Contributions of the Research Group in Management and Environmental Education to Interdisciplinary Dialogue and Socio-environmental Training in the Postgraduate Program in Agribusiness and Development

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Introduction

The relationship between society and nature, characterized by socio-environmental complexity, has been conflictual since the beginning of humanity, resulting in various sociocultural relationships and forms of knowledge that each society assumes as a stance towards nature (Morales, 2012). However, it was during the Industrial Revolution and its effects that the environmental crisis was established, marking the 20th century with socio-environmental emergency (Souza, 2022; Morales, 2012).

In this context, between the boundaries of modernity and post-modernity, through modern science, attention is directed to new forms of re-signification of the world, from the perspective of the construction, reconstruction, and integration of sciences that redefine interpretations of the relationship between society and nature, through the field of knowledge production, educational practices, management, and politics itself (Morales, 2012).

Thus, under the aspects of discussion of management and environmental education in the context of complexity, the Research Group in Management and Environmental Education (PGEA) was born in mid-2011 at the São Paulo State University "Júlio de Mesquita Filho" (UNESP)[7], Tupã campus, with undergraduate students in Administration. And, in 2012, research was initiated aimed at the inclusion of environmental education in the processes of the Environmental Management System in agro-industries of the far west of São Paulo and the dialogues established with relevant public bodies. This research, funded by the National Council for Scientific and Technological Development (CNPq) - Universal Call - involved thematic areas of management, environmental education, and communication, from an interdisciplinary perspective. Since then, the PGEA has initiated its interdisciplinary movement through this scientific investigation from 2012 to 2014, which began to add different areas, enhancing interdisciplinarity. Also, as a result of an interdisciplinary dialogue, with an even broader group of teachers from various fields of

[7] From the period of May/2011 to Dec/2022, the PGEA group was led by Prof. Angélica Gois Morales and Prof. Cristiane Hengler Corrêa Bernardo.

education and research interests, in 2014, the Postgraduate Program in Agribusiness and Development (PGAD) began at the same campus.

Based on Japiassú's (1976) perspective that three aspects: complex problems; urgency for a reorganization of research and concern with the economy, justify interdisciplinary work, the PGAD finds in the PGEA a great ally, in the sense of undertaking interdisciplinary dialogue, seeking solutions to socio-environmental problems that could not be resolved disciplinarily. This dialogue is carried out, mainly, from the interfaces between education, environmental management, and communication, and from these to various other areas that will be presented in this chapter from the master's theses defended at PGAD and which are the result of this dialogical relationship with the research group.

The PGAD is inserted in the interdisciplinary knowledge area of the Coordination for the Improvement of Higher Education Personnel (CAPES), which understands interdisciplinarity as a way of producing knowledge that encompasses theoretical and methodological exchanges, new methodological and conceptual discussions, seeking to meet the complexity and multiplicity of phenomena (CAPES, 2008).

It is precisely based on the characteristics of interdisciplinary research and teaching that the PGAD supports its objectives, which aim at the development of interdisciplinary research that addresses the demands of agribusiness, contributing to socio-economic and environmental development, providing analyses and solutions that promote local, regional, and national development (PGAD, 2023).

Divided into two research lines, one focused on the Competitiveness of Agro-industrial Systems and the other on Development and Environment (in which the PGEA group has more scientific research contributions), the PGAD has, specifically, over these ten years of existence, contributed to the advancement of interdisciplinary knowledge through research that reflects on: - the agro-industrial systems from the perspective of sustainable competitiveness; the heterogeneity of demands on resource use and management; - the formation of networks that can be important channels for the various social agents that act and/or are impacted by the sector,

and, finally, - the formation of professionals who work in interdisciplinary teams capable of solving complex problems in the area.

Given the contribution of the PGAD and the support of the PGEA in collaborative production and postgraduate training, this chapter aimed to present the contributions of the PGEA group to interdisciplinary dialogue in scientific knowledge production constituted in the master's and doctoral courses and the products derived from the PGAD and guided by the leading professors of the PGEA, from the interfaces of management, environmental education, and communication.

For the analyses undertaken in this chapter, the concept of interdisciplinarity conceived by Fazenda (2002) is adopted, which complements Japiassú's (1976) vision and sees interdisciplinarity much more as a personal attitude towards knowledge[8]. This conception understands this concept from a phenomenological perspective, as stated by Fazenda *et al.* (2010), since it is a vision focused on the subjectivity of the subjects, directed towards their experiences and practices; for dialogical action, in short, for an attitude that reaches the dimension of knowing-being.

It is also worth highlighting that this study was supported by a qualitative approach and exploratory and descriptive methods. For this purpose, a documentary survey was carried out in the Institutional Repository of Unesp[9] to verify the theses and dissertations defended at PGAD and guided by the teachers and leaders of the PGEA, which implies demonstrating how the research group under study has contributed to the formation of systemic dialogue between different areas of knowledge in the Postgraduate Program.

The following section addresses the results, covering the trajectory of the PGEA group and its interdisciplinary dialogue with the PGAD, as well as presenting the selected publications and the correlation of the analyzed

[8] According to Satolo *et al.* (2019, p.22), "the interdisciplinary attitude can be summarized as being willing to engage in dialogue; accepting opinions that diverge from the certainties of your field of knowledge; being open to constant learning; understanding your role in the process and that, when faced with a specific problem, you will be more or less demanded, therefore, there is no place for academic vanities."

[9] The scientific productions can be consulted on the website https://repositorio.unesp.br/.

dissertations with the study interfaces and the Sustainable Development Goals (SDGs).

Relations between PGAD and PGEA

The PGEA is linked to the Faculty of Sciences and Engineering (FCE), UNESP, Tupã campus, and interfaces directly with the PGAD through the Development and Environment Research Line, which is part of the interdisciplinary knowledge area of CAPES, offering master's and doctoral courses.

Created in mid-2011, the PGEA is a research group in constant dynamics and evolution, emerging from the interaction between various members of academia and civil society. Formed by people from various fields, it develops studies and research in socio-environmental management and education in both formal and non-formal contexts.

Since the group's formation and with the approval and start of the PGAD in 2014, the PGEA's work aims to expand the training of new researchers, as well as reflect on the process of socio-environmental management and education in various contexts, enabling connections, exchanges, planning, and execution of research and extension projects, which implies the (re)construction of knowledge and increases scientific production in the area. The PGEA group acts in three areas: - training and improvement, with study meetings, offering courses and participating in scientific events, - scientific production, which is more focused on developing research and publishing results, and – extension actions and projects, with scientific dissemination activities and others through the extension project Sala Verde Rede de Educação Ambiental da Alta Paulista (REAP), linked to FCE. Within its dynamics, the group holds biweekly meetings, where scientific articles and seminars are read, in addition to promoting a comprehensive analysis of the educational process aimed at environmental management and education, through an interdisciplinary approach divided into two research lines.

Research Line 1 involves the theoretical-methodological foundations and training in environmental education and is divided into the themes of Training in Environmental Education and Interdisciplinarity as a field of knowledge. Research Line 2 involves environmental management and education and is divided into the themes of social management analysis and socio-environmental education in organizations, environmental public policies, environmental communication, the relationship between agroecology and environmental education, and waste management, among other topics (FCE, 2023).

Therefore, this research group explores educational challenges in various spheres, and this perspective allows for the creation of numerous connections, encouraging the sharing of ideas and the development of research and extension projects, resulting in the continuous construction of knowledge, which, in turn, drives collaborative scientific production in various fields of knowledge (FCE, 2023). According to Lopez and Barbosa (2019), interdisciplinarity in higher education requires dialogue about the transformations of educational paradigms, which involve political and, mainly, methodological issues, making the PGEA and PGAD partners in this interdisciplinary endeavor.

Considering the necessary character of interdisciplinary work and the fact that knowledge cannot be produced alone, the research group has established different partnerships along its journey, strengthening ties with private and public institutions and projects, including the Rede de Educação Ambiental da Alta Paulista (REAP).

Through joint actions, the PGEA and REAP seek to promote, strengthen, and tighten relationships with civil society, Non-Governmental Organizations (NGOs), and public and private institutions in the Alta Paulista region, with the collaboration of undergraduate, master's, and doctoral students from FCE. The students involved in these actions represent different backgrounds and play a fundamental role in building interdisciplinary dialogues and reflections in the proposed approaches. This collaborative partnership is a commitment by the research group to translate scientific knowledge into concrete actions, strengthening the link between public universities and society.

During the journey of the PGEA group, other actions were included in the activities developed, such as Environment Week, Environmental Lecture Series, Research Integration, Career Fair, and Monthly Lives that disseminate socio-environmental research, tightening relationships with REAP and PGAD itself, based on the developed research. All these actions contribute to environmental education and scientific dissemination, taking the knowledge produced outside the university walls, collaborating with the formation of a scientific culture and decision-making based on evidence. It is worth noting that the highlighted actions are open to the public, both inside and outside academia.

Analysis of Dissertations Guided by PGEA Teachers and Leaders: Selection of Defended Dissertations and Their Relation to the SDGs

The selected publications for analysis were defended between 2016 and 2023, as with the program starting in 2014, the first defenses occurred from 2016 onwards. During this period, the PGEA's leading teachers guided 21 (twenty-one) researchers, with 10 (ten) guided by Prof. Dr. Angélica Góis Morales and 11 (eleven) guided by Prof. Dr. Cristiane Hengler Corrêa Bernardo. It is important to note that the PGAD, which began its activities in 2014, with its first master's course, started its doctoral course in August 2019 (FCE, 2023). Therefore, being a recent course with a duration of four years, few theses have been defended until 2023, and none have been guided by the teachers until now.

The analysis of the documents was carried out through an initial reading of the abstracts, keywords, introduction, and final considerations of each dissertation. It sought to verify how this research relates to the interfaces of management, environmental education, and communication. Box 1 presents a summary of the analyzed documents and for which SDGs[10] the dissertations contribute directly or indirectly.

[10] ODS1 Eradication of poverty; ODS2 Zero hunger and sustainable agriculture; ODS3 Health and well-being; ODS4 Quality education; ODS5 Gender equality; ODS6 Drinking water and sanitation; ODS7 Clean and accessible energy; ODS8 Decent work and economic growth; ODS9 Industry, innovation, and infrastructure; ODS10 Reduction of inequalities; ODS11 Sustainable cities and communities;

Box 1 – Dissertations and Theses Covering the Interfaces of Management, Environmental Education, and Communication

Year	Author	Advisory Committee	Title	SDGs
2016	Caroline P. Manoel	Cristiane H. C. Bernardo; Ana Elisa B. S. Lourenzani and Angélica G. Morales	Technical course in agribusiness at Centro Paula Souza: an analysis of the curriculum structure.	04
2016	Silvia Cristina Vieira	Cristiane H. C. Bernardo; Ana Elisa B. S. Lourenzani and Eduardo G. Satolo	The role of the extension agent in the bilateral flow of information between agribusiness researchers and rural producers.	04; 12 and 17
2016	Vanessa P. X. Satolo	Cristiane H. C. Bernardo; Ana Elisa B. S. Lourenzani and Angélica G. Morales	Interdisciplinarity in two postgraduate programs in agribusiness	04
2016	Carla N. B. Flozi	Angélica G. Morales; Cristiane H. C. Bernardo and Sérgio S. Braga Júnior	Analysis of environmental education in an agro-industry: a case study in the municipality of Guararapes/SP.	04; 09; 12 and 13
2017	Fábio F. dos Santos	Angélica G. Morales; Cristiane H. C. Bernardo and Nelson R. de. Moraes	Communication and environmental education: a content analysis of the magazine XXI Ciência para a Vida da Embrapa.	04; 09 and 17
2018	Juliana C. Bernardes	Cristiane H. C. Bernardo; Ana Elisa B. S. Lourenzani and Lorena C. Fleury	From city to countryside: analysis of the characteristics of the ruralized urban youth	11
2018	Luana F. Pires	Angélica G. Morales; Fernando F. Putti and Sandra Cristina. de Oliveira	Water Footprint as a management tool for water resources: analysis in cassava processing plants of the Rural Development Office of Assis.	12
2019	Cristina V. dos R. Fernandes	Angélica G. Morales; Ana Elisa B. S. Lourenzani and Manoel B. B da Costa	Narratives of family farmers: under an agroecological perspective.	02; 03 12 and 15

ODS12 Responsible consumption and production; ODS13 Action against global climate change; ODS14 Life below water; ODS15 Life on land; ODS16 Peace, justice, and effective institutions; and ODS17 Partnerships and means of implementation (UN, 2023).

Year	Author	Advisory Committee	Title	SDGs
2019	Omar Fernando de Carvalho Júnior	Cristiane H. C. Bernardo; Kássia Watanabe and Eduardo Kawasaki	The correlation between the principle of human dignity and the environment with a focus on sugarcane straw burning.	12
2020	Luiza R. Trisoglio	Cristiane H. C. Bernardo; Andrea R. Scalco and Timóteo R. Queiroz	Social networks as a marketing strategy in the Short Food Supply Chain (SFSC): a case study.	02 and 09
2020	Mara Sílvia R. Ramos	Cristiane H. C. Bernardo; João Guilherme de C. F. Machado and Timóteo R. Queiroz.	The potential of organized groups on social networks for the adoption of innovation in Brazilian livestock: the case of the Brazilian Livestock Group, GPB.	09 and 17
2020	Flávia Eliana de Melo Colucci	Angélica G. Morales; Sandra Cristina. de Oliveira and Pedro Fernando Cataneo	The environmental theme in the undergraduate law course: a focus on curricular environmentalization.	04
2020	Josiane Tamires S. Silva	Angélica G. Morales; Dra. Sandra Cristina de Oliveira and Wanda D. Miotto	Bibliographic and documentary analysis of environmental education in early childhood education in the municipalities of Parapuã and Rinópolis-SP.	04
2021	José H. Ndambuca	Cristiane H. C. Bernardo; Ana Elisa B. S. Lourenzani and Roberto Bernardo	Crossed stories: rural extension in Brazil (from Oiapoque to Chuí) and in Angola (from Cabinda to Cunene).	17
2021	Júlio Martins J. Muhongo	Angélica G. Morales and Ana Elisa B. S. Lourenzani	Application of the IDEA Method for evaluating the sustainability of family farming establishments in the municipalities of Tupã/São Paulo and Ebo/ Cuanza Sul.	02 and 12

Year	Author	Advisory Committee	Title	SDGs
2021	Valquiria Cristina Martins	Angélica G. Morales; Marilia X. Cury and Nelson R. de Moraes	Knowledge and socio-environmental practices in the Vanuíre Indigenous Land: understanding the ethnoknowledge of the Kaingang and Krenak groups.	11 and 15
2022	Jéssica Dayane N. Pessôa	Cristiane H. C. Bernardo; João Guilherme de C. F. Machado and Ricardo C. G. Sant'Ana.	The scientific dissemination strategies of the Agricultural Research Institutes of the state of São Paulo aimed at the rural public.	09; 12 and 17
2022	Monique M. dos Santos	Angélica G. Morales and Roberto Bernardo	NBR ISO 14001:2015 Environmental Management System - analysis of the difficulties for maintenance in a food sector company.	04; 09; 12 and 13
2022	Karina A. Finati	Angélica G. Morales and Rodrigo L. Manzione	Environmental Education in the context of the Aguapeí and Peixe River Basin Committees.	04 and 06
2023	Evelin Aparecida F. P. Miyahara	Cristiane H. C. Bernardo; Roberto Bernardo and Angélica G. Morales	Analysis of the updates to ISO 14001:2015 compared to ISO 14001:2004 in environmental communication in a food and beverage industry.	04; 09, 12 and 13
2023	Luís Fernando P. Pereira	Cristiane H. C. Bernardo; Angélica G. Morales and Luciana F. Leal	The Discourse in "Torto Arado" and SDG 5: female voices enunciate the conflict between society and nature.	05

Source: Prepared by the authors (2023).

It is worth noting that the interdisciplinary research produced in PGAD demonstrates the importance of advisory committees with distinct areas and the relevance of dialogue and systemic reasoning in developing potential solutions for environmental issues (Satolo, 2016). Additionally, they express how organizations can benefit from the conscious management

of natural resources, using communication tools to disseminate their socio-environmental responsibility actions (Flozi, 2016; Santos, 2022). Therefore, developing research within the analyzed interfaces directly contributes to achieving the SDGs broadly.

Analysis of Dissertations Guided by PGEA Teachers and Leaders: Profile of Guided Students and Their Production

Over the ten-year history of the PGAD, numerous interdisciplinary studies and research have been developed. In this regard, this section highlights how the research guided by teachers Angélica Góis Morales and Cristiane Hengler Corrêa Bernardo is related to the interfaces of management, environmental education, and communication. Additionally, it demonstrates how the PGEA, directly or indirectly, has contributed to the interdisciplinary dialogue in the dissertations guided by both teachers, considering that most of the postgraduates mentioned here were or are active members of the PGEA.

The mission of the PGAD is to develop interdisciplinary research and train human resources for high-quality scientific research and teaching, capable of acting in public and private institutions, anticipating the demands and problems of agribusiness, contributing to socio-economic and environmental development, and providing analyses and solutions to enhance its competitiveness and regional and national development (PGAD, 2023). Thus, concerning studies on agribusiness, it is worth noting that it is an interdisciplinary and fruitful field of investigation in the areas of education and environmental management, with communication as a tool for disseminating scientific knowledge and as a fundamental theoretical contribution to understanding how relationships between society and nature are established. It is also worth noting that in the PGAD, there is a mandatory course "Construction of Interdisciplinary Knowledge" in which the two teachers jointly teach, and two optional courses, "Society and Nature Relationship" and "Scientific Dissemination," under the responsibility of Prof. Angélica and Cristiane, respectively, which permeate their areas of academic training and work in the PGEA and PGAD groups.

To identify the areas of knowledge that encompass the training of the graduates and students guided by the teachers and leaders of the PGEA, Figure 1 portrays the profile of postgraduate students.

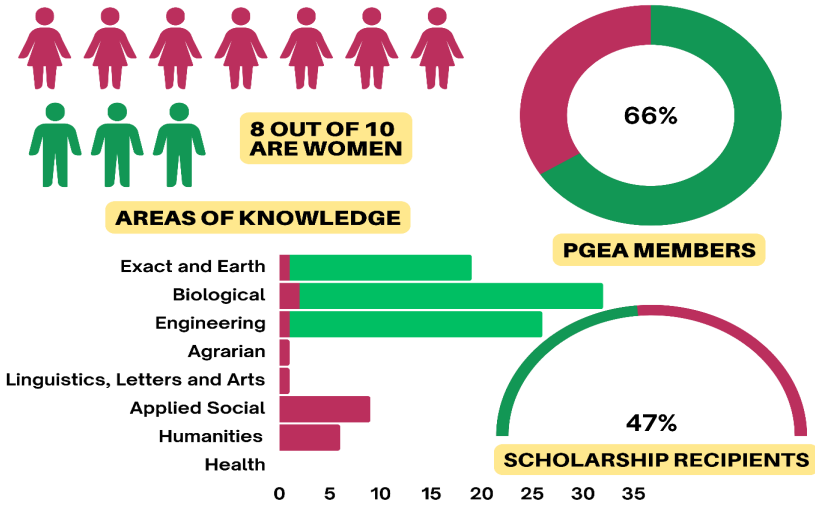
Of the 21 researched, 76% were conducted by women and 24% by men. Of this amount, 47% of postgraduate students received scholarships to develop their research. According to the United Nations Educational, Scientific and Cultural Organization (Unesco), in the fields of science and culture, there is a gender disparity; data show that women represent only 30% of scientists worldwide (Unesco, 2019). In this sense, it is possible to highlight that the PGEA has contributed to the inclusion of more women in research.

Another highlighted point is related to the areas of knowledge (figure 1), as there is heterogeneity in the students' training. Among the professional areas are training in veterinary medicine; environmental management; social communication/journalism; biology; environmental engineering; pedagogy; administration; law; philosophy; geography; architecture and urbanism, and literature. This heterogeneity occurs because the PGAD is an interdisciplinary program and, therefore, receives postgraduate students whose training is in the most varied areas of knowledge.

In this research, the active members of the PGEA were also verified. Of the 21 students and graduates guided by teachers Angélica Góis Morales and Cristiane Hengler Corrêa Bernardo, 66% were or are part of the PGEA. It is important to clarify that only members who are officially registered with the National Council for Scientific and Technological Development (CNPq) and had active participation in PGEA activities were considered. From the analysis of the keywords of the analyzed dissertations, the wide variety of themes studied in PGAD is perceived (Figure 2).

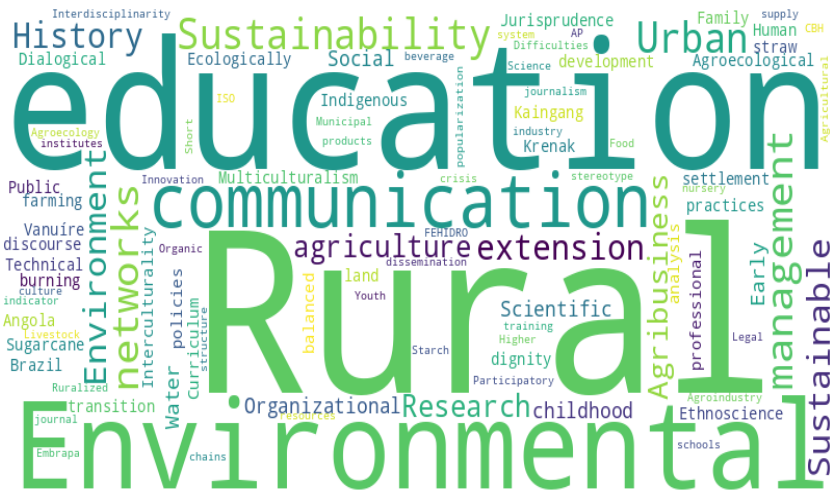
The mapping carried out refers to the themes used for the development of the 21 analyzed dissertations. As evidenced in Figure 2, the words environmental, education, rural, communication, and sustainability stand out. It is observed that the occurrences presented in the dissertations are very close. This fact corroborates the idea that the research is aligned with the interfaces of the PGEA. Thus, the following presents the categories of analysis of the productions, the dialogues established between them, and their interfaces with the SDGs.

Figure 1 – Profile of PGAD Students and Graduates Guided by PGEA Teachers and Leaders



Source: Prepared by the authors (2023).

Figure 2 – Word Cloud of Analyzed Dissertations



Source: Prepared by the authors (2023).

Environmental Management (ISO 14001)

Environmental management comprises the guidelines and administrative activities carried out by an organization to achieve positive effects on the environment, to reduce, eliminate, or compensate for the environmental problems arising from its operations, and to prevent others from occurring in the future (Barbieri, 2016). Thus, among the works carried out, Flozi's (2016) research aimed to analyze how environmental education is embedded in the organizational structure of an agro-industry in the municipality of Guararapes/SP. The author highlights the development of actions such as training and lectures on environmental education developed by the management of the studied agro-industry and demonstrates a direct relationship between management and environmental education in the business context.

Furthermore, Flozi's (2016) work relates to the studies conducted by Santos (2022) and Miyahara (2023). With the objective of "analyzing the difficulties encountered by a food sector company in maintaining an Environmental Management System (EMS), according to the requirements of the ABNT NBR ISO 14001:2015 standard," Santos' (2022) research highlighted the challenges faced since the certification ABNT NBR ISO 14001:2015 implementation. The author highlighted various environmental management and education activities carried out by the studied company. Additionally, according to the research results, the challenges of maintaining EMS involve the three studied interfaces.

Moreover, Miyahara (2023, p. 15) investigated "how a food and beverage industry faced the update of the ABNT NBR ISO 14001:2015 certification compared to ISO 14001:2004, concerning environmental communication". The author highlighted the importance of organizational communication flow during the implementation of certification updates, involving management and environmental education strategies. Thus, the research contributes to the three interfaces under analysis.

Environmental Education: Scientific Dissemination, Teaching and Curriculum, Water Resources, and Ethnoconknowledge

Environmental education, conceived as a process of continuous and interdisciplinary training at all levels of education, is essential for building values, knowledge, and skills aimed at environmental conservation and promoting sustainability. The National Environmental Education Policy (PNEA), established by Law 9.795/99, and the National Environmental Education Program (ProNEA) emphasize the universality of this right, guaranteeing democratic access to environmental information (Brasil, 1999).

In the formal education context, various researchers highlight the importance of integrating Environmental Education interdisciplinarily in curricular subjects. The interconnection between communication and environmental education is explored by Santos (2017) in scientific dissemination, promoting awareness and social transformation. Silva (2020) focuses on early childhood education, Manoel (2016) on technical Agribusiness education, and Colucci (2020) on the undergraduate law course, emphasizing the need for interdisciplinary practices to develop critical thinking regarding environmental issues.

In the academic context, Satolo's (2016) research investigates postgraduate programs in Agribusiness, highlighting the importance of an interdisciplinary approach to understand the complexity of this field. Environmental education is addressed by Finati (2022) in river basin committees, emphasizing the relevance of a critical approach to participatory water resources management. Flozi's (2016) research analyzes the incorporation of Environmental Education in an agro-industry, evidencing practical application and internal training activities for awareness.

Finally, Martins' (2021) study portrays the ethnoknowledge of the indigenous Kaingang and Krenak groups, highlighting the importance of respecting traditional knowledge and preserving valuable socio-environmental practices.

In summary, the interdisciplinary approach to environmental education, supported by the PNEA and ProNEA, permeates various educational contexts and research practices. This approach is crucial for developing critical thinking, reflection, awareness, and sustainable actions concerning the environment, strengthening participatory management and promoting the appreciation of traditional knowledge.

Communication and Its Interfaces: Scientific Dissemination, Rural Extension, Culture, Law, and Marketing

According to Vilalba (2006, p.05), communication is "a word derived from the Latin term communicare" and means "to make common", or "to associate". Thus, at first, we can say that communicating is the social action of making common".

Due to its relevance, communication is the subject of many research studies, as it plays a determining role in the development of scientific research, directly influencing the object of study and problematization (Bernardo, 2014). Thus, among the analyzed researches in the field of communication, there are the studies of Vieira (2016), Santos (2017), Ramos (2020), Trisoglio (2020), and Pessôa (2022). Besides communication, the researchers share the development of the rural context as a backdrop.

However, the field of communication was also observed in the researches of Satolo (2016), Flozi (2016), Bernardes (2018), Martins (2021), Santos (2022), and Finati (2022). Communication occurs in interfaces with other areas of knowledge, providing specific knowledge, as highlighted by Braga (2004). An example is Finati's (2022) research, which had environmental education as a field of study, but also interfaced with the field of communication by addressing the importance of activity in the participatory governance of river basin committees. This articulation between areas occurs mainly in interdisciplinary research, providing new reflections and expanding scientific knowledge.

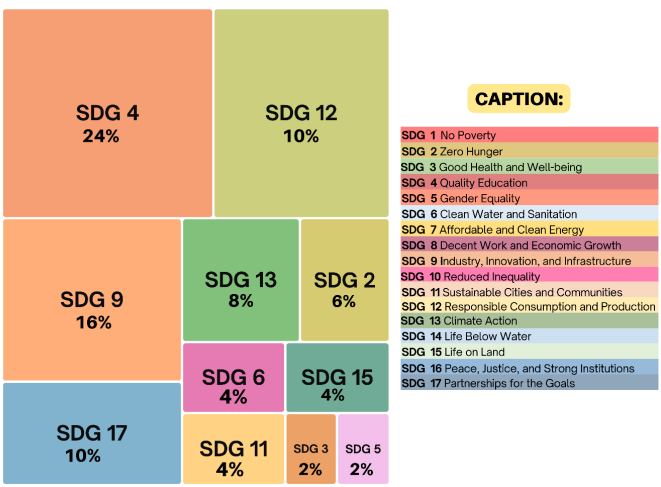
As presented in the previous topics, among the productions originating from PGAD, it is noteworthy that six (06) are related to the interface of

environmental management, twelve (12) to environmental education, and eleven (11) to communication. It is important to highlight that the studies interface with more than one of the investigated areas. Additionally, the studied themes demonstrate PGEA's connection with the development of interdisciplinary research in PGAD and contribute to the SDGs.

In recent years, the United Nations (UN), through the 2030 Agenda, proposed a global pact for sustainable development, aiming to ensure human development by meeting society's basic needs through a political, economic, and social process that respects the environment and sustainability (UN, 2015). Additionally, the 2030 Agenda encompasses 17 SDGs. Figure 3 demonstrates the established dialogues between dissertations and the SDGs.

According to the Times Higher Education (THE) International Research Institute, UNESP is part of the ranking that points to universities most aligned with the SDGs, and PGAD, together with PGEA, has greatly contributed to the development of research that collaborates to achieve the goals proposed by the 2030 Agenda (THE, 2020).

Figure 3 – Established Dialogues between Dissertations and SDGs



Source: Prepared by the authors (2023).

Final Considerations

This chapter, aimed at presenting the contributions of PGEA to interdisciplinary dialogue in scientific knowledge production, constituted in the master's and doctoral courses and products derived from PGAD and guided by PGEA's leading professors, provided an overview of the establishment of dialogical relationships, both in PGAD and within the PGEA group itself. Additionally, it sought to verify how these researches relate to the interfaces of management, environmental education, and communication.

This scenario allowed observing that the three interfaces were contemplated, sometimes between two perspectives and in some cases in all three. However, research was also observed that indirectly passes through one of the three interfaces and relates to other themes, including health, worker dignity, marketing, culture, rural appreciation, technical education, and postgraduate teaching and research.

It is worth highlighting that the research that interfaces between environmental management, education, and communication stems from an open space for interdisciplinary dialogue. A space where, besides the willingness for dialogue, there is also, inherently, the program itself located in CAPES' Interdisciplinary Chamber, and therefore, from the selection, it not only allows but encourages the admission of professionals from the most varied fields of knowledge. Additionally, the requirement for advisory committees also stimulates these interfaces to be possible.

Finally, it is concluded that the interaction between PGAD and PGEA offers the necessary resources and support for advanced research, allowing postgraduate students to deepen their understanding in various fields and contribute to the expansion of knowledge in a truly interdisciplinary manner. Through collaboration, students from different academic backgrounds create a fertile environment for exchanging ideas, perspectives, and approaches. They challenge traditional boundaries of disciplines, fostering innovation and solving complex problems that often transcend conventional knowledge barriers.

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Remissive Index

Book Organizers

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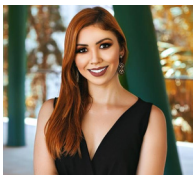

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The work that I have the pleasure of writing the preface for represents the consolidation of the efforts of the group of Professors and Researchers of the Graduate Program in Agribusiness and Development (PGAD) of the São Paulo State University in the Tupã Campus. The reader should not be mistaken if they think that this is a hermetic work aimed at an audience restricted to the academic environment. Upon reading the material, I understood its usefulness for defining public policies aimed at agriculture, agroindustry and regional development, as well as for formulating private strategies, whether for rural producers and agroindustries or for collective entities such as cooperatives and associations of producers. In addition, I believe that the chapters that make up the work can attract the attention of the general public interested in contemporary issues involving the environment, social organization and the governance of complex organizations.

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