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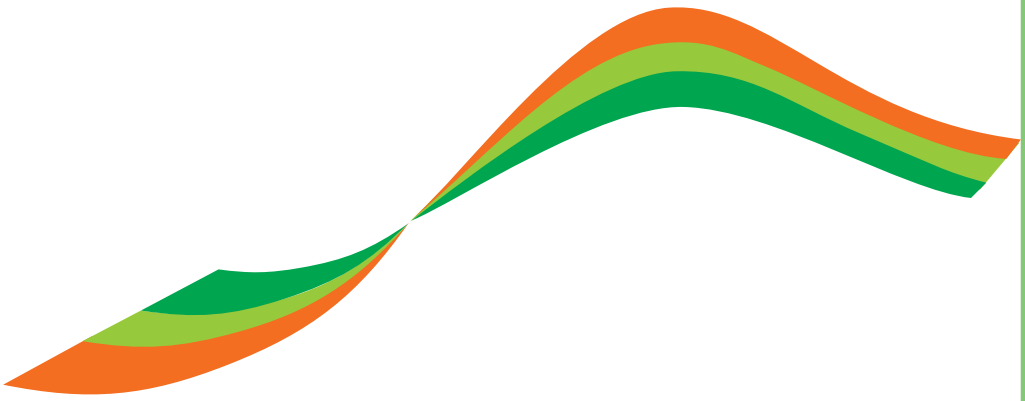

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ECONOMIA AGRO-ALIMENTARE
Food Economy

(Rivista fondata da Fausto Cantarelli)

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Sommario

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Editorial for the Issue 1/2025

Valeria Borsellino[a], Søren Marcus Pedersen[b], Giovanna Bertella[c], Luca Cacciolatti[d], Nicola Cantore[e], Alessandra Castellini[f], Alessio Cavicchi[g], Fabio A. Madau[h]

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We are happy to introduce our journal's first issue of volume 27. This issue is the first entirely managed by the editorial board, whose composition was finalized by SIEA in October 2024.

This issue contains six regular articles, all written in English. The articles cover various topics related to the agri-food sector, spanning geographical areas in Europe (Italy and Croatia), South America (Brazil), and Asia (Indonesia and Thailand). The authors are affiliated with Institutions based in Brazil, Croatia, Greece, Indonesia, Italy, Portugal and Thailand. While addressing different issues and disparate geographic contexts, the contributions collectively offer a rich and nuanced overview of the current dynamics of the agribusiness sector globally. Following the tradition of this journal, the papers range from rigorous quantitative analyses to in-depth qualitative studies, providing useful insights for researchers, practitioners and policymakers.

We open this issue with an interesting study conducted by Hani, Muhlison, Saputra, Yulianto, Ilman Widuri, Kustiawan Alfarisy and Yanuarti in Jember region, Indonesia, entitled "Strategy for Accelerating the Environmentally Friendly Use of Gamal Leaves as Forage Feed Additives with in Location-Specific Insights in Jember". This research explores the potential for accelerating the production and adoption of environmentally

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friendly, location-specific Gamal leaf fertilizers. Through the application of a Business Model Canvas and SWOT analysis, the paper identifies six significant internal forces that represent potential areas of professional and business development in the local context, from leaf processing equipment management to Gamal enhancement in livestock feed to farmer group leadership and product durability.

The second paper, "Simultaneous Equation of Concentration, Efficiency, and Competitiveness of Indonesia's CPO Industry: Impacts and Policies", by Ariodillah Hidayat, Bernadette Robiani, Taufiq Marwa, Suhel, Didik Susetyo, Mukhlis, Imam Asngari analyzes, through econometric models, the concentration, efficiency, and competitiveness of Indonesia's Crude Palm Oil (CPO) industry, a key sector for the country's economy. The results show a negative correlation between technical efficiency and industry concentration, as measured by CR4 (Four Firm Concentration Ratio), and a positive relationship between industry concentration and competitiveness, suggesting that more efficient firms tend to dominate the market, which in turn may foster competitiveness.

Moving to Thailand, the third paper, "Factors affecting economic profits of stocker cattle farming business in Sakon Nakhon, Thailand", by Chanoknan Srilapat, Thanada Konkan, Narawut Rapankum analyzes factors affecting the profitability of stocker cattle farmers in Sakon Nakhon province. Through a survey of 390 breeders and the use of descriptive statistics and binary logistic regression, the research identifies five significant factors that influence economic profits: membership in trade associations, herd size, feed and labor costs, and sale price.

The fourth paper, titled "Innovative behavior of family farmers in Brazil in the face of innovations in the agricultural sector", by Luis Felipe Dias Lopes, Silvana Bortoluzzi Balconi, Raquel Dalvit Flores, Martiele Gonçalves Moreira, Deoclécio Junior Cardoso da Silva, Rayssa Cleide de Oliveira, Daniela Pegoraro, Gilnei Luiz de Moura, Daniel Knebel Baggio, Adriane Fabricio, Joana Vieira dos Santos, explores the relationship between participatory leadership, external contacts and innovative outcomes in the rural agricultural context. The study, which distinguishes between organic and conventional farms, uses a quantitative approach with Likert scales and structural equation models (PLS-SEM) to analyze how shared leadership and external interactions influence innovation capacity on farms.

The fifth contribution, "Understanding consumers' willingness to use omega-3 enriched eggs", by Marina Tomić Maksan, Željka Mesić, Branka Šakić Bobić, Damir Kovačić, Andreas C. Drichoutis focuses on consumer behavior in the market for omega-3 enriched eggs. Applying the Health Belief Model, the research examines how consumers' perceptions of barriers, benefits, efficacy, susceptibility and severity of certain health conditions,

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as well as action cues, influence their willingness to purchase and consume functional eggs.

Finally, in the sixth paper, titled "Incorporating social dimensions and sustainable marketing into an agri-food company's development strategy", Brunella Arru, Roberto Furesi, Pietro Pulina and Fabio A. Madau present a case study on integrating social sustainability and sustainable marketing into an agri-food company's strategy. The analysis focuses on the evolution of corporate strategy, considering the impact of the social dimension on stakeholders and the achievement of corporate objectives. The study analyzes the company's business development in the Italian market and expansion to foreign markets in light of an increasing focus on social sustainability.

Taken together, these six articles offer a multifaceted view of the challenges and opportunities facing the agribusiness sector today. From strategies for the development of sustainable local supply chains to analysis of competitiveness at the international level, from the study of factors influencing the profitability of livestock farmers to understanding consumer behavior toward innovative and sustainable products, this collection of papers contributes significantly to the scholarly debate and provides valuable insights for addressing the complexities of the contemporary agrifood system.

The journal *Economia agro-alimentare/Food Economy* has undertaken a full review of the membership of its Editorial Board. Sedef Akgüngör, Catherine Chan, Alessio Ishizaka, Simona Naspetti, and Stefanella Stranieri leave the Board with our deepest appreciation for their valuable contributions, hard work, and perseverance over the years. We are sincerely grateful to all former board members who have served the journal with dedication and competence, ensuring its continuity through challenging times and contributing to the high standards of the articles published. While we were preparing this new editorial phase, we were struck by the untimely passing of Professor Maurizio Canavari, Editor-in-Chief of the journal. The SIEA and the journal's editorial team mourn the loss of a colleague whose tireless commitment and inspiring vision guided *Economia agro-alimentare/Food Economy* with unwavering passion. Until his final days, Maurizio remained devoted to the journal, leaving us an enduring legacy of intellectual rigor and scientific integrity. His remarkable contributions have enriched not only this journal but the broader academic community. Our thoughts are with his family, friends, and colleagues. May his memory continue to guide and inspire us all.

The new Editorial Board include two Editors-in-Chief and six Associate Editors, and it shows a remarkable feature: it increased the involvement of members from non-Italian institutions as evidence of the efforts made to broaden the international reach of our journal. The new Editors-in-Chief, Valeria Borsellino and Søren Marcus Pedersen, were part of the previous

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Editorial Board and are committed to continuing the job with the same passion and dedication. The new editorial team, including Giovanna Bertella (UiT The Arctic University of Norway), Luca Cacciolatti (University of Westminster, UK), Nicola Cantore (UNIDO Vienna, Austria), Alessandra Castellini (Alma Mater Studiorum University of Bologna, Italy), Alessio Cavicchi (University of Pisa, Italy), and Fabio A. Madau (University of Sassari, Italy), will no doubt continue to guide the journal to new heights.

The new Editorial Board as a whole thanks the SIEA Presidential Board for trusting us. We are all proud to be part of this team and aware that our commitment to achieving the goals set when we were appointed is important for SIEA and for the community of academics and scholars who are interested in the food economy.

In this framework, a renewed Scientific Advisory Board (SAB) has also been appointed in accordance with the SIEA presidential board.

One of the policies promoted by the journal *Economia agro-alimentare/ Food Economy* has been the involvement of many international scholars from the fields of agricultural and applied economics, agri-food marketing, behavioural sciences, food policy, and others in the editorial process of our SAB. Every year, some of the members of the SAB are substituted. We express our warmest appreciation to those SAB members who have served until 2024 and now leave the Board. Their contribution to the development of the journal has been invaluable, helping to improve the quality of articles published in our journal and consequently the reputation of the journal itself. We are delighted as well to welcome the new members who have recently joined the SAB, namely Hamid El Bilali (CIHEAM-Bari, Italy), Marilena Gemtou (Agricultural University of Athens, Greece), Florence Gachango (Pwani University, Kenya), Luis Gaspar Miret Pastor (Polytechnic University of Valencia, Spain), Bettina Maish (University of Applied Sciences Munich, Germany), Giampiero Mazzocchi (Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria – CREA, Italy), Mangirdas Morkūnas (Vilnius University, Lithuania), Agoston Temesi (Hungarian University of Agriculture and Life Sciences, Hungary), Francesca Varia (Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria – CREA, Italy). We are grateful for their availability to join us and help us review, suggest reviewers, and evaluate papers for the "Best Paper Award" in the previous year.

Our current SAB includes 17 scholars based in Italy and 29 based in institutions across the globe. They represent a wide range of prominent academic and research institutions. More specifically, the SAB is composed of members affiliated with institutions in Austria, Belgium, Brazil, China, France, Germany, Greece, Hungary, Japan, Lithuania, the Netherlands, Norway, Poland, Spain, the United Kingdom, and the United States. In addition, three members are affiliated with international research

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organizations with a global scope. The updated list of 46 SAB members for the year 2025 can be found in the preliminary section of the journal as well as on the journal's website, https://economiaagroalimentare.it. The newly appointed SAB will continue to enhance the reputation of our journal by bringing the Board's varied experience across the breadth of disciplines related to the food economy. They will help us maintain the rigour of the review process and guarantee that we continue complying with the highest publishing standards. The Editors-in-Chief and the Editorial Board look forward to working with our new SAB members, relying upon their expertise and commitment.

Lastly, we extend our sincere thanks to the staff of FrancoAngeli Edizioni for their outstanding work in editing and publishing the journal. Their steadfast commitment to upholding the high standards of our publication is truly commendable, and we look forward to continuing this valuable collaboration in the coming year.

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Valeria Borsellino & Søren Marcus Pedersen
The Associate Editors
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Strategy for Accelerating Gamal Leaves as Forage Feed Additives in Migrant-Dense Areas: A Case Study in Jember

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Abstract

Small-scale livestock farmers face challenges in feed availability, particularly during the dry season. Gamal leaf forage, with its high protein content and durability, offers a sustainable solution to these issues. This study focuses on Klungkung, Sukorambi District, a migrant-dense area where economic empowerment through innovative business models is crucial. By exploring entrepreneurship-based gamal fertilizer production, the research assesses its potential to meet local economic needs and improve community welfare. The objectives are to analyze the business position, create a business plan, and formulate strategies to accelerate the adoption of environmentally friendly, location-specific gamal leaf forage in Jember Regency. The study surveyed 30 members of livestock farmer groups in high-potential areas, utilizing the Business Model Canvas (BMC) and SWOT methods for analysis. Results reveal the business position is highly promising, with strategies emphasizing leveraging group strengths to capitalize on opportunities.

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Introduction

Downstream processing is the process of transforming raw materials into a more valuable product that can be marketed and is ready for end consumers (Östensson & Löf, 2017). Downstream processing is a strategic industrial activity because it not only adds value to raw materials but also provides job opportunities and boosts economic growth from regional to national levels (Datar & Rosén, 2020). Downstream processing is crucial for the agricultural sector because it enhances the value of agricultural products and post-harvest waste from the perspective of raw materials. Raw materials typically have low value, but processing them will enhances their value and directly improving the income of farmers (Wong *et al*., 2020). Therefore, accelerating the downstream processing of agricultural raw materials is a strategic concept in efforts to improve the welfare of farmers and society in general.

Livestock is the agricultural sub-sector that utilizes plants, where plants are used as the primary feed for livestock. Livestock that require large amounts of plants as their main feed are ruminants (Blakely & Bade, 1998; Soetanto, 2019). Plants used as livestock feed are known as Forage. Ruminant livestock require that 75% of their feed consists of forage (Setiana. 2002) even up to 94% (Arifin & Hermansyah, 2019), the rest is in the form of concentrate. The types of forage needed are grass and legume. The availability of foreage in Indonesia is highly dependent on the season. Forage is abundant during the rainy season. Conversely, forage is difficult to obtain in the dry season. This seasonal dependence disrupts the continuity of forage availability. The inconsistency in the availability of forage will affect the quality of the feed. Impact of low quantity and quality of forage causes low livestock productivity (Olivares-Perez *et al*., 2011; Rusdiana & Hutasoit, 2014). Therefore, the availability of high-quality forage throughout the year is very important.

High-quality forage must have a balanced content of protein, fat, carbohydrates, minerals, and vitamins (Yessenamanova *et al*., 2021). Crude protein and crude fiber are very important substances for the growth and development of livestock. Crude protein is largely found in legume plants, while crude fiber is found in grass types (Widodo, 2017). One type of legume that is high in nutritional protein is gamal (Hartadi *et al*., 1990). Gamal can serve as the main forage for livestock or be given as a supplementary forage to meet protein needs when the primary feed is grass. The use of gamal as livestock feed is better when mixed or used as an additive to straw (Rosani, 2022).

Forage additive is an essence that is added to staple foods (Utomo *et al*., 2021). The purpose of adding this additive is to obtain better feed quality, especially protein. It is recommended to provide gamal in a fresh state (Disnakkeswan Prov. NTB., 2020) but it can still be good if provided in a

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dry and chopped condition (Sudirman *et al.*, 2023). Recent research on gamal as forage additive have not been focusing in its downstream processing, its mainly focusing on gamal as supplementary substance towards livestock health conditions (body weight, diseases, meat quality) (Aryanto *et al.*, 2020; Sawitri *et al.*, 2023; Sofyan *et al.*, 2020). In order to address the scarcity of both quantity and quality of forage during the dry season, downstream processing that lead to the provision of multi-nutritional supplements (feed additives) like gamal to straw are necessary.

Moreover, the use of supplementary feed for ruminants has not been extensively studied over the past 20 years, from 2000 to 2021, including supplementary feed from gamal. Research focusing on the utilization of gamal leaves is seen as an important and strategic step. This is because, in addition to gamal easily growing in various types of soil, it is also beneficial in addressing issues of nutrient deficiency and food (Michalak *et al.*, 2021), mitigating methane gas emissions (Herliatika & Widyawati, 2021), and controlling erosion (Jermias *et al.*, 2021; Disnakkeswan Prov. NTB, 2020). Ultimately, it can improve the welfare of farmers (Dahlanuddin & Hermansyah, 2022). The ruminant livestock cultivated by Indonesian farmers include beef cattle, goats, sheep, dairy cattle, and buffalo (PPID Agriculture, 2020). These livestock have economic value and play a complex role, both as meat producers supporting the provision of national meat needs and as manure producers to maintain soil fertility, thereby aiding in the acceleration of environmentally sustainable development.

Among the areas with high potential in natural resources, Jember stands out as a center of agricultural activities in Indonesia. Located in East Java, Jember's geographical features include canyon areas surrounded by mountains (Salim, 2022). The formation of these canyons is caused by river flow erosion. Most residents of Jember Regency still rely on farming and livestock cultivation as their main source of income. One specific location of interest is Klungkung, Sukorambi District, which is characterized by a high level of migrant population (Badan Pusat Statistik, 2024). This demographic dynamic makes it crucial to assess whether innovative business models, such as entrepreneurship-based production of gamal-derived fertilizers, are necessary and beneficial for the community. Such models could potentially address local economic challenges and provide sustainable solutions to improve the economic welfare of both local and migrant populations. Therefore, the management of natural resources with an environmental perspective becomes a top priority in the community's economic development. The objectives of this research are (1) to analyze the business prospects of gamal leaf additive forage and (2) to develop an environmentally sustainable strategy for advancing gamal leaf additive forage in Jember Regency. Jember has unique combination of geographical features

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(Salim, 2022), agricultural potential (Astuti, 2017; Retnani & Bukhori, 2017), and high migrant population (Juddi *et al*., 2021; Nurdin *et al*., 2018) makes it an ideal location for research and innovation in downstream processing of agricultural products like gamal forage.

Methodology and analysis

Research Area Determination. This study was conducted in Klungkung, Sukorambi District, Jember Regency, in 2023. The research area was determined purposively where Klungkung is known for its high potential in ruminant livestock farming, supported by the presence of organized farmer groups actively engaged in livestock cultivation. Additionally, the area is prone to environmental challenges such as landslides and floods, which exacerbate the seasonal scarcity of high-quality forage. One specific aspect of interest in Klungkung is its high level of migrant population. By focusing on Klungkung, this study not only addresses the technical challenges of forage scarcity but also explores the socio-economic potential of integrating migrant populations into sustainable agricultural value chains.

Respondent and Sampling. The study population comprised members of the "Tumbuh Sejahtera Lereng Mujan" Farmer Group, totaling 30 individuals. Farmer group Maju Tumbuh Sejahtera is the only group who active in producing forage feed especially using gamal based on field observations and information from local agricultural extension workers. A total sampling method was employed, involving all members of the group as respondents. This approach was chosen to comprehensively capture the perspectives and practices within the group, ensuring robust and representative data collection.

Data Sources and Data Collection. Primary data were gathered directly from respondents through structured interviews, group discussions, and observations. Secondary data were obtained from institutional records. Data inclue farmer activity and active farmer group data were obtained from the Jember Regency Agriculture Office (via agricultural extension workers). Interactive methods (interviews and discussions) were used to explore respondents' knowledge, attitudes, and practices related to gamal leaf forage feed additives, while non-interactive methods (document review and observation) provided supplementary insights.

Data Analysis. The analysis involved two main tools: the Business Model Canvas (BMC) and SWOT analysis. Business Model Canvas (BMC) used to determine the prospects and downstream strategy of gamal leaf additive livestock feed focusing on environmentally sustainable village-specific (one village one product). Business Model Canvas (BMC) was selected as

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the primary analytical tool for this study due to its ability to provide a comprehensive, visual, and structured framework for evaluating business prospects and developing downstream strategies (Cardeal *et al.*, 2020; Khodaei & Ortt, 2019). Unlike traditional business analysis tools which often focus on isolated aspects of a business, BMC offers a holistic view of the entire business ecosystem (Joyce & Paquin, 2016). This is particularly important for assessing the potential of gamal leaf forage feed additives, as it involves multiple interconnected components, including value creation, customer segments, supply chains, and revenue streams. The analysis covered nine elements (Alexander & Yves, 2012): customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, cost structure.

Following the BMC, SWOT framework was employed to integrate internal and external factors influencing the business. Strengths (S) and weaknesses (W) were identified from the internal environment, while opportunities (O) and threats (T) were derived from the external environment (Ciarmiello & Mansi, 2016). Each factor was assigned a weight (importance level) and a rating (influence level). Weights ranged from 1 to 5, indicating the relative importance of each variable, and ratings ranged from 1 to 5, indicating their influence. The use of a 1-5 scale for weighting and rating SWOT factors was chosen for its simplicity, practicality, and alignment with the study's participatory approach (Ciarmiello & Mansi, 2016). The weights were determined through a structured process involving stakeholder consultation, expert judgment, consensus building, and validation, ensuring that they accurately reflect the importance of each factor in the local context (Qayyum *et al.*, 2023; Stacchini *et al.*, 2022). This approach not only enhances the credibility of the analysis but also ensures that the results are actionable and relevant to the stakeholders involved (Khalilzadeh *et al.*, 2021; Ma *et al.*, 2018). Scores for each variable were calculated by multiplying weights and ratings. Moreover Lastina & Sunarni (2019) further argue that BMC and SWOT analysis are complementary tools because SWOT analysis identifies internal and external factors of each BMC element currently in operation within a company, subsequently facilitating strategy development for its enhancement.

Furthermore, to ensure data quality, validity and reliability tests were conducted:

1. Validity Testing: Correlation analysis was used to assess the validity of each variable in the internal and external factors. Data were considered valid if the computed correlation coefficient exceeded the critical r-value (0.361 at $\alpha = 0.05$, df = 28) (Sugiono, 2008)
2. Reliability Testing: Cronbach's Alpha was employed to evaluate data reliability. A Cronbach's Alpha value greater than 0.60 was considered

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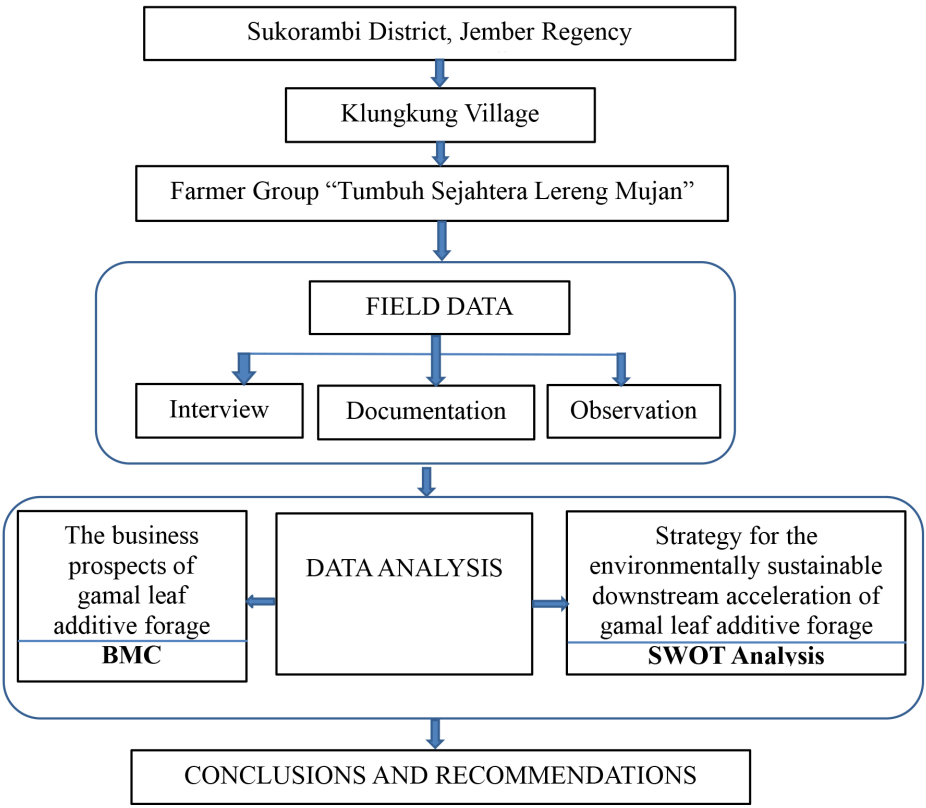
acceptable. In this study, the Cronbach's Alpha value of 0.841 indicated high reliability (Ghozali, 2005).

Figure 1 shows the overall research method which used in this research. Data interpretation for SWOT analysis then used to construct Internal Factor Analysis Strategy (IFAS) and External Factor Analysis Strategy (EFAS) matrices. The total scores from these matrices were plotted on a SWOT quadrant to determine the strategic position of the gamal leaf forage feed additive business. The findings positioned the business in Quadrant I (aggressive strategy), suggesting favorable conditions for leveraging internal strengths to exploit external opportunities effectively.

Figure 1 - Research design mindmap



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Results and discussion

Livestock Husbandry and Ownership System in Research Area

Livestock management systems consist of three types: extensive, intensive, and semi-intensive (Pugliese *et al*., 2021). In an extensive system, livestock graze freely on large open areas such as pastures or rangelands, relying primarily on natural forage with minimal human intervention (Confessore *et al*., 2022). This system is low-cost but often results in lower productivity due to limited control over nutrition and health. In contrast, a semi-intensive system combines grazing with supplemental feeding and housing (Pugliese *et al*., 2021). Intensive farming systems are often used in Indonesia due to their efficiency in terms of feed provision, stall cleaning, disease management, and livestock bathing. All respondents (100%) indicated that all livestock farmers in their development activities use intensive systems, where animals are kept in stalls. Farmers opt for intensive systems due to limited land availability, absence of communal grazing lands for cattle/goat herding, and to prevent theft.

On average, small-scale farmers in Jember Regency raise 9 goats per household and 4 cows per household. Ownership of cows varies; some are jointly owned ("gaduhan"), meaning the cow's owner and caretaker share the profits equally after deducting the initial purchase cost borne by the owner. Others use a "perang buduk" system, where the second calf becomes the property of the caretaker. In contrast, all goats raised by farmers are owned outright. The cattle breeds raised include Limousin and Metal, while the goat breeds include Dormas and Malibu. Meanwhile. the average experience of respondents in livestock farming is 13.5 years. The shortest experience reported is 2 years, and the longest is 42 years. Farmers in Jember integrate gamal into their farming systems by planting it along field boundaries or in agroforestry systems, where it serves as a dual-purpose crop. Gamal leaves are harvested as a high-protein forage supplement for livestock, while its roots help prevent soil erosion and improve soil fertility (Aryanto *et al*., 2020; Roza *et al*., n.d.). Gamal is particularly valued for its adaptability to marginal soils, low maintenance requirements, and ability to grow year-round, making it a sustainable solution for small-scale farmers with limited land and resources.

Business Canvas Model (BMC)

The Business Model Canvas (BMC) for the gamal leaf additive forage business highlights several critical components essential for the operation and success of the venture (Seufert *et al*., 2023; Zanella *et al*., 2024). This BMC provides a comprehensive overview of the gamal leaf additive forage business, outlining its key components and how they interact to create value and generate revenue.

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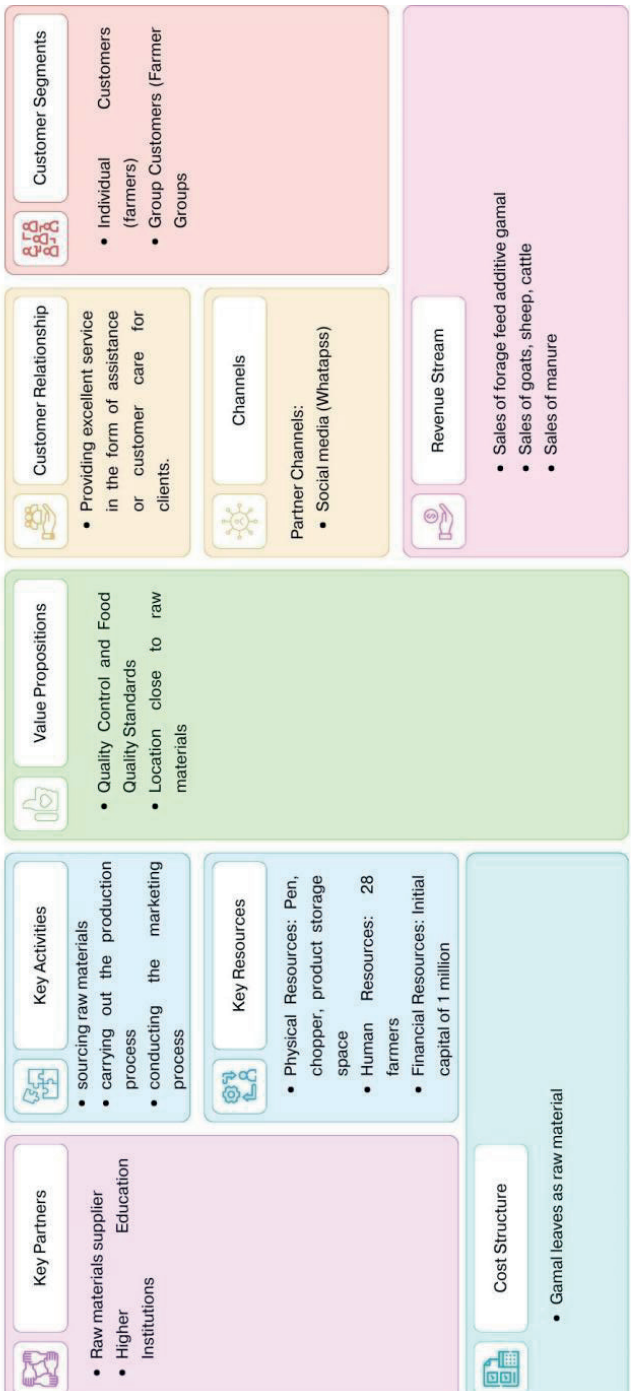

Figure 2 - Business Model Canvas for Gamal Forage Feed Additive

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Below are the explanation the nine keys element:

1. Key Partners include raw materials suppliers and higher education institutions. These partners are crucial for ensuring a steady supply of necessary inputs and providing expertise and research support for the business.
2. Key Activities focus on three primary areas: sourcing raw materials, carrying out the production process, and conducting the marketing process. These activities are fundamental for transforming raw materials into marketable products and ensuring these products reach the target customers effectively.
3. Key Resources are divided into physical, human, and financial resources. Physical resources include the pen, chopper, and product storage space necessary for production. Human resources consist of 30 farmers who are involved in the cultivation and processing of the forage. Financial resources involve an initial capital of 1 million, which is used to fund the start-up and operational activities.
4. Value Propositions emphasize quality control and food quality standards, ensuring that the products meet the required benchmarks for safety and efficacy. Additionally, the location close to raw materials is highlighted as a significant advantage, reducing transportation costs and ensuring fresh inputs.
5. Customer Relationships are built by providing excellent service in the form of assistance or customer care for clients. This approach helps in maintaining customer loyalty and satisfaction by addressing their needs promptly and effectively.
6. Channels include partner channels such as social media (WhatsApp), which are used to communicate with and reach out to customers. These channels help in marketing the products and maintaining customer engagement.
7. Customer Segments target individual customers (farmers) and group customers (farmer groups). These segments are the primary market for the gamal leaf additive forage products, providing them with high-quality feed additives for their livestock.
8. Cost Structure is centered around the use of gamal leaves as the primary raw material. This cost is a significant part of the business expenses and is crucial for budgeting and financial planning.
9. Revenue Streams are generated from the sales of forage feed additive gamal, sales of goats, sheep, and cattle, as well as sales of manure. These diverse revenue streams help in sustaining the business and ensuring profitability by tapping into different aspects of the agricultural market.

Prospects for Downstream Processing of Gamal Leaf Forage Feed Additive

Farmers who raise ruminant animals are generally crop and horticulture farmers. Ruminant farming is a side job. Since most ruminant farmers in

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Jember are small-scale farmers (Hani *et al*., 2023), including the respondents in this study, farmers have been producing animal feed from processed straw with legumes for approximately one year. Business model evaluation with SWOT analysis is conducted to determine the position of the gamal leaf additive feed business as a business unit (Puglieri *et al*., 2022). Market conditions and other conditions are assessed so that farmer groups can adapt to the situations they face. The items in the BMC elements (Figure 2) are grouped into internal and external factors. The results of the grouping are shown in Table 1.

Table 1 - Variables in the Internal and External Factors

STRENGTHS		**WEAKNESS**	
Variable	**Description**	**Variable**	**Description**
S1	Chopper	**W1**	Knowledge of the best formula between straw and gamal leaves
S2	Response to downstreaming of gamal leaf additive forage feed	**W2**	Financial management
S3	Networking	**W3**	Storage facilities for production results
S4	Knowledge about the gamal tree	**W4**	Member participation in group activities
S5	Leadership of farmer groups	**W5**	Optimization of gamal leaf additive forage feed processing
S6	Durable product	**W6**	Business capital
OPPORTUNITIES		**TREATHS**	
Variable	**Description**	**Variable**	**Description**
O1	Availability of gamal trees	**T1**	Reforestation activities of gamal trees
O2	Product price	**T2**	Habit of feeding fresh fodder
O3	Soil topography	**T3**	Technology
O4	Availability of chopper equipment	**T4**	Financial assistance
O5	Higher education institutions	**T5**	Training as a project
O6	Demand for gamal leaf additive supplements	**T6**	Competitors of forage feed supplements

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The results of the correlation test to assess data validity indicate that all internal variables (strengths and weaknesses factors) and external variables (opportunities and threats factors) have correlation values above the critical r value (0.361) at 99% and 95% confidence levels, meaning all data are valid (Table 2).

Table 2 - Results of data validity test

IFAS				EFAS			
Variable	**Value of r-Table**	**Pearson Correlation**	**Validity**	**Variable**	**Value of r-Table**	**Pearson Correlation**	**Validity**
S1	0.361	.726**	Valid	O1	0.361	.722**	Valid
S2	0.361	.835**	Valid	O2	0.361	.658**	Valid
S3	0.361	.766**	Valid	O3	0.361	.851**	Valid
S4	0.361	.683**	Valid	O4	0.361	.676**	Valid
S5	0.361	.877**	Valid	O5	0.361	.822**	Valid
S6	0.361	.766**	Valid	O6	0.361	.702**	Valid
W1	0.361	.674**	Valid	T1	0.361	.708**	Valid
W2	0.361	.646**	Valid	T2	0.361	.711**	Valid
W3	0.361	.659**	Valid	T3	0.361	.711**	Valid
W4	0.361	.816**	Valid	T4	0.361	.667**	Valid
W5	0.361	.666**	Valid	T5	0.361	.667**	Valid
W6	0.361	.678**	Valid	T6	0.361	.729**	Valid

* Correlation is significant at the 0.05 level (2-tailed), r-table = 0.361.
** Correlation is significant at the 0.01 level (2-tailed), r-tabel =0.306.

The analysis of data reliability using the Cronbach's Alpha model is shown in Table 3. From Table 3, it is evident that all internal variables (strengths and weaknesses) and external variables (opportunities and threats) have Cronbach's Alpha values of 0.841 > 0.60, indicating that the data obtained from the field is reliable.

Table 3 - Results of Data Reliability Analysis

Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.841	0.854	24

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With the valid and reliable data, we proceed to the analysis of the IFAS (Internal Factor Analysis Strategy) matrix and EFAS (External Factor Analysis Strategy) matrix. The results of the IFAS and EFAS matrix analysis are as follows:

a. IFAS Matrix (*Internal Factor Analysis Strategy*)

The IFAS matrix is a matrix used to identify strengths and weaknesses that influence farmers' interest in developing downstreaming of gamal leaf additive forage feed. The analysis of the IFAS matrix is conducted by calculating the multiplication of the average weight values and the average rating values for each internal strategic variable. The rating value in the IFAS matrix indicates the strengths and weaknesses of internal factors for the business unit, obtained from the multiplication of weights with ratings for each variable in each factor (Putri *et al*., 2020). Table 4 presents the results of the IFAS matrix analysis.

Table 4 - Internal Factors Analysis

INTERNAL FACTORS						
STRENGTHS					**Rating**	
Variable	**Description**	**Weight**	**Rating**	**Score**	**Min**	**Max**
S1	Leaf Chopper	0.09	3.60	0.31	3	4
S2	Response to downstreaming of gamal as a livestock feed additive	0.08	4.00	0.34	4	4
S3	Networking	0.09	4.00	0.36	4	4
S4	Knowledge of gamal tree	0.09	3.30	0.30	3	4
S5	Leadership of group chairman	0.09	4.00	0.38	4	4
S6	Durable product	0.09	3.70	0.34	3	4
	Total	0.54	22.60	2.03		
WEAKNESSES					**Rating**	
Variable	**Min**	**Min**	**Rating**	**Score**	**Min**	**Max**
W1	Knowledge of the formula between straw and gamal leaves	0.07	3.30	0.24	3	4
W2	Financial management	0.07	4.00	0.27	4	4
W3	Storage facilities for production results	0.07	3.50	0.26	3	4
W4	Member participation in group activities	0.08	3.80	0.31	3	4
W5	Optimization of product processing	0.08	3.60	0.31	3	4
W6	Business capital	0.08	3.30	0.27	3	4
	Total	**0.46**	**21.50**	**1.65**		
	TOTAL IFAS			**0.38**		

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The explanation of these internal factors is as follows:

Strength

- Leaf chopper (S1): This leaf chopper helps accelerate farmers in cutting gamal leaves and branches into small pieces, making production more efficient, facilitating storage and packaging, and aiding in livestock digestion. Half (50%) of the respondents consider the leaf chopper essential for accelerating the production of gamal leaf additive forage feed. All livestock groups have one leaf chopper. The importance of grass/leaf/branch choppers for farmers to be more efficient, especially for large-scale farmers, has also been emphasized by (Amelia *et al.*, 2022). The leaf chopper variable scores 0.31.
- Response to downstreaming of gamal as livestock feed (S2): All respondents have a positive response to the acceleration activities of downstreaming gamal leaf additive forage feed. Fifty percent of respondents deem this acceleration activity highly important. The score for this response variable is 0.34, ranking third highest.
- Networking (S3): Networking refers to cooperation networks among farmers, both within and between groups, as well as with traders and even universities. All respondents have a good network with fellow livestock farmers. Sixty percent of respondents consider networking crucial for accelerating the downstreaming of gamal leaf additive forage feed. The networking variable scores 0.36, making it the second highest.
- Knowledge of gamal tree (S4): Respondents' knowledge of cultivating gamal trees and their understanding of the benefits of gamal trees as livestock feed has been established. Gamal trees grow easily on various types of soil, making them easy to cultivate and widely utilized as forage feed, albeit irregularly. Sixty percent of respondents deem knowledge of the gamal tree essential for accelerating the downstreaming of gamal leaf additive forage feed. The score for the knowledge of the gamal tree variable is 0.30.
- Leadership of group chairman (S5): The influence of the group chairman's leadership in organizational development is crucial. Seventy-seven percent of respondents believe that the leadership of the group chairman is highly important as an internal factor for accelerating the downstreaming of gamal leaf additive forage feed. Respondents also view the leadership of livestock groups as highly creative and innovative. The score for the leadership of the group chairman variable is 0.38, the highest score.
- Durable product (S6): Since gamal leaf additive forage feed is a dry product used to provide forage feed during the dry season, its durability allows it to last up to 2-3 years. Sixty percent of respondents emphasize the importance of a durable product as a determinant for accelerating the downstreaming of gamal leaf additive forage feed. The score for the durable product variable is 0.34.

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Weakness

- Knowledge of the formula between straw and gamal leaves (W1): Gamal leaf additive forage feed is a mixture of straw and gamal leaves. The nature of gamal leaves as a supplement means that the main raw material is straw, which contains a lot of coarse carbohydrate fiber. Due to this mixture, a balanced blend is necessary for optimal results. The best formula for the mixture of straw and gamal leaves is not widely known among respondents. Seventy percent (70%) of respondents consider knowledge of the formula for straw and gamal leaf mixture essential as a weakness factor in accelerating the downstreaming of gamal leaf additive forage feed. The variable W1 scores 0.24.
- Financial management (W2): (Frida, 2020) asserts that financial management determines the fate of a company because financial management activities involve acquiring funds, allocating, developing, and storing funds. The three groups of farmers in this study have not been given knowledge or skills in financial management, despite its importance. Sixty percent (60%) of respondents are neutral regarding financial management as a weakness factor among farmer groups. The variable W2 scores 0.27, the second highest score.
- Storage facilities for production results (W3): Storage facilities for production results are crucial, especially when producing on a large scale. Farmer groups have storage facilities in the form of tanks, but the number is limited, with an average of 4 large tanks per group. Fifty percent (50%) of respondents believe that storage facilities are a weakness factor in accelerating the downstreaming of gamal leaf additive forage feed. Variable W3 scores 0.26.
- Member participation in group activities (W4): Farmer groups have a minimum agenda of bi-weekly meetings to discuss farming or other urgent activities related to farming. It is expected that all members attend each meeting, but in reality, not everyone can attend. The level of member participation in group activities is low. Forty percent (40%) of respondents deem member participation as an important weakness factor in the downstreaming of gamal leaf additive forage feed. This variable scores 0.31, the highest score.
- Optimization of product processing (W5): Respondents feel that the processing of gamal leaf additive forage feed products is not yet optimal. This relates to the limited number of chopper machines and the lack of active participation by group members in the production process. Currently, the groups produce approximately 75 kg of gamal leaf additive forage feed per month, whereas this could potentially be increased to 125-150 kg per month. Seventy-seven percent (77%) of respondents state that optimizing product processing is highly important as a weakness factor. This variable also scores 0.31, the highest score, similar to variable W4.

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- Business capital (W6): Business capital is a crucial aspect of any business. The size and scope of the business are determined by its capital. In business, capital is a facilitator. Respondents' business capital for gamal leaf additive forage feed business is relatively low, around 100 thousand per respondent, which hinders the development of livestock feed operations. For instance, this capital might be insufficient for packaging costs, transportation costs for straw, and other expenses. Fifty percent (50%) of respondents consider capital as an important weakness factor in the downstreaming of gamal leaf additive forage feed. This variable scores 0.27, the second highest score.

b. EFAS Matrix (*External Factor Analysis Strategy*)

The EFAS matrix is a matrix used to identify opportunities and threats that influence farmers' interest in downstreaming gamal leaf additive forage feed. The analysis of the EFAS matrix involves calculating weights and ratings for each external factor. The rating values in the EFAS matrix indicate the opportunities and threats of external factors for the research subject. These assessments are provided by each respondent, revealing the opportunities and threats. Below is the table of EFAS matrix analysis.

Table 5 - EFAS Analysis

EXSTERNAL FACTORS						
OPPORTUNITIES					**Rating**	
Variable	**Description**	**Weight**	**Rating**	**Score**	**Min**	**Max**
O1	Availability of gamal trees	0.08	4.00	0.33	4	4
O2	Product price	0.09	4.00	0.35	4	4
O3	Soil topography	0.09	3.60	0.31	3	4
O4	Variety of chopper tools	0.08	4.10	0.34	4	5
O5	Supporting company	0.09	4.00	0.34	4	4
O6	Demand for additive feed	0.09	4.00	0.34	4	4
	Total	**0.51**	23.70	2.01		
THREATS						
Variable	**Description**	**Weight**	**Rating**	**Score**		
T1	Reforestation of gamal trees	0.08	2.00	0.17	2	2
T2	Habit of providing fresh feed	0.08	2.00	0.17	2	2
T3	Technological development	0.08	1.70	0.14	1	3
T4	Business capital assistance	0.07	1.40	0.10	1	2
T5	Development as a project	0.08	1.00	0.08	1	1
T6	Competitors of additive feed	0.09	1.60	0.14	1	2
	Total	**0.49**	9.70	0.80		
	TOTAL EFAS			**1.22**		

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The explanation of the external factors is as follows:

Opportunities

- Availability of gamal trees (O1): Gamal trees grow easily in various types of soil, making them self-propagating, and many are intentionally cultivated as fence plants planted in front of houses or along roadsides (Khusnul & Prihatin, 2020). Under normal conditions, the availability of gamal leaves in the research area is assured. Forty percent (40%) of respondents consider the availability of gamal trees as an important opportunity factor in the downstream processing of gamal leaf additive forage feed. The variable O1 scores 0.33, the Third score among opportunity factors.
- Product price (O2): The price of gamal leaf additive forage feed sold by respondents is Rp. 3000 per kg, relatively cheaper compared to elephant grass which can reach Rp. 10,000 per kg. Sixty percent (60%) of respondents indicate it is important if product price is an opportunity factor in the downstream processing of gamal leaf additive forage feed. This variable has a score of 0.35, the highest score among opportunity factors.
- Regional topography (O3): The topography of the research area is steep and prone to landslides and floods (specific to the research location), making planting gamal trees beneficial for preventing landslides and floods. Gamal trees are not only planted in front of houses or along roadsides but also on hillsides to prevent erosion, demonstrating that the community has implemented environmentally conscious local wisdom. Sixty percent (60%) of respondents deem it important if regional topography is an opportunity factor in accelerating the downstreaming of gamal leaf additive forage feed. Variable O3 scores 0.31.
- Variety of chopper tools (O4): This variable refers to the variety of types of leaf/stem chopper tools available. The availability of various types of leaf/stem chopper machines allows farmers to choose according to their needs and available funds. These chopper tools can be purchased at agricultural stores, marketplaces, or online. Sixty percent (60%) of respondents state it is important if the variety of chopper tools is an opportunity factor in accelerating the downstreaming of gamal leaf additive forage feed. This variable scores 0.34, the second highest score.
- Supporting companies (O5): Universities (PT), represented by lecturers and students, transfer technology to the community, including farmer groups, through research and community service activities. Farmer groups or livestock groups become partners with universities, thereby enhancing technology transfer and knowledge dissemination. Fifty percent (50%) of respondents consider universities as an important opportunity factor in accelerating the downstreaming of gamal leaf additive forage feed. Variable O5 scores 0.34, the second highest score.

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- Demand for additive feed (O6): The availability of various types of forage feed increases the demand for these products. This trend presents an opportunity for the gamal leaf additive forage feed business. Therefore, 70% of respondents find it important if demand for additive forage feed products is an opportunity factor. Variable O6 scores 0.34, the second highest score.

Threats

- Reforestation of gamal trees (T1): Although gamal trees are easy to cultivate, continuous harvesting without reforestation efforts will lead to a scarcity of gamal trees. Sixty percent (60%) of respondents find it important if reforestation is considered a threat factor in accelerating the downstreaming of gamal leaf additive forage feed. This variable scores 0.17.
- Habit of feeding fresh forage (T2): Generally, people prefer to feed fresh forage such as grass, straw, and wild plant leaves from forests. This forage is usually collected in the morning and during the day. Forty percent (40%) of respondents consider it important if the habit of feeding fresh forage is a threat factor. Variable T2 scores 0.17.
- Technological development (T3): Agricultural technology is constantly evolving in production, marketing, finance, and administration. If human resources cannot keep up and adapt to technological changes, they will be left behind. Technology in smallholder farming in Jember District is still relatively simple.This variable score 0.14.
- Business capital assistance (T4): Business capital is crucial for farmers, especially smallholder farmers who often lack access to financial assistance. Variable T4 scores 0.10.
- Coaching as a project (T5): Farmers appreciate partnerships with external entities, but they are concerned if these partnerships only last for a short period, such as 6 months to a maximum of 1 year. Sustainable development projects require longer-term commitment to ensure continuity and effectiveness. Forty percent (40%) of respondents deem it important if coaching as a project is a threat factor. This variable scores 0.08.
- Competitors in additive feed (T6): Besides gamal leaf additive forage feed, there are many other similar products in the market, posing competition to farmers focusing on gamal leaf additive forage feed. Therefore, variable T6 is important to include as a threat factor. This variable scores 0.14.
- Based on the total score of internal factors (Total IFAS score) and external factors (Total EFAS score) in Tables 4 and 5, namely Total IFAS score = 0.38 and total EFAS score = 1.22, it positions the environmentally-focused green fodder business of gamal leaf additive for livestock feed in specific locations in Jember in quadrant 1, indicating aggressive prospects (Figure 3). This position signifies favorable conditions for smallholder

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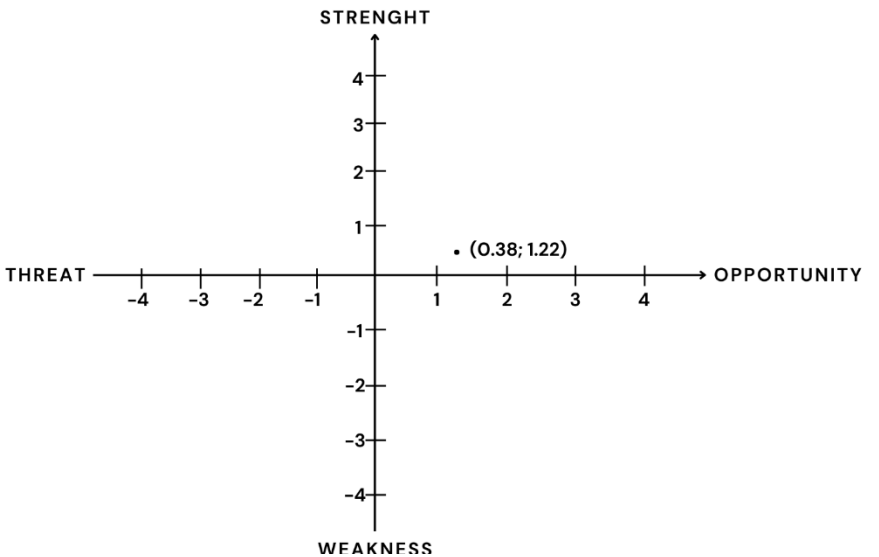
farmers in Jember because internally, they possess strengths to capitalize on external business opportunities in gamal leaf additive for livestock feed. This aggressive strategy quadrant is characterized by high potential for growth and expansion due to the favorable alignment of internal strengths and external opportunities (Todorov & Akbar, 2018).

Figure 3 - The position of accelerating the downstream process of gamal leaf additive for livestock feed



Source: Primary data processed, 2023.

Strategy for Accelerating Downstream Processing of Forage with Gamal Leaf Additives

The strategy that should be implemented by the community of small-scale livestock farmers in Jember Regency to accelerate the downstreaming of environmentally aware FLF with specific location-based Gamal leaf additives at a potentially aggressive business position is to leverage the group's strengths to capitalize on existing opportunities. The aggressive strategies that can be implemented are listed in the Aggressive Strategy Matrix in Table 6.

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Table 6 - Aggressive Strategy Matrix

STRENGHT / **OPPORTUNITY**	O1. Availability of Gamal trees
	O2. Product price
	O3. Topography of the area
	O4. Variation of chopping tools
	O5. Supporting company
	O6. Demand for additive feed
	AGGRESSIVE STRATEGY
S1. Chopping tool	1. S1 – O1 and O6
S2. Response to downstreaming of Gamal as livestock feed	2. S2 – O5 and O6
S3. Networking	3. S3 – O5
S4. Knowledge of Gamal trees	4. S4 – O2 and O3
S5. Leadership of the group chairman	5. S5 – O5
S6. Durable product	6. S6 – O5 and O6

The pairing of strengths (S) with opportunities (O) in the Table 6 was carefully determined by analyzing how each internal strength could be strategically leveraged to capitalize on specific external opportunities based on researcher's assessment and observation. For example, S1 (Chopping Tool) was paired with O1 (Availability of Gamal Trees) and O6 (Demand for Additive Feed) because the chopping tool enables efficient processing of Gamal leaves, ensuring a steady supply of raw materials to meet growing market demand. Similarly, S2 (Response to Downstreaming of Gamal as Livestock Feed) was linked to O5 (Supporting Company) and O6 (Demand for Additive Feed) to highlight how innovation in downstream processing can attract external support and address market needs. S3 (Networking) was paired with O5 (Supporting Company) to emphasize the role of strong stakeholder relationships in securing resources and partnerships.

S4 (Knowledge of Gamal Trees) was matched with O2 (Product Price) and O3 (Topography of the Area) to demonstrate how farmers' expertise can optimize production costs and adapt to environmental conditions, ensuring competitive pricing. S5 (Leadership of the Group Chairman) was connected to O5 (Supporting Company) to underscore the importance of effective leadership in negotiating and managing external support. Finally, S6 (Durable Product) was paired with O5 (Supporting Company) and O6 (Demand for Additive Feed) to highlight how product durability enhances market appeal

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and aligns with external support. Overall, these pairings were designed to create synergies between internal capabilities and external opportunities, ensuring a strategic and competitive approach to business development. Simple detail as explained below:

1. The chopping tool owned by the group is used optimally to process the abundantly available Gamal leaves to meet market demand.
2. Maintaining a positive response to the acceleration of downstreaming FLF with Gamal leaves ensures continuous production of FLF with Gamal leaf additives and fosters networking with supporting institutions/universities to enter the market and meet market demand.
3. The strong network among livestock farmers can be used as a marketing medium to promote and sell FLF with Gamal leaf additives.
4. With farmers' knowledge of Gamal tree cultivation and the area's suitable topography for growing Gamal trees, reforestation can be carried out to prevent a shortage of Gamal, keeping product prices lower than other processed forage products and reducing landslide risks.
5. The inspirational group leader communicates and builds relationships with supporting institutions or universities to receive guidance and produce competitive FLF with Gamal leaf additives, both in price and product quality.

The durable FLF with Gamal leaf additives can be stored and well-packaged with training support from supporting institutions or universities.

Suggestion

This study highlights the potential of Gamal leaf additive forage as a sustainable solution to address feed scarcity and improve livestock productivity among small-scale ruminant farmers in Jember Regency. The findings demonstrate that Gamal, with its high nutritional value and adaptability to marginal soils, can significantly enhance feed quality, particularly during the dry season when traditional forage is scarce. The integration of Gamal into farming systems not only supports livestock health but also contributes to environmental sustainability by reducing overgrazing and improving soil health. Based on the total score of internal factors (Total IFAS score) and external factors (Total EFAS score) 3.63, which has positions in quadrant 1, indicating aggressive prospects. The proposed strategies are combination of strenght and oppurtunity components namely, optimize the use of chopping tool and downstream process, build strong network among livestock farmer, enhance farmer knowledge, build connection with supporting institutions and farmer's tarining support. However, the study has certain limitations. For instance, the research focused primarily on small-

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scale farmers in Jember, which may limit the generalizability of the findings to other regions with different climatic, socio-economic, or agricultural conditions. Additionally, the study relied on self-reported data from farmers, which may introduce biases in the analysis. The applicability of Gamal leaf additive forage in other regions depends on several factors, including climatic suitability, availability of Gamal trees, and the existing livestock management practices. Regions with similar agro-ecological conditions and small-scale farming systems, such as parts of Southeast Asia, Sub-Saharan Africa, and Latin America, could potentially benefit from adopting this innovation. However, successful implementation would require tailored strategies to address local challenges, such as land tenure systems, access to resources, and farmer education.

One of the key findings of this study is the high level of migrant population in Jember, particularly in areas like Klungkung, Sukorambi District. This demographic dynamic makes it crucial to assess whether innovative business models, such as entrepreneurship-based production of Gamal-derived fertilizers or feed additives, are necessary and beneficial for the community. Such models could not only address feed scarcity but also create economic opportunities for both local and migrant populations, fostering inclusive growth and improving overall welfare. Future research can be focusing on comprehensive cost-benefit analysis should be conducted to evaluate the economic viability of Gamal leaf forage, including production costs, savings on traditional feed, and potential increases in farmer income.

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Simultaneous Equation of Concentration, Efficiency, and Competitiveness of Indonesia's CPO Industry: Impacts and Policies

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Abstract

This study simultaneously analyzed the industrial concentration measured using CR4, technical efficiency measured using Stochastic Frontier Analysis (SFA), and competitiveness using the Revealed Comparative Advantage (RCA) approach of the CPO industry in Indonesia. The study uses time series data from 2001 to 2020, sourced from the Central Statistics Agency (BPS), the World Bank, and UN Comtrade. This study uses a simultaneous model approach of Two Stage Least Squares (2SLS). The results show that the efficiency of the technique has a negative and significant impact on industrial concentration. The market concentration measured by CR4 shows a positive and significant relationship with competitiveness. Large companies that dominate the market are able to create price stability and encourage innovation, which ultimately improves the profitability and quality of CPO. RSPO policy is negatively correlated with concentration levels, the high cost of certification can be a barrier for new companies to enter the market. Biodiesel policy opens up new opportunities, the push to meet domestic demand can reduce the pressure to innovate.

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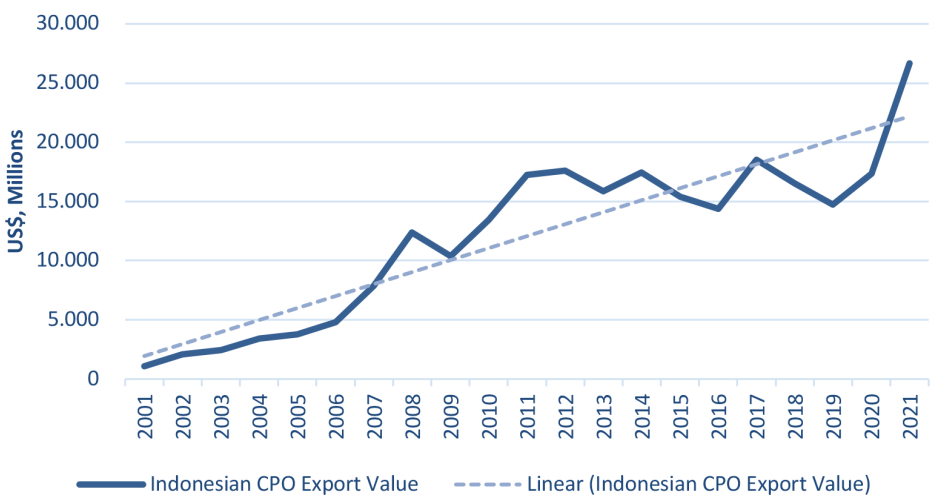
Introduction

Crude Palm Oil (CPO) is one of the mainstay products in Indonesia as a major contributor to the division. Indonesia in international trade, is the largest producer of CPO, which is usually used in the manufacture of food, cosmetics, and biodiesel. The data also shows that the value of Indonesia's CPO exports continues to increase (Figure 1), also supported by previous findings that the competitiveness of Indonesia's CPO industry continues to increase (Khatiwada *et al.*, 2021; Gaskell, 2015). However, although the market share and demand for CPO continue to increase, there are various obstacles faced. Changes in CPO prices play a very important role in maintaining competitiveness. These fluctuations are caused by external factors such as climate change and geopolitical factors. In addition, the CPO industry is also required to implement sustainability with existing certifications.

Figure 1 - The Value of Indonesia's CPO Exports



Source: UN Trade (2001-2021).

The economy in Indonesia is quite impactful if CPO prices fluctuate. This challenge extends to Indonesia's CPO export destination countries, such as China, India, and Pakistan, with large populations also increasing demand for CPO (see Figure 2). Several factors are also suspected to be the potential cause of CPO price fluctuations. There are allegations related to the existence

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of cartels, the implementation of the biodiesel (B30) policy, the impact of corruption and collusion, and the ban on the use of CPO by the European Union (Halimatussadiah *et al*., 2021; Innocenti & Oosterveer, 2020). CPO's main competitor products such as sunflower oil are also suspected to be the cause that can affect CPO's competitiveness. In recent years, the emergence of COVID-19 has also been the cause of price fluctuations and a decline in global CPO demand. Malaysia as Indonesia's main competitor is also often examined by previous research as a factor that hinders Indonesia's competitiveness.

The price of cooking oil in Indonesia is very volatile, allegedly affecting the technical efficiency and competitiveness of the CPO industry. Land area also plays a role in palm oil production, demonstrating a complex relationship with industrial concentration, production efficiency, and global competitiveness (Pye, 2019). In answering the problems of the CPO industry, Indonesia must prioritize production efficiency and strive for innovation in the supply chain to remain competitive in the global market. There are many research results that state that there is a simultaneous relationship between the factors discussed earlier. Murti (2017) analyzing the simultaneous relationship between CPO prices, Indonesian CPO exports, vegetable oil demand, CPO consumption, and Biodiesel utilization shows that several exogenous variables can affect the main endogenous variables, and shows simultaneous factors. Recent research by Othman *et al*., (2023) discussing how the competitiveness of exports in the Malaysian CPO industry is affected by European Union (EU) environmental regulations, the results revealed that EU environmental regulations have a positive impact on the competitiveness of the palm oil industry. These results are consistent with Porter's hypothesis, which states that stricter environmental regulations can fuel innovation to the cost of non-compliance. Other research by Alii *et al*., (2021), comparing the export performance and export competitiveness of Indonesia's CPO trade in the Chinese and EU markets. According to him, the difference in the competitiveness of Indonesia's CPO exports in the Chinese and EU-25 markets is due to the Roundtable on Sustainable Palm Oil (RSPO) policy. Rosyadi *et al.* (2021) how various factors affect the intensity and competitiveness of crude palm oil (CPO) exports. The results show that the importer's gross domestic product (GDP) and export quantity have a significant and positive effect on the intensity of Indonesia's CPO exports, while the GDP and the economic distance of exporters have a significant and negative effect. Factors that have a positive and significant effect on competitiveness are the value of soybean imports and the Roundtable on Sustainable Palm Oil (RSPO) certification, while Malaysian CPO exports and the population of importing countries have a negative effect on the competitiveness of Indonesian CPO. Based on previous research, this study

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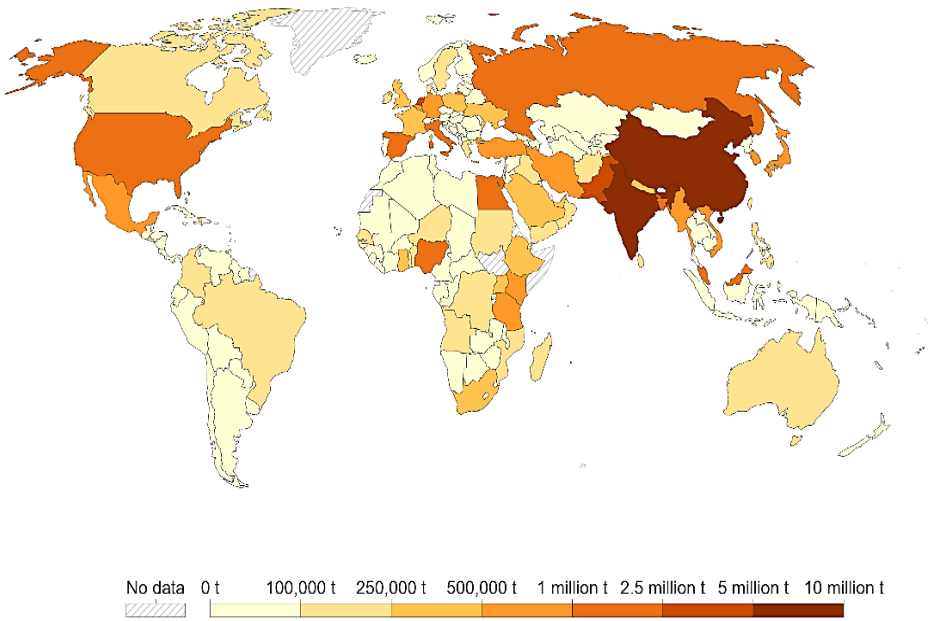
will fill the gap by simultaneously analyzing the relationship between concentration, efficiency, and competitiveness of Indonesia's CPO industry, which has never been explored before.

Figure 2 - World Crude Palm Oil Imports



Source: Food and Agriculture Organization of the United Nations (2019).

By integrating key variables in a simultaneous equation model, this study provides a new foundation for understanding the complex interactions between concentration, efficiency, and competitiveness of the CPO industry. The study also opens the door for further research in this area by identifying potential areas for further research. By highlighting the complexity of the relationships between variables and using sophisticated analytical methods, this study contributes significant novelty in the scientific literature related to the CPO industry. Therefore, we answer the following questions:

1. How is the concentration, efficiency, and competitiveness of the Indonesian CPO industry?
2. How does the relationship between concentration, technical efficiency, competitiveness, RSPO policy, CPO prices, cooking oil prices, global prices of sunflower oil, the export value of Indonesian and Malaysian CPO,

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the price of Indonesian industrial solar power, and the Biodiesel policy affect the Indonesian CPO industry?

The rest of this research is as follows. Literature reviews are checked in Part 2. Part 3 explores the data, methodology, and identification of the Simultaneous Equation System. Variable movements, empirical results and discussions are reported in Section 4. Part 5 explains the conclusions and policy implications for the Indonesian CPO Industry.

1. Literature Review

The Structure, Conduct and Performance (SCP) paradigm is one of several analytical frameworks used in the analysis of industrial organizations. This paradigm is used to show the relationship between Structure, Conduct and Performance of the industry in the market. Referring to the analysis model from the previous theory Martin (1989) regarding structure, behavior, and performance (SCP) that there are various frameworks and perspectives explained, namely: "Harvard Tradition", "Chicago-UCLA School", "Contestable Market", "Game Theory", "New-Harvard Tradition" and "Strategic Behavior" perspective.

The traditional view is that the high concentration of an industry will encourage the formation of a high level of collusion between companies in the industry, thus facilitating the formation of a monopoly market structure in the industry. This creates high prices, especially if the profits of these companies increase if they are supported by continuous production. The traditional New-Harvard approach to the SCP model states that each component interacts with each other, i.e., market performance depends on market behavior. Furthermore, the market structure depends on fundamental factors, namely demand and production, including demand, substitution, seasonality, economic growth rate, location, number of orders, development methods and technologies, raw materials, product consistency, product elasticity, location, economies of scale and economic reach. The basic conditions of structure, conduct, and performance affect government policies. According to Martin (1989), the framework of industrial organization is always developed, there is a very simple causal relationship in a linear model. With the model developed, it matches the impact and mutual influence between structure, conduct, and performance in the real world.

Market structure, as a vital component in the context of the industry, indicates stability that tends to persist in the corporate environment, influenced by market behavior and performance (Tremblay, 2012). Market structure analysis aims to understand how this affects industry behavior and performance. The market structure includes industry characteristics such as company size, number of competitors, level of competition, and market

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type (Scherer, 1980), all of which have a significant impact on efficiency, innovation, and industrial competitiveness. Concentration Ratio (CR) according to Bikker and Haaf (2002). Concentration Ratio (CR), according to Bikker and Haaf (2002), is used to measure concentration levels using structural models to explain the competitive performance of an industry resulting from market concentration. It is used in the measurement of concentration degrees with structural models in explaining the competitive performance of the industry as a result of market concentration. CR is defined as the percentage of the overall industrial output produced by the largest firms.

In economic analysis, efficiency is divided into two main aspects, namely productive efficiency and allocative efficiency (Lipsey, 1990). Industrial efficiency, as a result of the market structure, can be measured relatively. Farrel (1957) introduces the concept of technical efficiency, which reflects the company's ability to produce maximum output from a given input, and allocative efficiency, which assesses the company's ability to be in optimal input allocation to achieve the desired output. In measuring performance, Stochastic Frontier Analysis (SFA) is one of the methods used in estimating production limits (frontiers) and also measuring the level of production efficiency. The idea of SFA began with two articles published independently by two teams of authors, namely Meeusen & van den Broeck (1977) and Aigner *et al.* (1977), followed by the third article by Battese & Coelli (1992). The three ideas have similarities with each other, namely discussing the error structure formed in production frontier modeling. The model is expressed in the form of the following equation (Coelli *et al*., 2005).

In international theory, this study highlights several relevant concepts. Adam Smith's theory (1776) in Cho (2003) explained that a country will increase in wealth if it is in line with the increase in skills and efficiency of the involvement of the country's workforce and population in the production process. Comparative advantage theory of Ricardo (1817) in Cho (2003), explaining that a country trades even though it does not have an absolute advantage, or in other words does not have an absolute disadvantage against other countries in the production of two goods trade can still be profitable if countries have absolute losses in the production of goods with smaller absolute losses. Theory Heckscher and Ohlin (1991) in Salvatore (2017) developing an economic model by stating the cause of the difference in productivity due to the difference in the proportion of labor, capital, and land factors owned by a country. The Heckscher-Ohlin theory is known as "The Proportional Factor Theory" where countries with relatively high production factors and low production costs will specialize production to export.

The most common measure of competitiveness used by previous studies is using the Revealed Comparative Advantage (RCA) calculation, which was first introduced by Ballasa (1965). The RCA method is able to measure the comparative advantage that a country has in terms of exports to similar

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products that other countries are capable of producing. The RCA approach helps to compare a country's performance in international trade, so it can also be considered by policymakers.

Previous research has examined the palm oil industry and its derivative products such as CPO. Tandra *et al.* (2022), showing that vegetable fats and oils are able to have a positive and significant effect on competitiveness, GDP per capita and the application of RSPO have negative effects. Setyadewanta *et al.* (2016) stated that CPO commodities can be replaced with other vegetable oils such as soybean oil and sunflower. The study also states that the increase in the exchange rate is able to reduce the price of palm oil. More studies by Othman *et al.* (2021), stating that the tax provided by the EU is positively correlated with the competitiveness of CPO. Rosyadi *et al.* (2021) explained that the GDP of importing countries and the number of exports have a positive effect on competitiveness.

Research results by Islamiya *et al.* (2022) shows that the productivity of the CPO industry has declined in Indonesia. However, this decline tends to be smaller in mid-sized companies compared to large companies. Anam & Suhartini (2020) also evaluate the technical efficiency of the use of DEA, allocative, cost, and scale of palm oil companies in Indonesia. The findings show that some regions in Indonesia have low and efficient cost allocation. Nur *et al.* (2022) analyze the technical efficiency of palm oil exports and evaluate the export potential of Malaysia and Indonesia with the SFA approach. Indonesia shows a higher technical efficiency score than Malaysia. Malaysia and Indonesia have different market dominances with great export potential to countries such as China, India, Thailand, and the United States.

There are three previous studies that examined Indonesia's competitiveness as a sample, in the study Ramadhani & Santoso (2019) stated that Indonesia is more competitive in international trade than Malaysia. Indonesia's CPO export market is growing faster. Meanwhile, a study by Ali *et al.* (2019) shows that the competitiveness of Indonesian CPO exports in the United States market is higher than that of India. Furthermore, research by Fatma *et al.* (2019) shows that Indonesia has a strong competitive advantage over the United States, the Netherlands, Malaysia, China, and Singapore. According to him, competitiveness is greatly influenced by the openness of trade and the export value of competitors.

Several previous studies have used the 2SLS simultaneous equation model as a research method to analyze the simultaneous relationship between structure, efficiency, and competitiveness. The Simultaneous Equation Framework was used to study the relationship between structure, behavior, and performance in U.S. manufacturing in the 1980s and 1990s in research Delorme *et al.* (2002). The results show that the structure of the industry does not depend on the current performance of the industry. Second, little evidence has been found that industrial behavior is influenced by the

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structure of the industry. Furthermore, the performance of the industry does not depend on the behavior of the industry, although it is sensitive to the structure of the industry. McCafferty & Bhuyan (2012) tested the relationship between concentration and market forces in the U.S. brewing industry using a contemporary simultaneous Structure-Behavior-Performance (SCP) approach. The analysis period is from 1980-2009. Using a modified SCP model, it was found that higher levels of concentration in the industry had led to higher levels of profitability as measured by the Lerner index.

2. Materials and methods

The purpose of this study is to examine the simultaneous influence between industrial concentration, technical efficiency, and competitiveness of the CPO industry in Indonesia. The data in this study uses a type of secondary data obtained from the publication of several institutions such as the Central Statistics Agency (BPS), UN Comtrade, and the International Monetary Fund. This study uses a simultaneous model approach from the Two Stage Least Squares (2SLS) type. The data used in this study includes parameters such as the number of companies, the area of oil palm land, global CPO prices, sunflower oil prices, and international trade data, including global CPO prices, the total value of Malaysian and Indonesian CPO exports, cooking oil prices, and policies in supporting CPO industry governance.

Table 1 - Variable Operational Definition

Variable	Definition	Formula/Unit	Source
Concentration Ratio of the Four Largest Companies (CR4)	A measure of market concentration that calculates the combined market share of the four largest companies in a given industry. Concentration calculations using CR4 are based on research by Boyle (1973).	$CR_n = \sum_{i=1}^{n} \frac{X_i}{T_j}$ Where: CR_n: Concentration Ratio for n largest companies. X_i: Sales (or output) of the i-th year company in the industry. T_j: Total sales (or total output) of all companies in the industry j. Σ: Summing symbol, summing from the 1st company to the nth largest company.	Central Statistics Agency of the Republic of Indonesia

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Technical Efficiency is measured using the Stochastic Frontier Analysis (SFA) method	The econometric method is used to measure the technical efficiency of an organization or company by considering uncontrollable factors such as environmental factors, government policies, and luck factors. The SFA calculation is based on the formula submitted by Meeusen & van den Broeck (1977) and Aigner *et al*. (1977), followed by the third article by Battese & Coelli (1992).	$\ln Y_t = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + (V_i - U_i)$ where: $\ln Y_t$: The natural logarithm of the output (Y) at time t. β_0: A constant or intercept in a production function. $\ln X_i$: Natural logarithms of the i input (e.g., labor, capital, raw materials). V_i: random error component that follows a symmetrical (usually normal) distribution. U_i: component of technical inefficiencies, which is always a positive value.	Central Statistics Agency of the Republic of Indonesia
Competitiveness (RCA)	Competitiveness is the ability of companies, regions, countries, or between regions to increase income by utilizing productive and sustainable labor and other resources to face competition by maximizing the potential of their superior products (Porter, 1990). RCA calculations refer to UN Trade & Development (2024).	$RCA = \left(\frac{X_{ik}}{X_{im}}\right) / \left(\frac{X_{wk}}{X_{wm}}\right)$ Where: X_{ik}: Export of K Commodities from Country i. X_{im}: Total exports of all commodities from country. X_{wk}: K Commodity Exports from all over the world (W). X_{wm}: Total exports of all world Commodities.	UN Trade
Roundtable on Sustainable Palm Oil (RSPO)	RSPO is certified to promote sustainable palm oil production by developing and promoting green, social and economic practices.	Policy	rspo.org

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International CPO Prices (PCPO)	International CPO price refers to the price of CPO traded in the international market.	USD	World Bank
Packaged Cooking Oil (PCO) Prices	The price of Indonesian packaged cooking oil refers to the price of cooking oil packaged in ready-to-use packaging and produced in Indonesia.	Rupiah (IDR)	Central Statistics Agency of the Republic of Indonesia
Global Sunflower Oil Prices	The price of sunflower oil is measured in US dollars per ton, according to conventions commonly used in international trade.	US Dollars per Metric Ton	International Monetary Fund
Export Value of Indonesian CPO (XCPO)	The value of Indonesia's CPO exports is the total value of all palm oil (CPO) exports carried out by Indonesia in a certain period of time. This value includes the selling price of CPO and its derivative products, minus export costs such as shipping costs, insurance, and export duties.	CPO Export Value = CPO Export Volume x CPO Export Price – Export Cost	UN Trade
Malaysian CPO Export Value (EXM)	The value of Malaysia's CPO exports is the total value of all palm oil (CPO) exports carried out by Indonesia in a certain period of time.	CPO Export Value = CPO Export Volume x CPO Export Price – Export Cost	UN Trade

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Land (LL)	The area of oil palm plantations includes agricultural land used to plant oil palm trees and produce oil palm fruits which are then processed into CPO.	Hectares	Central Statistics Agency of the Republic of Indonesia
Indonesian Industrial Solar Power (PSOLI) Prices	The price of diesel is measured in Indonesian currency units, such as Rupiah per liter or Rupiah per kilogram, according to the general unit used in industry.	Rp	Ministry of Energy and Mineral Resources of the Republic of Indonesia
Biodiesel (BD) Policy	The policy stipulates that the main raw material for biodiesel is CPO, which is produced from palm oil.	Dummy	Ministry of Energy and Mineral Resources of the Republic of Indonesia

Source: Author's Compilation (2024).

According to Gujarati (1993), the simultaneous equation method is a method for solving a group of linear equations consisting of two or more variables. In this method, the equations are solved simultaneously and variable values are generated that satisfy all the equations in the system. There are two types of variables that are included in simultaneous equations: endogenous, that is, variables (whose values) are determined in the model; and predetermined, namely variables whose values are determined outside the model. Endogenous variables are considered stochastic, while predetermined variables are needed as non-stochastic.

2.1. *Identify Simultaneous Equation Systems*

Model identification is needed to determine the estimation method to be carried out. The identification will show whether or not it is possible to obtain structural parameters, a system of simultaneous equations from reduced form parameters. The identification of the simultaneous equation model in this investigation is as follows:

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CR4 = f (RCA, E, PCPO, RSPO, PCO, BD, XCPO)
E = f (CR4, LL, BD, PSOLI)
RCA = f (CR4, E, PCPO, PSFO, RSPO, BD, EXM)

$$CR4_t = \alpha_0 + \alpha_1 E_t + \alpha_2 RCA_t + \alpha_3 RSPO_t + \alpha PCO_t + \alpha_5 PCO_t + \alpha_6 BD_t + \alpha_7 XCPO_t + \varepsilon_{1t} \quad (1)$$

$$E_t = \beta_0 + \beta_1 CR4_t + \beta_2 LL_t + \beta_3 BD_t + \beta_4 PSOLI_t + \varepsilon_{2t} \quad (2)$$

$$RCA_t = \gamma_0 + \gamma_1 CR4_t + \gamma_2 E_t + \gamma_3 PCPO_t + \gamma_4 PCPO_t + \gamma_5 RSPO_t + \gamma_6 BD_t + \gamma_7 XM_t + \varepsilon_{3t} \quad (3)$$

Where:
Formula (1) is the equation model for Concentration; Formula (2) is the equation model for efficiency, and Formula (3) is the model for competitiveness measured using RCA. RCA stands for Competitiveness; CR4 stands for Industrial Concentration Ratio; E is Technical Efficiency; PCPO shows Global CPO Prices; PSFO refers to the global Sunflower Oil Price; RSPO is the RSPO Dummy; BD represents the Biodiesel Policy Dummy; EXM is Malaysia's CPO Export; XCPO represents Indonesian CPO Exports; PSOLI is the Price of the Solar Power Industry in Indonesia; PCO is the Price of Cooking Oil; LL represents the Area of Oil Palm Land in Indonesia; and ε represent the term error.

Endogenous Variables = RCA, E, CR4.
Exogenous Variables = PCPO, PSFO, RSPO, BD, EXM, PCO, XCPO, PSOLI, LL.

Table 2 - Order identification results

Equation	K	k	M	Information	Identification
CR4	9	5	3	K – k > m – 1	Overidentified
E	9	3	2	K – k > m – 1	Overidentified
RCA	9	5	3	K – k > m – 1	Overidentified

Source: Data processed (2023).

Based on Table 2, it shows that the three structural models are overidentified equations so that they can be continued by estimating using simultaneous equations using the Two-stage Least Squares (2SLS) method.

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In addition, the rank condition of identification in econometric analysis is a condition in which a simultaneous linear regression model can be identified or estimated consistently.

Table 3 - Rank Condition

Type	Con Stant	Endogenous Variable Coefficients			Exogenous Variable Coefficient (Predetermine)								
		CR4	E	RCA	PCPO	PSFO	RSPO	BD	EXM	PCO	LL	XCPO	PSOLI
1	$-\alpha_0$	1	$-\alpha_1$	$-\alpha_2$	$-\alpha_3$	0	$-\alpha_4$	$-\gamma_6$	0	$-\alpha_5$	0	$-\alpha_7$	0
2	$-\beta_0$	$-\beta_1$	1	0	0	0	0	$-\beta_3$	0	0	$-\beta_2$	0	$-\beta_4$
3	$-\gamma_0$	$-\gamma_1$	$-\gamma_2$	1	γ_3	$-\gamma_4$	$-\gamma_5$	$-\gamma_6$	$-\gamma_7$	0	0	0	0

Source: Data processed (2023).

In the equation model (1) does not involve PSFO, EXM and LL and PSOL1, it is obtained that at least a matrix A of the order 2x2 has a determinant not equal to zero, namely:

$$|A| = \begin{vmatrix} 0 & -\beta_2 \\ -\gamma_4 & 0 \end{vmatrix} \neq 0$$

In model (2) not involving RCA, PCPO, RSPO, EXM, PCO and XCPO, it is obtained that at least a matrix B of order 2x2 has a determinant not equal to zero, namely:

$$|B| = \begin{vmatrix} -\alpha_2 & -\alpha_3 \\ 1 & \gamma_3 \end{vmatrix} \neq 0$$

In model (3) not involving PCO, LL, XCPO, and PSOLI, at least a matrix C of order 2x2 is obtained with a determinant not equal to zero, namely:

$$|C| = \begin{vmatrix} 0 & -\alpha_7 \\ -\beta_2 & 0 \end{vmatrix} \neq 0$$

Thus models (1), (2) and (3) meet the order conditions so that they can be estimated by the Two-Stage Least Squares Method (2SLS).

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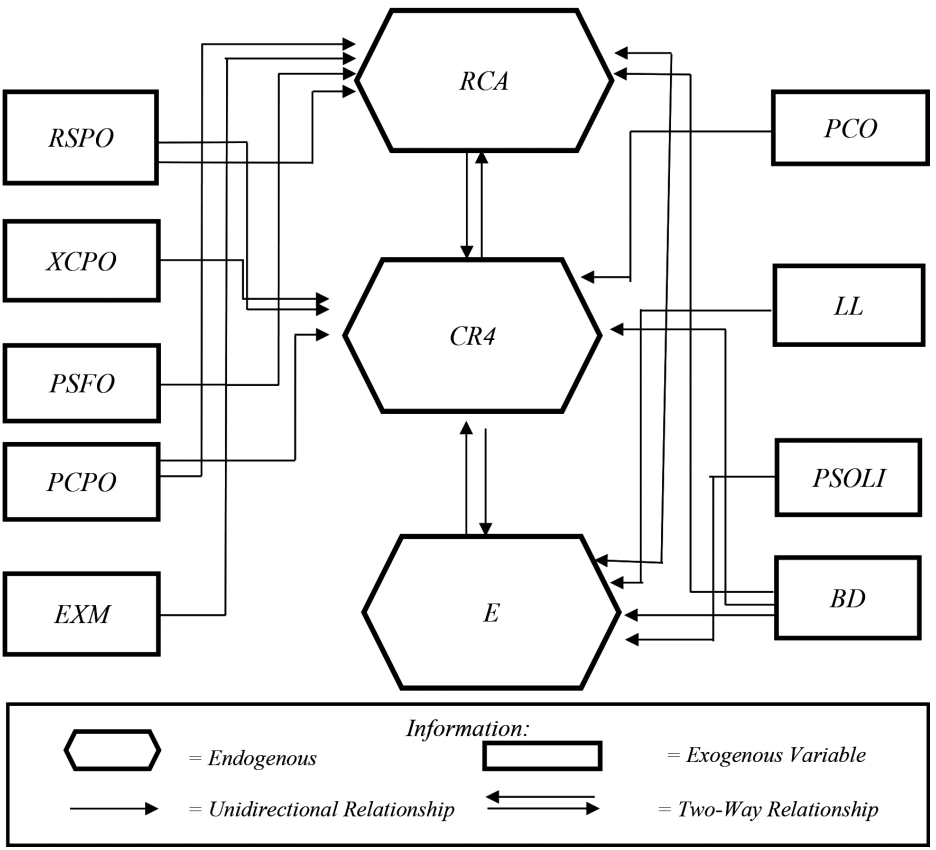
Figure 3 - Framework for RCA, CR4, and E Simultaneous Equations along with other Exogenous Variables



3. Results

3.1. *Endogenous Variable Motion Analysis*

The measurement of the concentration of the CPO industry in Indonesia is carried out through the Four Firm Concentration Ratio (CR4), an analysis method that measures the contribution of the four largest companies to the total industrial output. With an average CR4 value of 12.90 percent in the 2001-2020 period, it can be concluded that the CPO industry in Indonesia has a significant dominance, but still shows a very competitive market tendency towards oligopoly. The figure of 12.90 percent reflects the average

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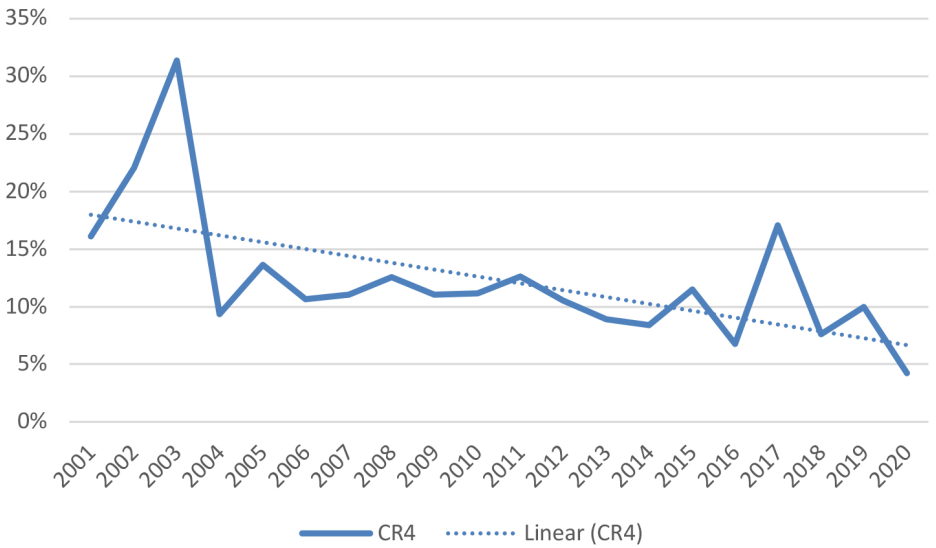
market share held by the four largest companies, giving the impression that the sector tends to create a competitive business environment, but with a tendency to have a few big players dominating.

Figure 4 - Concentration of Indonesian CPO Industry



Source: BPS Indonesia, Indonesian Industrial Agency, UN Comtrade (2024).

In the initial period (2001-2003), a significant increase in the concentration of the palm oil industry (CPO) was observed, peaking in 2003 with a Four Firm Concentration Ratio (CR4) of 31.37 percent. In 2003, there was an increase in export volume by 85.46 percent, reaching a total of 45,160,000 metric tons compared to the previous year. This increase is due to the growth of palm oil production. At this rate, large companies tend to have a significant impact on the total industrial production, reflecting their dominance in the market. However, the dynamics of the industry changed drastically in 2004, where there was a sharp decline of 9.34 percent. This decline indicates the industry's sensitivity to certain external factors. One of the main contributing factors is regulatory changes or fluctuations in global market conditions. Various changes in government and global policies related to CPO and fluctuations in international market demand are the main triggers for the decline in market concentration.

The decline in the concentration of the CPO industry in 2020 was also caused by the spread of the COVID-19 pandemic virus (Hafiz *et al.*, 2021).

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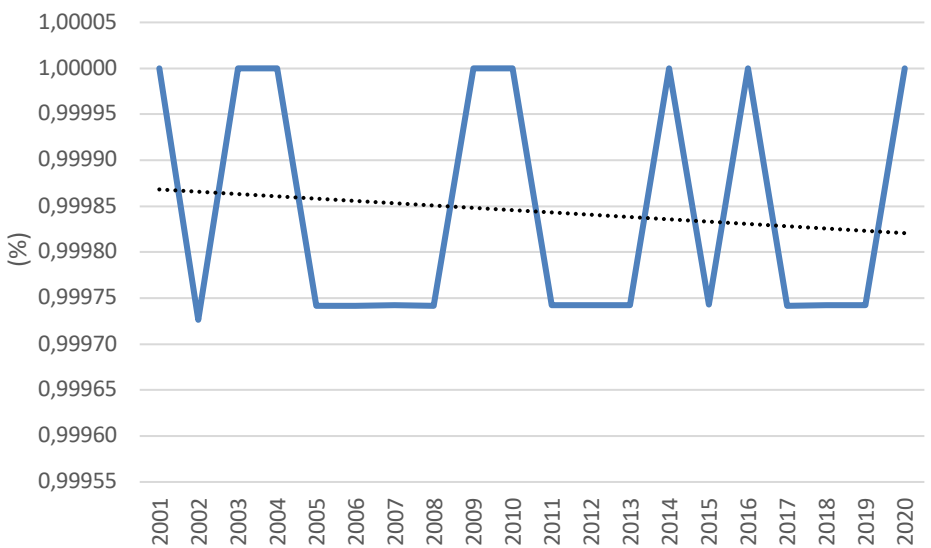
Therefore, there are supply chain disruptions, changes in consumer lifestyles, a decrease in purchasing power and economic activity. Global CPO prices fell 6.32 percent due to the global oil trade war, which had an impact on industrial concentration. In addition, in Indonesia there is a shortage of cooking oil, so the price has soared.

Based on the category, if the technical efficiency measured using SFA is greater than 0.70, then it is included in the efficient category (cut-off value) (Darmawan, 2016; Abdul *et al*., 2022; Hadiguna & Tjahjono, 2017). Based on Figure 5, the results of the calculation of technical efficiency show an average of 0.99. This means that the Indonesian CPO industry has managed to achieve very high technical efficiency by utilizing production inputs efficiently and effectively in producing maximum output.

Figure 5 - Results of Technical Efficiency of Indonesia's CPO Industry



Source: Central Statistics Agency of the Republic of Indonesia (2020).

Investment in more modern technology can strengthen the competitiveness of Indonesia's CPO industry (Harahap *et al*., 2019). Modern technology makes the production process more efficient, from land cultivation to cultivation processes. For example, automation and the use of IoT (internet of things) technology in plantation monitoring can increase crop yields and reduce production costs. In addition, the existence of global criticism

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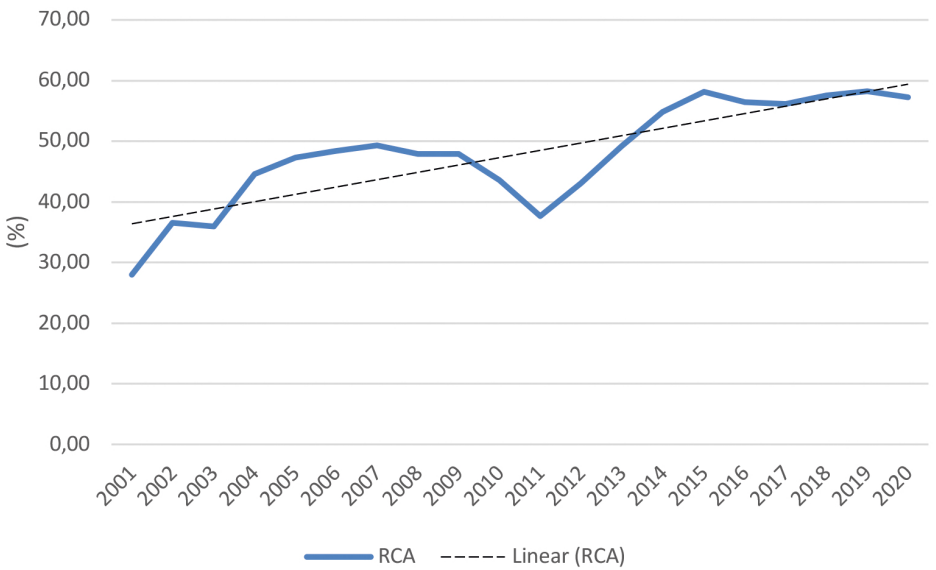
to reduce environmental impact has also made CPO companies apply technology that supports sustainability, Indonesian CPO products are able to be more in demand in markets that care about environmental issues such as the EU.

Figure 6 - Competitiveness of Indonesia's CPO Industry



Source: UN Comtrade, 2001-2020.

The results of the calculation using the RCA method stated that Indonesia has a comparative advantage in CPO exports. The average RCA rate is about 47.88. According to theory, if the RCA number is more than 1, it means that Indonesia is quite dominating the global market. Indonesia is one of the largest palm oil producers in the world, with a very large area of oil palm plantations. Indonesia also has extensive CPO exports, especially to countries such as India, China, and European Union countries. The high RCA shows that Indonesia is able to meet the demand of the international market and compete with other vegetable oil products such as sunflower oil and soybean.

3.2. *Movement Analysis of Exogenous Variables*

The land area in Indonesia is always increasing, reaching 14 million hectares in 2020. This increase in palm oil area has led to an increase in

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CPO production. This allows Indonesia to maintain its position as the first largest exporter to compete with Malaysia. CPO exports contribute greatly to state revenue (Pratama *et al.*, 2023). Indonesia is a large country with abundant resources, so it is expected to always be able to meet the demand of the global market (Hidayat *et al.*, 2023). However, the growth of oil palm land also poses challenges related to environmental and social sustainability, especially sanctions imposed by the world. Components of this challenge include deforestation, habitat degradation, and land conflicts.

The price of packaged cooking oil tends to increase consistently. First, the demand for cooking oil continues to increase in line with population growth and lifestyle changes which tend to lead to an increase in fried food consumption. Second, fluctuations in world crude oil prices have a direct impact on cooking oil prices (Sun *et al.*, 2023). For example, when world crude oil prices fall, cooking oil producers usually reduce production to avoid losses, which in turn can result in price increases. This occurred in late 2008 and early 2009, when world crude oil prices fell significantly due to the global financial crisis and falling demand from the largest consumer countries. In 2020, there was a significant increase in cooking oil prices in Indonesia, which then led to a shortage. Some of the factors that cause this condition are supply disruptions due to the COVID-19 pandemic which affects the cooking oil supply chain from production to distribution. However, in the long term, the general trend suggests that the price of packaged cooking oil tends to increase in line with factors such as inflation, production costs, and increasing demand.

Apart from Indonesia, Malaysia is the main competitor in the CPO production industry at the global level (Schouten *et al.*, 2023). As the countries with the largest CPO production in the world, the two have long competed to dominate the international market. Over the years, Malaysia has taken a leading position as a leading CPO producer. However, as time went on, its position gradually declined, while Indonesia emerged as the main competitor that managed to take over the dominant role in the industry. In observing the dynamics of the industry, it can be seen that both countries experienced a significant decline in CPO exports in 2009. However, the decline turned out to be sharper for Malaysia compared to Indonesia. Indonesia's CPO exports fell 19.37 percent, while Malaysia fell 37.58 percent in the same year. Ahead of 2021, projections show that Indonesia will become the world's largest CPO exporter, accounting for around 58 percent of the world's total CPO exports, while Malaysia only has a proportion of around 31 percent. This signals a shift in the landscape of the CPO industry, where Indonesia has succeeded in asserting its dominance and replacing Malaysia as the main exporter of CPO at the global level.

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World CPO prices have experienced significant fluctuations over the past two decades, with upward and downward trends reflecting global market dynamics and fundamental factors in the palm oil industry. In that period, there was a considerable increase in CPO prices, starting from 2001 with a price of around US$ 287.4583 per metric ton, reaching the highest peak in 2011 with a price of US$ 1193.3700 per metric ton, then declining sharply in the following years, reaching a low point in 2015 at a price of US$ 663.3908 per metric ton. These price fluctuations are influenced by a variety of factors including global demand, production, changes in trade policy, and external factors such as weather conditions. In years where CPO prices are rising, this is often attributed to increased demand from key markets such as China and India, as well as factors such as changes in energy and public health policies that have led to increased biodiesel use. In 2011, data from Bloomberg showed that CPO prices on the Malaysian Derivatives Exchange and the Indonesia Commodity and Derivatives Exchange increased. This increase is triggered by the tightening of rules on the import of vegetable oil from China as well as the possibility of a CPO export tax war between Indonesia and Malaysia, which could lead to a decrease in supply and an increase in prices. However, when CPO prices fall, this can be caused by various factors, including increased global palm oil production, competition with other vegetable oils, and global economic uncertainty.

CPO is the main commodity with the highest number of demands in the world in terms of vegetable oils (Nurcahyani *et al.*, 2018). So, when there is a price change in CPO, it will have an impact on market behavior that triggers changes in other vegetable oil substitution patterns. During the research year, CPO prices fluctuated greatly. In 2009, when the global financial crisis occurred, it led to severe fluctuations in world vegetable oil prices. However, in that year, Indonesian and Malaysian CPO production increased significantly. The increase in production has an impact on suppressing world CPO prices. The implementation of the biofuel policy by the European Union in 2009 also affected the dynamics of the CPO market.

The price of industrial diesel in Indonesia is very uncertain because it is closely related to subsidies. One of the factors that affect the price of industrial diesel is the fluctuation of crude oil prices in the global market, because diesel is a derivative product of petroleum. If the price of crude oil increases, then it tends that the price of industrial diesel will also rise, and vice versa. Geopolitical events, global demand and supply, and energy-related government policies can also affect the price of industrial solar power. In addition to external factors, internal factors such as production and distribution costs also play a role in determining the price of industrial diesel. An increase in production costs can result in an increase in prices, while an increase in distribution costs can also affect prices at the end consumer level.

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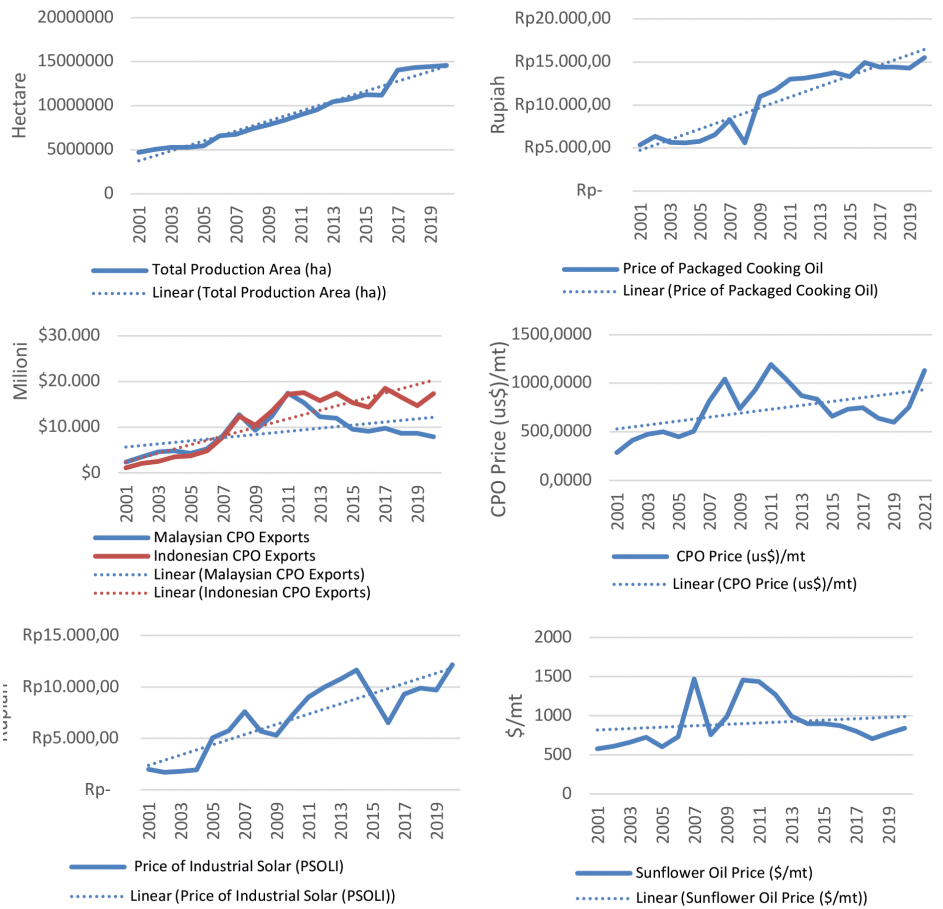
Figure 7 - Movement of land area data, packaged cooking oil, Indonesian and Malaysian CPO exports, CPO prices, industrial diesel prices, and sunflower oil prices



Source: Central Statistics Agency of the Republic of Indonesia, Indonesian Industry Office, UN Comtrade, 2001-2020.

In the Indonesian context, fluctuations in industrial solar prices can also be influenced by domestic factors such as government policies related to energy prices and subsidies, infrastructure conditions, and demand and supply in the local market. The increase in industrial solar power in Indonesia was the highest in 2005, growing by 61.39 percent from the previous year. In 2005, there was a massive reduction in subsidies for oil, including industrial diesel, but with a lower rate of rejection, due to the introduction of a social

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assistance compensation program for low-income households (Ichsan *et al*., 2022). In April 2016 the government froze domestic gasoline and diesel prices even though international prices began to soar, as a result of which industrial diesel prices fell significantly by -39.37 percent (Chelminski, 2018).

One of the vegetable oils that is a competitor to CPO is sunflower oil (Parsons *et al*., 2020). Pricing competition between vegetable oil commodities has triggered global trade conflicts among vegetable oils, affecting the competitiveness of the CPO industry (Hamulczuk *et al*., 2021). The influence of competitor vegetable oil prices on CPO competitiveness has been studied by Inovia (2020); Gan and Li (2014). The price of sunflower oil in the period 2001-2020 has experienced considerable fluctuations. 2007 was the year when global demand for vegetable oils, including sunflower oil, increased. This is due to economic growth in developing countries, especially China and India, which has led to higher consumption of vegetable oils. This high demand makes the price of sunflower oil rise. Since 2010 the world price of sunflower oil has been declining. The arrival of more affordable sunflower oil from Russia and Ukraine has led to a decline in palm oil prices. Both major producers are taking advantage of the depreciation of their currencies to increase their market share. As a result, sunflower oil, which previously had a higher price, is now more economical than soybean oil and only slightly more expensive than palm oil (The Economic Times, 2024). Monitoring vegetable oil price trends and adjusting raw material procurement strategies are important for food industry practitioners to maintain cost efficiency and competitiveness of their products in the market. Consumers who are increasingly concerned about sustainability and environmental impact may prefer products that use vegetable oils with a lower carbon footprint. Therefore, food industry practitioners need to consider sustainability aspects in the selection of raw materials to meet the demand of increasingly environmentally conscious consumers.

3.3. *Descriptive Statistics*

Table 4 shows the range of values for each variable studied, showing significant variation between the highest and lowest values. As an illustration, the RCA variable shows an average of around 47.89, while the BD variable records an average of around 0.25. The results of slope and curtosis data show variations in the characteristics of variable distribution. For example, the CR4 variable has a positive slope (1.65) which indicates a right-skewed distribution, while the PCPO (CPO price) has a negative slope (–0.58) indicating a left-skewed distribution. Other variables tend to be more symmetrical. In addition, the kurtosis values of CR4 (6.07) and PCPO (2.58) above 3 showed significant pointedness in the data distribution, signaling a thicker tail. These results need to be considered in further statistical analysis.

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Table 4 - Descriptive Statistics

	CR4	E	RCA	PCPO	PSFO	RSPO	BD	EXM	PCO	XCPO	PSOLI	LL
Mean	0.13	0.99	47.89	6.62	6.76	0.65	0.25	22.80	9.19	22.89	8.70	15.96
Median	0.11	0.99	48.15	6.62	6.71	1.00	0.00	22.94	9.46	23.35	8.912	15.98
Maximum	0.31	1.00	58.24	7.08	7.29	1.00	1.00	23.58	9.65	23.64	9.40	16.49
Minimum	0.04	0.99	27.98	6.11	6.36	0.00	0.00	21.57	8.59	20.80	7.44	15.36
Std. Dev.	0.06	0.00	8.61	0.27	0.29	0.49	0.44	0.53	0.41	0.87	0.66	0.38
Slope	1.65	0.41	–0.58	–0.10	0.60	–0.69	1.15	–0.72	–0.42	–1.06	–0.99	–0.05
Curtosis	6.07	1.17	2.58	2.28	2.33	1.39	2.33	2.72	1.39	2.81	2.57	1.71
Jarque-Bera	16.92	3.35	1.29	0.47	1.59	3.46	4.81	1.80	2.77	3.80	3.42	1.39
Probability	0.00	0.19	0.53	0.79	0.45	0.18	0.09	0.41	0.25	0.15	0.18	0.50
Number of Sq. Dev.	0.068	3.23E–	1409.6	1.41	1.63	4.55	3.75	5.32	3.28	14.37	8.21	2.78

Source: EViews Release (2023).

3.4. *Simultaneity Test*

The importance of using simultaneity testing is to ensure that in a concentration equation model, all components are arranged simultaneously. Possible simultaneity problems can be identified by examining the relationship between residual effects and endogenous effects.

Table 5 - Simultaneity Test

Variable	Coefficient	PMS errors.	t-Statistics
C	49.1577***	7.7349	6.3553
EF	–48.8295***	7.7476	–6.3025
RCAF	–0.0046***	0.0003	–13.0180
error	1.3125***	0.0388	33.8503
C	49.1577***	7.7349	6.3553
CR4F2	–48.8295***	7.7476	–6.3025
error	–0.0046***	0.0003	–13.0180
C	3085.95***	4577.504	6.7403
CR4F	–73.3592***	9.2770	–7.9076
EF	–3080.66***	4576.612	–6.7302
error	1.5888***	0.4318	3.6799

Note: *** represents statistical significance at 1 percent.

Source: EViews Output (2023).

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Table 5 shows the importance of t-error tests for CR4, EF, and RCAF models. This signifies that (E) and (RCA) collectively affect the concentration variable (CR4). Model E produced noteworthy results, and the same was true for the endogenous variable CR4F. The interpretation shows a reciprocal influence, suggesting that the concentration variable (CR4) also together impacts the efficiency variable (E). The RCA model also produced significant results, covering all endogenous variables CR4F and EF, showing the co-influence of concentration (CR4) and efficiency (E) variables on competitiveness variables (RCA).

3.5. *Exogeneity Test*

The application of the Hausman test was used to evaluate whether the variables in the simultaneous equations of the CR4, E, and RCA models could be classified as exogenous or endogenous variables.

Table 6 - Exogeneity Test Results

Model	**F-stats**
Model 1 CR4F	7.9559***
Model 2 EF	4103.467***
Model 3 RCAF	10.6227***

Note: *** represents statistical significance at 1%.

Source: EViews Release (2023).

Based on the results of the exogeneity test of the CR4F model (Table 6), the F test was obtained at 7.9559 with a probability of 0.001, which is less than $\alpha = 0.05$. That is, rejecting the null hypothesis (Ho), EF and RCAF are variables that influence each other in the equation system simultaneously. In the EF model, the F test is 4103.467 with a probability of 0.0000 or less than $\alpha = 0.05$. This means rejecting the null hypothesis (Ho), CR4F is a mutually influencing variable in a system of simultaneous equations. Meanwhile, in the RCAF model, the F test value is 10.6227 with a probability of 0.0002, which is also smaller than $\alpha = 0.05$. This means that CR4F and EF are mutually influencing variables in a system of simultaneous equations.

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3.6. *Classical Assumption Test*

3.6.1. Normality Test

The normality test was carried out to find out whether the residuals obtained in each model were normally distributed or not.

Table 7 - Normality Test

Type	JB	Probability
Model 1 (CR4)	2.109756	0.348235
Model 2 (E)	3.333333	0.188876
Model 3 (RCA)	0.046455	0.977040

Source: Data processed (2023).

Based on the results of the analysis, the Probability Jarque Bera for model 1, model 2, and model 3 was 0.348235, 0.188876, 0.977040 > α (0.05), respectively, so that H_0 was not rejected (accepted). This means that the residuals follow the normal distribution and the assumption of normality is met.

3.6.2. Autocorrelation Test

The autocorrelation test aims to determine whether or not there is a correlation between the current observation time (t) and the previous observation time (t – 1) that affects each other. A method that can be used to test autocorrelation is the Breusch-Godfrey Serial Correlation LM test.

Table 8 - Breusch-Godfrey Test Serial Correlation LM (Autocorrelation)

Type	Obs*R-squared	Prob. Chi-Square
Model 1 (CR4)	2.503542	0.2860
Model 2 (E)	3.600939	0.1652
Model 3 (RCA)	5.792471	0.0552

Source: Data processed, Eviews Output (2023).

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The results of the autocorrelation test in Table 8 show the Prob value. The Chi-Square for model 1, model 2, and model 3 is 0.2860, 0.1652, and 0.0552 > α (0.05), respectively, so H_0 is not rejected (accepted). This means that there is no autocorrelation in each regression model.

3.6.3. Heteroscedasticity Test

The heteroscedasticity test aims to determine whether there is a variant inequality in the residual regression model. The method that can be used is the Breusch-Pagan-Godfrey test with the following hypothesis.

Table 9 - Breusch-Pagan-Godfrey Test (Heteroskedasticity)

Type	**F-Statistic**	**Prob. F**
Model 1 (CR4)	0.640738	0.7156
Model 2 (E)	1.054218	0.4127
Model 3 (RCA)	1.107990	0.4173

Source: Data processed (2023).

The results of the heteroscedasticity test in the Table 9, show that the Prob F values for model 1, model 2, and model 3 are 0.7156, 0.4127, and 0.4173 > α (0.05), respectively, so that H_0 is not rejected (accepted). This means that there is no heteroscedasticity or variance in each regression model that is the same or fixed (homoscedasticity).

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3.7. *Two-Stage Least Squared Result (2SLS)*

Table 10 - 2SLS Results

Pattern	Variable	Coefficient	T Statistics	Prob. F-stats	R2
Model 1 (CR4)	C	55.1979*	2.0349	0.0000	0.9999
	E	–54.8716*	–2.0281		
	RCA	0.0026***	75.2942		
	RSPO	–0.0310***	–6.0350		
	PCPO	0.0345***	9.6134		
	PCO	0.2070***	11.4368		
	BD	0.0156	1.0209		
	XCPO	–0.0880***	–145.569		
Model 2 (E)	C	0.9963***	1230.364	0.0005	0.6713
	CR4	–0.0010**	–2.2104		
	LL	0.0004***	5.4348		
	BD	–0.0001***	–3.5937		
	PSOLI	–0.0004***	–6.7099		
Model 3 (RCA)	C	–10233.6*	–2.0727	0.0000	0.9952
	CR4	29.3454**	2.2664		
	E	9953.339*	2.0245		
	PCPO	–24.1508***	–6.5609		
	PSFO	–10.7052**	–2.3641		
	RSPO	–5.0142**	–2.8066		
	BD	7.6721***	8.2121		
	EXM	24.5478***	6.6190		

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.
Source: EViews Output (2023).

3.8. *F-Stats Test*

Table 11 - F-Stats Test

	F-stats
Model 1 CR4	13058.6***
Model 2 E	9.2848***
Model 3 RCA	359.2859***

Note: *** represents statistical significance at 1%.
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Based on Table 11, exogenous variables together have a significant impact on equation model 1 (CR4), equation model 2 (E), and equation model 3 (RCA).

3.9. *Industrial Concentration Analysis (Model 1)*

The results show that technical efficiency is negatively and significantly correlated with CR4 in the palm oil industry (CPO) in Indonesia. High technical efficiency is associated with lower production costs and higher profits, thus allowing the company to dominate the market by reducing the number of competitors. This is in line with research conducted by Manjunatha *et al.* (2013); Hidayat *et al.* (2024). In addition, more efficient companies can sell their products at more competitive prices, which further strengthens their dominance in the market. A high CR4 indicates that the industry is dominated by a handful of large companies, reflecting the increasing market concentration. Further, these findings suggest that high competitiveness in the industry can increase market concentration, as large companies tend to leverage their efficiency to expand market share. However, this competitive advantage can also create a more exclusive market environment, where small businesses find it difficult to compete (Crouzet & Eberly, 2019).

Policies at RSPO lower the level of industrial concentration. This certification aims to improve sustainable practices in the CPO Industry. The implementation of such certification increases the costs incurred by the Company (Saswattecha *et al.*, 2015). This policy can be an obstacle for companies that want to enter this industry. The RSPO policy was officially implemented in 2008. Meanwhile, the Government of Indonesia supports the RPPO through the Indonesian Sustainable Palm Oil (ISPO) national certification scheme launched in 2011. When compared to other sustainability initiatives, such as the Forest Stewardship Council (FSC) for the forestry sector or the Rainforest Alliance certification for agriculture, RSPO and ISPO have unique characteristics (Rafael *et al.*, 2018; Munasinghe *et al.*, 2021). The RSPO is more targeted at the international market and is globally recognized as the gold standard for palm oil sustainability, while the ISPO is more focused on domestic legal compliance and strengthening the role of governments in industry supervision. However, several studies show that the main challenge of ISPO is the lack of recognition in the global market compared to RSPO, thus affecting the competitiveness of Indonesian palm oil products at the international level (Hidayat *et al.*, 2018). Along with the growth of the biodiesel industry, this policy is also closely related to efforts to reduce carbon emissions through sustainable fuels. The implementation

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of sustainability standards, both under RSPO and ISPO, can help ensure that feedstocks for biodiesel are produced responsibly.

The European Union is likely to continue to introduce policies that prioritize environmental sustainability and deforestation reduction in the palm oil supply chain. Programs such as RED II (Renewable Energy Directive II) will further tighten the requirements for products imported into the EU, requiring palm oil producers from Indonesia and Malaysia to meet higher sustainability standards. In the future, the EU could impose stricter policies, forcing palm oil-producing countries to increase their production methods, as reflected in the increasing focus on deforestation and Carbon Emission Reduction (Ostfeld & Reiner, 2024). The EU will be very careful in paying close attention to collaborative projects with major palm oil producing countries, such as Indonesia and Malaysia, to support sustainability in the palm oil sector. Projects such as the USAID Palm Oil Smallholder Support Projects in Liberia can serve as a model for broader initiatives in other palm oil-producing countries, with the goal of increasing smallholder incomes while reducing deforestation (Mai, 2024). Through this cooperation, the EU can provide solutions such as green agricultural technology, access to credit, and training of farmers on more efficient and sustainable agricultural practices.

Palm oil is the most widely used vegetable oil for cooking, food processing, cosmetics, oleochemicals and fuels (Oosterveer, 2015). The EU's stricter policy on palm oil imports could affect the supply of raw materials for the food industry, causing an increase in raw material prices and affecting the production costs and selling prices of food products. Additionally, changing regulations and consumer preferences are opening up opportunities for the food industry to innovate by using more sustainable alternative raw materials, such as other environmentally friendly vegetable oils, or developing products with sustainability claims to appeal to specific market segments. Food practitioners need to monitor these changes to adjust their raw material procurement strategies and meet consumer demand that is increasingly concerned about sustainability and environmental impact.

In addition, the increase in CPO prices is able to increase industrial concentration. The increase in CPO prices has the potential to increase profitability and a more competitive position (Shahida *et al.*, 2018). The increase in CPO prices tends to encourage the improvement of the Company's operational efficiency by investing in more modern and sustainable technology. On the other hand, the influence of packaged oil prices has a positive and significant effect on the concentration of the CPO industry (Dey *et al.*, 2021). Biodiesel policy has a positive but insignificant effect on the concentration of the CPO industry, in line with research (Kumar *et al.*, 2013). The biodiesel policy has no effect because the implementation is still relatively new.

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3.10. *Efficiency Analysis (Model 2)*

Based on the findings in model 2 (efficiency), the industrial concentration measured by CR4 has a negative and significant influence on technical efficiency. Large companies concentrated in the four dominant players in Indonesia's CPO industry have significant market power (Destiarni *et al.*, 2021). This concentration has a detrimental impact on technical efficiency because large companies tend to hinder healthy competition in the CPO industry market. In a market dominated by a few large companies, the limited number of potential competitors reduces the pressure to innovate and improve technical efficiency. This happens because large companies are more focused on maintaining market share than aggressively competing, which ultimately lowers the incentive for more efficient technological innovation. Instead, these companies often rely on existing and proven technologies, which lack the drive for efficiency in the production process.

This dynamic demonstrates the need for policies that can balance the market structure by encouraging healthy competition and innovation. For example, regulatory frameworks can mandate or encourage investment in research and development and facilitate technology sharing initiatives that can improve efficiency across industries.

In addition, the land area has a positive and significant influence on technical efficiency. The positive relationship between land area and industrial efficiency highlights the importance of this factor in improving the company's operational performance. Research by Uckert *et al.* (2015) supports these findings, where large land holdings directly increase production capacity and enable economies of scale to be achieved. Companies with large plots of land have greater opportunities to optimize their agricultural practices, such as the application of data-driven fertilization, proper irrigation, and more effective pest and disease management. These measures significantly increase the production of fresh fruit bunches (FFB) per hectare and overall efficiency.

To harness this potential, policies that support equitable land allocation and better access to advanced agricultural technology are needed. Programs that provide land management training and promote sustainable agricultural practices can help small businesses improve their production capacity and efficiency. The integration of these measures into broader sustainability frameworks, such as RSPO and ISPO certifications, can also align industry practices with national and global goals for sustainable palm oil production.

The biodiesel policy has a negative and significant impact on the technical efficiency of Indonesia's CPO industry. The B30 Mandatory Program will be implemented simultaneously throughout Indonesia starting January 1, 2020. Indonesia is also recorded as the first country to implement B30 in the world.

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Biodiesel policies usually increase the demand for CPO as the main raw material for biodiesel production (Kinseng *et al*., 2023). The biodiesel policy can cause fluctuations in CPO prices, as the market must meet the needs of food and energy consumption at the same time. In producing biodiesel from CPO, different processing technologies are needed compared to CPO processing for food products. This means forcing companies to invest in new technologies and infrastructure specifically for biodiesel production. The comparison with other countries' policies also highlights Indonesia's position as a pioneer in the implementation of 30% biodiesel-based blend-based fuels. Brazil, for example, despite being known for its successful biodiesel program, has not implemented a blending level as high as Indonesia. The Brazilian biodiesel market faces different periods, from an initial non-mandatory blend of 2% to an actual blend of 13% in diesel (Rodrigues, 2021). However, Brazil takes a different approach by utilizing more varied raw materials such as soybeans and sugar, which reduces pressure on one particular commodity. Meanwhile, in Thailand, Crude Palm Oil (CPO) is produced from FFB (Fresh Fruit) which is then processed into pure biodiesel (B100). The mixing rate of biodiesel is called B2, B3, B5, and B7, when mixed with fossil diesel by 2%, 3%, 5%, and 7%, respectively (Nupueng *et al*., 2018).

The price of diesel has a negative and significant effect on the technical efficiency of the CPO industry. The transportation of FFB from plantations to processing plants is highly dependent on vehicles that use diesel. The increase in diesel prices increases transportation costs. The use of mechanical equipment such as tractors, excavators, and harvesting machines also relies heavily on diesel. In CPO plants, diesel is widely used to drive generators and machines needed for the palm oil extraction process. When the price of diesel rises, energy costs increase so that it has a direct impact on technical efficiency because the cost per unit of production increases (Procházka & Hönig, 2018). Companies can't quickly switch to more efficient energy sources, so they continue to incur higher energy costs.

3.11. *Competitiveness Analysis (Model 3)*

In the third model of simultaneous equations that analyze the factors affecting competitiveness, the results show that industrial concentration has a positive and significant influence on competitiveness. These findings are in line with research Maier (2013) which shows that industrial concentration allows large companies to achieve production efficiency, enjoy economies of scale, as well as invest in innovation. These advantages ultimately increase the profitability and quality of the CPO products produced. Concentrated firms are also able to stabilize prices and reduce unwanted price volatility,

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both for producers and consumers. The four largest companies that dominate the industry have greater bargaining power and strong influence in regulating market conditions, especially in market pricing. This strong bargaining position also applies in negotiations with suppliers and buyers, providing an additional competitive advantage. Thus, these advantages strengthen the position of the Indonesian CPO industry in international trade, emphasizing the important role of industry concentration in driving market efficiency and competitiveness.

Furthermore, technical efficiency has a positive and significant relationship in influencing the competitiveness of the Indonesian CPO industry. More technically efficient companies can produce more CPO by using fewer resources, such as labor and raw materials. This efficiency contributes to a decrease in production costs, allowing the company to offer more competitive selling prices of CPO in the international market. These lower prices attract buyers from major export markets, such as China, India, and Europe, thus strengthening Indonesia's position in global trade. These findings are consistent with research Islamiya *et al.* (2022) and Kadarusman and Herabadi (2018). An efficient production process not only lowers costs but also improves product consistency and quality through better resource management and quality control. High-quality and reliable products help improve the reputation of the Indonesian CPO industry in the global market, creating a sustainable competitive cycle driven by efficiency and quality.

CPO prices have a positive and significant influence on the competitiveness of Indonesia's CPO industry. These results are supported by the findings Rifin *et al.* (2020); Anyamvu *et al.* (2005); Yanita *et al.* (2020); and Setyadewanta *et al.* (2016). When CPO prices rise, companies in the CPO industry can earn large revenues making it possible to invest more in technology development, productivity improvement, and product quality improvement. Higher prices will increase profits from exports. Higher CPO prices provide incentives for companies to invest in the development of downstream products from CPO, such as cooking oil, biodiesel, and other derivative products.

Lower sunflower oil prices can increase the competitiveness of the palm oil (CPO) industry globally. Sunflower oil and palm oil are two vegetable oils that are often used as substitutes for each other. When the price of sunflower oil falls, consumers and producers tend to choose sunflower oil as a more economical alternative. In addition, low sunflower oil prices will encourage countries such as India, the European Union, and China to increase palm oil consumption. This can affect the dynamics of the global vegetable oil market, including the supply and demand for palm oil. For food industry practitioners, fluctuations in sunflower oil prices can affect production costs and raw material procurement strategies. The increase in the price of sunflower oil could encourage food producers to turn to palm oil as a more affordable

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alternative, while the decline in the price of sunflower oil could increase the price competition between the two vegetable oils. Therefore, monitoring vegetable oil price trends and adjusting raw material procurement strategies are important for food industry practitioners to maintain cost efficiency and competitiveness of their products in the market. In addition, changes in the price of sunflower oil can affect consumer preferences for food products. Consumers who are increasingly concerned about sustainability and environmental impact may prefer products that use vegetable oils with a lower carbon footprint. Therefore, food industry practitioners need to consider sustainability aspects in the selection of raw materials to meet the demand of increasingly environmentally conscious consumers.

The implementation of the RSPO has a negative and significant effect. Certification requires a large cost for CPO producers. These costs include audits, environmental monitoring and operational adjustments in accordance with RSPO sustainability standards. Small and medium-sized producers who do not have access to large capital often struggle to bear these costs. As a result, manufacturers who are unable to compete due to high costs are able to reduce competitiveness and efficiency. Although RSPO is supported by markets in developed countries such as Europe and North America, global demand for RSPO-certified palm oil is still limited. In many countries, especially Asia and Africa, consumers and food producers do not always care whether or not certified palm oil is sustainable, and this policy is ambiguous, especially in Indonesia. The implementation of RSPO is complicated and time-consuming. This is supported by the Indonesian Palm Oil Entrepreneurs Association (GAPKI) which is influential in urging the government to use ISPO so that there is no global condemnation and increased demand for CPO in Indonesia as well as maintaining diplomatic relations with the European Union (Choiruzzad *et al.*, 2021), However, GAPKI also mentioned that the implementation of this sustainability certification is quite high in terms of cost (Supriyono, 2016).

The biodiesel policy has a positive and significant influence on the competitiveness of the CPO industry. These results are also highlighted by the research Kharina *et al.* (2018). The implementation of the biodiesel mandate (for example, B30 in Indonesia, where the biodiesel blend contains 30 percent palm oil), increases the demand for CPO as the main raw material in biodiesel production. This increase in biodiesel mandate increases the volume of palm oil needed to meet the needs of biofuel production. The CPO industry is gaining new market share in the energy sector as renewable energy. With the increasing production of biodiesel from palm oil, countries implementing this policy can reduce their dependence on fossil fuel imports.

Malaysia's CPO exports have a positive and significant effect on the competitiveness of the CPO industry in Indonesia, supported by a study Lim

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et al., (2015). Malaysia as Indonesia's main competitor encourages strong competition. Along with the increase in Malaysian CPO exports, especially to countries with stricter environmental standards, Indonesia will indirectly be encouraged to increase its production standards in order to compete in the same market. In addition, there is a close relationship in the regionalization of ASEAN, making the possibility of knowledge and technology transfer higher. Not only competitors, Indonesia and Malaysia also often collaborate on palm oil trade policies, especially in the face of strict international regulatory barriers from the European Union and other developed countries.

Conclusion

This study examines the simultaneous impact on three research models, namely industrial concentration, technical efficiency, and competitiveness of the Indonesian CPO industry. Model 1 shows that competitiveness, technical efficiency, global CPO prices, RSPO, cooking oil prices, and CPO exports have a significant effect on the concentration of the CPO industry. Model 2 shows that exogenous factors such as industrial concentration, oil palm land area, biodiesel policy, and RSPO have a significant influence on technical efficiency. In addition, on Model 3, exogenous factors such as industrial concentration, technical efficiency, CPO prices, sunflower oil prices, RSPO policies, biodiesel, and Malaysian CPO exports have a significant influence on competitiveness. In addition, the study highlights that the CPO industry in Indonesia shows a high level of concentration, with several large companies dominating the CPO market. Indonesian CPO companies also demonstrate a high level of technical efficiency, which contributes to global competitiveness. Malaysia as a competitor country of Indonesia, shows that the high export of competitors has a positive impact on the Indonesian CPO industry.

In sustainable goals, there are several policies that can be obstacles in the process of increasing the competitiveness of the CPO industry. As in Indonesia, the implementation of ISPO is still very minimal and still ambiguous. The government needs to ensure that regulations related to certification are in accordance with the principles that support the improvement of the SDGs. In addition, by optimizing the implementation of certification, Indonesia will not be criticized by the European Union. The government can provide subsidies or financial assistance schemes to support small companies in obtaining ISPO certification. The government also needs to consider the evaluation of this policy dynamically, following technological developments and market changes. Indonesia and Malaysia must also unite against negative rumors related to the anti-palm oil campaign. As the two main producers of palm oil, the two countries have the same economic

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interest in CPO commodities. Therefore, Indonesia and Malaysia must work together against discriminatory measures from Europe that focus on reducing the use of palm oil in their industries. Governments and industry associations should encourage the adoption of green technologies and efficient production processes through fiscal incentives, such as tax breaks for companies that invest in green technologies.

This study has some limitations, such as the use of a simultaneous model to provide an overview of the relationship between variables, but it has not fully captured the complexity of the European Union's discriminatory discrimination against CPO. The results of this study are mainly applicable to the CPO industry in Indonesia and may not be fully relevant to other CPO producing countries with different market structures. Further research may include social variables, such as smallholder well-being or the environmental impact of RSPO policies. Additionally, a comparative analysis of policies in a competitor country like Malaysia can provide additional insights. In addition, researchers can use panel data with longer time coverage and policy impact more accurately.

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Factors affecting economic profits of stocker cattle farming business in Sakon Nakhon, Thailand

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Abstract

The stocker cattle farming business is an essential component of the cattle production system for farmers in Thailand. Raising stocker cattle independently allows for a reduction in costs related to fattening. This research aimed to investigate the factors influencing the economic profits of farmers in SCFB. The study was carried out in Sakon Nakhon, Thailand. Data were collected via a semi-structured questionnaire through face-to-face interviews with 390 stocker cattle farmers supplying cattle to the Phon Yang Kham Livestock Cooperative Limited in Sakon Nakhon. Data analysis utilized descriptive statistics and binary logistic regression. The results indicated that the majority of the farmers were male, with an average age of 52.78 years and 11.78 years of experience in stocker cattle farming. During an 18-month production period, farmers realized cash profits amounting to 73.43 percent of the total production cost per cattle, whereas the economic profit value was negative. The study identified five factors that significantly impacted the economic profits of SCFB: membership in the association (MA), cattle herd size (CS), feed cost (FC), labor cost (LBC), and selling price (SP). This study provides essential insights into the factors affecting the economic profits of SCFB, which should be considered in policy design aimed at assisting farmers in optimizing stocker cattle farming for profit.

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Introduction

The global food demand has been increasing due to a rapidly growing population (Hoang, 2021), which is one of the biggest challenges in agri-food production. Increasing global beef consumption parallels a surge in global beef production (Office of Agricultural Economics, 2023). The United States is the leading global beef producer and consumer, followed by Brazil and China (United States Department of Agriculture, 2023). In order to cope with the increasing food demand, animal improvement technology has been implemented to increase agricultural productivity related to animals (Dayoub *et al*., 2024), including beef cattle. It brings about a greater growth rate and higher productivity than parents (De Smalen *et al*., 2024).

Beef cattle improvement plays a crucial role in the beef cattle industry across countries. In the United States, selecting traits such as reduced cow weight and increased cumulative weight weaned can improve feed efficiency and reduce methane emissions. Crossbreeding and maintaining genetic diversity through heterotic effectively enhance these traits, contributing to productivity and sustainability (Snelling *et al*., 2022). Effective pasture management and strategic supplementation are crucial for improving productivity in Brazil. It helps maintain optimal animal health and growth rates, reducing the environmental impact per beef unit produced (D'Aurea *et al*., 2021; Lopes *et al*., 2022). In China, the beef cattle industry needs to prioritize production over technological innovation, with targeted training for farm managers to improve efficiency (Xue *et al*., 2024). In Vietnam, the genetic proportion of breeds like Brown Swiss can also be optimized for better productivity outcomes (Bang *et al*., 2022). Beef cattle improvement is important and has been implemented by farmers across countries, including Thailand.

Thailand's government has promoted the adoption of beef cattle farming to develop beef products over the past decade. The government has implemented a project called "The Beef Farm Career Creation Project" from 2016 to 2024, intending to purchase approximately 19,500 stock cows and 97,800 calves from farmers (Office of Agricultural Economics, 2023). Although this program has motivated farmers to produce beef cattle, Thailand experienced a yearly decline with the outbreak of lumpy skin disease. Nevertheless, beef cattle production increased to 1.424 million heads in 2022, marking an 82.48% rise compared to 2021 (Office of agricultural economics, 2022). The growth can be attributed to resolving the epidemic crisis and sustained market demand, leading farmers to expand their beef cow farming operations.

Sakon Nakhon is one of the areas in Thailand with the largest beef cattle population. In 2022, Thailand's beef cattle population reported 289,400 animals, with 5,013 labeled as fattening cattle (Office of agricultural

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economics, 2022). Pon Yang Kham Breeding Cooperatives N.S.C. Ltd plays an important role in farmers' beef cattle raising business in Sakon Nakhon. Pon Yang Kham Cooperatives monitor and regulate the production standards for members' cattle raising, breeding procurement, concentrated feed production, slaughtering, and cutting according to international regulations. The Phon Yang Kham's beef cattle breed originates from a crossbreeding program between Thai and French cattle, which involved using semen from three distinct breeds of beef bulls: 1) the Charolais breed, which originated in France and served as the primary breed; 2) the Simmental breed, which originated in Switzerland, and 3) the Limousine breed, which also originated in France (Chantanusornsiri, 2018). Phon Yang Kham beef cattle have been widely popular and renowned among Thai and international consumers. Besides, Phon Yang Kham beef has also been registered as a Geographical Indication (GI) Sakon Nakon's product since 2016, further increasing its value and reputation (Sakon Nakhon Provincial Public Relations Office, 2022).

The beef cattle farming system in Sakon Nakhon comprises three categories: cow/calf production, stocker production, and fattening. However, the stocker cattle for entering the fattening process came from two distinct sources: 1) stocker cattle purchased from Phon Yang Kham Cooperative's members, who raise stock cattle to sell to other members, or using from the farmer's stocker cattle, and 2) stocker cattle purchased from external sources, which is must be met the breed specified by the Phon Yang Kham cooperative, with a 50% European bloodline. Chaosap *et al.* (2019) reported that approximately 77.20% of fattening cattle farmers purchased stocker cattle from external sources. Purchasing stocker cattle for fattening accounted for 73.90% of the total cost of fattening cattle (Sarma *et al.*, 2014). By allowing farmers to raise stocker cattle, the expenses associated with fattening can be minimized (Millen *et al.*, 2011). Stocker cattle refer to cattle that attain approximately two years of age or a weight of 400 kilograms. These cattle are raised from weaned calves, generally around six months old. Cattle in stocker production were permitted to graze and provided with supplemental feed to fulfill nutritional needs. Therefore, stocker cattle production is considered essential to beef cattle farmers.

Although smallholder farmers have adopted beef cattle production, they still face the problem of high production costs. Rapankum *et al.* (2022) reported that beef cattle production cost in Sakon Nakhon was US$ 2054.69 per head per year, and they earned an annual profit of US$ 41.81 per head. However, only cash income contributed to the profit, which did not represent the farmer's actual profit (Hariyanto *et al.*, 2021). Furthermore, the Sakon Nakhon beef cattle farmers traditionally relied on family labor to store rice straw for their livestock, which resulted in high economic costs (Rapankum *et al.*, 2022). Hence, the application of economic profit theory is needed.

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Economic profit demonstrates the actual production cost, and examining the opportunity cost of alternative uses for resources within the firm is also never neglected. Economic profit is the difference between total revenue and total costs, with total costs encompassing both explicit and implicit costs (Barnard *et al*., 2020).

In beef cattle farming, production cost is affected by various factors such as production volume, roughage prices, concentrates, labor, and calf prices (Achmad & Mulyo, 2019). Some studies on factors influencing the profitability of beef cattle farming have been conducted in different regions. In Tajikistan, the research by Jobirov *et al*. (2022) claimed that the profitability of beef cattle farming among farmers was significantly affected by factors such as education level, family size, farming experience, pasture availability, land size owned, selling contracts, feed costs, medication expenses, access to credit, and sales costs. In northern Australia, the timing of calving and nutritional management were key to improving reproductive rates, which directly influenced economic returns (McCosker *et al*., 2022). Similarly, higher calving rates in Thailand were associated with better herd management practices (Panbamrungkij *et al*., 2024). Efficient feed management is crucial, as demonstrated by the profitability of fall-calving herds with added hay sales in the U.S., which benefit from strategic herd size management and fertilizer use (Tester *et al*., 2019). Additionally, herd health and genetics, access to veterinary services, and pasture availability are critical, as they directly impact production costs and cattle health (Jobirov *et al*., 2022; Severe & ZoBell, 2011). Socioeconomic factors such as education level, access to credit, and farming experience also play a significant role in profitability, influencing farmers' ability to adapt to challenges like climate change (Jobirov *et al*., 2022; Putri *et al*., 2023). Therefore, the profitability of beef cattle farming is influenced by a multitude of factors, including economic, environmental, and management aspects. However, there is currently no documented study examining the factors that influence the profitability of beef cattle farming across the various systems: cow/calf production, stocker production, and fattening, as indicated by the previous research. Most of the past research has been done on fattening systems. Besides, the profitability of the previous studies was not identified as economic profit and/or accounting profits. Therefore, this paper provides insight into the stocker farming system by addressing these areas.

The two objectives of this research were established: (1) to describe the characteristics of stocker cattle farmers and their farm's profile in the study region and (2) to determine factors that affect the economic profits of the stocker cattle farming business of the stocker cattle farmers. This study seeks to understand better the performance and economic contributions of stocker cattle farming by smallholder farmers in Thailand. Farmers can reduce

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risk and use opportunities to improve their financial performance. (Tuovil *et al*., 2024; Chaisombut *et al*., 2022; UT Institute of Agriculture, 2020). It helps policymakers and stakeholders in the agribusiness sector assess their profitability and competitiveness (Achmad & Mulyo, 2019; Jobirov *et al*., 2022). The paper is structured as follows. The next section briefly describes the research methodology. Then, key results and a discussion of the research are presented. The final section is about conclusions and implications.2. Materials and methods

1. Sampling Design and data collection

A sample selection utilized a purposive and snowball randomized sampling technique to determine the sample size of 390 stocker cattle farmers for an unknown population size with a confidence level of 95% and a sample error of 5% based on Cochran (1977) formula. A structured questionnaire was used as a tool for data collection. The two sections of the questionnaire were developed to collect data. The first section contained information about the farmer's demographics, farm profile, and economic cost and return of stocker cattle farming, while the second section consisted of factors affecting the economic profits of stocker cattle farming. The questionnaire was reviewed and tested for content validity by five experts in the field of study and then pre-tested with 30 stocker cattle farmers. The reliability of the interview questionnaire was determined using the formula for calculating the alpha coefficient according to Cronbach's method (Cochran, 1977). The result of finding the confidence value of the questionnaire was 0.88, which is higher than 0.70 (Terwee *et al*., 2007). Improved the interview form and presented it to experts for corrections and improvements until the tool was effective. The researcher has improved and used the complete interview form with the sample group. The farmers who run the business of raising stocker cattle for sale to members of Phon Yang Kham Livestock Cooperative Limited., Sakon Nakhon Province, to continue fattening cattle were targeted as the population of this research. Data were collected over one year through face-to-face interviews with the farmers via a semi-structured questionnaire.

2. Theoretical framework

Economic profit provides a framework for this research. Economic profit depicts the difference between total revenue and total costs, with total costs encompassing both explicit and implicit costs. An explicit cost comprises payments to resource suppliers, such as land, labor, materials, fuel, and

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comparable goods. Implicit cost refers to the non-cash expenses associated with production by examining the opportunity costs of alternative uses for resources within the firm (Barnard *et al*., 2020). Economic profit can be written as the formula (Okrenets, 2022):

Economic profit = Total Revenue – (Explicit Costs + Implicit Costs)

Many factors, including economic, environmental, and management aspects, influence the profitability of beef cattle farming. In this research employed predictors as follows;

Education positively influences farmers' income, suggesting that higher education correlates with increased economic profits in beef cattle farming (Asnawi *et al*., 2020; Utami *et al*., 2022).

Household size: large households have more family members available for employment; however, this may result in diminished incomes if the workforce exceeds the optimal threshold (Islam, 2024). Large households incur increased expenses, potentially impacting the profitability of beef cattle farming (Akello & Mwesigwa, 2023).

Off-farm income enhances farmers' capital, enabling investments in animal feed, health, and breeding, potentially increasing production and profits (Anang & Apedo, 2023). Furthermore, off-farm employment among farmers improves income distribution, enhancing financial stability and decreasing reliance solely on beef cattle income (Adam *et al*., 2022).

Experienced farmers demonstrate superior management and decision-making skills, which are crucial for determining optimal selling times for beef cattle and managing associated costs. This factor is crucial for profit generation (Jacinto *et al*., 2022). In Tajikistan, the average age of beef farmers was 52.73 years, and their experience enhanced the profitability of operations, enabling them to leverage their knowledge to maximize returns (Jobirov *et al*., 2022).

Membership in an association enhances profits and efficiency for members compared to non-members, as it provides access to services and support due to proximity to the production site (Dang, 2017). Conversely, members of distant groups may experience reduced profits compared to local farmers, leading to diminished profitability in beef cattle farming (Ali & Flinn, 1989).

The cattle herd size is a critical determinant of farmers' income, as evidenced by Roessali *et al*. (2011), and is statistically significant in enhancing farm profits, according to Mumba *et al*. (2012). Larger herds on farms are associated with increased net profits per head (Boggs & Hamilton, 1997).

Ownership of land enables farmers to modify their land management practices in diverse ways, particularly regarding animal husbandry. This

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positively impacts pasture quality and beef cattle health, facilitating weight gain and enhancing returns. This also decreases reliance on the acquisition of animal feed (Adom *et al*., 2024). Furthermore, land ownership diminishes land rental expenses, directly enhancing profits by reducing overall production costs (Wahyuni & Sulistiyowati, 2015).

Ownership of pasture facilitates the effective management of pasture quality, subsequently enhancing profits from cattle fattening (Dos Santos *et al*., 2024). Furthermore, more cattle can be raised within a confined area. This will enhance the economic efficiency of cattle farming (Gianetti & Filho, 2024).

Feed cost - The expense associated with animal feed is a critical determinant of profitability for farmers involved in the beef cattle industry (Muyasaroh *et al*., 2015), as it directly influences the weight gain of cattle (Sumaryanto *et al*., 2024). Cattle farming utilizes a combination of concentrates and roughages in animal feed.

Labor costs significantly influence livestock farming. Effective management of labor costs can lead to increased profits (Otampi *et al*., 2017). Technological advancements influence the management of labor expenses. Compared to conventional beef cattle production systems, this approach necessitates significantly more labor and frequently yields lower profitability (Trukhachev *et al*., 2022).

Transportation costs significantly influence the overall production expenses associated with beef cattle farming. The decision to supplement the diet and implement other operational strategies is influenced, leading to improved financial outcomes (Alonso *et al*., 2019). Selecting an appropriate vehicle can alleviate stress and enhance the health and performance of cattle. This leads to enhanced economic returns (Thomson *et al*., 2015).

The selling price is the primary factor influencing the profitability of the beef cattle business, exhibiting a positive correlation (Langemeier, Mintert, *et al*., 1992). This factor is the primary determinant of profit variation (Mintert *et al*., 1993).

3. Data analysis and model specification

This research employed the binary logistic regression analysis, which was utilized to determine factors affecting the economic profits of the stocker cattle farming business. According to Greene (2003), the binary logistic regression model is derived from the linear probability model;

$$\begin{aligned} Pi &= F(Y) \\ &= F(\alpha + \beta_i X_i) \\ &= 1/(1+e^{-Y}) \end{aligned}$$

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where

Pi is the probability of a farmer having economic profits in the stocker cattle farming business, depending on the Xi factor.

E is 2.718 (base for logarithm).

Y is an opportunity for farmers to gain economic profits in the stocker cattle farming business. There are two values: Y = 0 means economic profit in the stocker cattle farming business <= 0, and Y = 1 means the economic profit in the stocker cattle farming business > 0.

The equation can be written as follows:

$$Y = \alpha + \beta_1 ED + \beta_2 HS + \beta_3 OF + \beta_4 PE + \beta_5 MA + \beta_6 CS + \beta_7 LO + \beta_8 PA + \beta_9 FC + \beta_{10} LBC + \beta_{11} LOC + \beta_{12} LOC$$

Table 1 describes the independent variables used to determine the economic profits of farmers in the stocker cattle farming business in Sakon Nakhon, Thailand.

Table 1 - Description of The Variables

Independent Variables	**Description and Measurement**	**Symbol**
Education	Education level (years)	ED
Household size	Number	HS
Off-farm income	1 = Off-farm income 0 = Otherwise	OF
Production experience	Years	PE
Membership in association	1 = Member 0 = Non-member	MA
Cattle herd size	Number of beef cattle	CS
Land owned	Land owned (rai)	LO
Pasture availability	1 = Yes 0 = No	PA
Feed cost	Cost of feed (baht/head)	FC
Labor cost	Cost of labor (baht/head)	LBC
Transportation cost	Cost of transportation (baht/head)	TOC
Selling price	Cattle sale price (baht/head)	SP

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4. Results and discussion

4.1. *Respondent's profiles*

Table 2 indicates that the stocker cattle farmers were primarily male (77.95%), with females comprising 22.05%. This finding aligns with the study conducted by Wongnaa *et al*. (2018), indicating the dominance of male farmers in maize cultivation in Ghana. The average age of farmers was 52.78 years. The finding is consistent with the research conducted by Rapankum *et al*. (2022), which revealed that the average age of dairy farmers in Thailand was 49.94 years old. Approximately 73.09% of stocker cattle farmers report having attained an elementary school education level. The farmers had an average household size of 4.28 individuals. The average number of farmers involved in stoker cattle farming per household was 1.41 people. The farmer had an average of 11.78 years of experience in stocker cattle farming. These results are similar to the scenario of a small-scale farmer in Thailand.

Table 2 - Characteristics of the Stocker Cattle Farmers

Characteristics	**Percentage**
Gender	
Male	77.95
Female	22.05
Average ages (year)	52.78
Education	
Primary school	73.09
Secondary school	21.02
Bachelor's degree or higher	5.89
Average family members (people)	4.28
Average family members involved in stocker cattle farming (people)	1.41
Average experience in stocker cattle farming (years)	11.78

Source: own survey computation, 2021

4.2. *Economic costs and returns of the stocker cattle farming business*

Table 3 shows the average economic costs and returns from the 18 months of stocker cattle farming. The findings discovered that the stocker cattle farmers received a net profit of USD447.99 per head, accounting for 73.43 percent of the total production cost. However, the economic profit from stocker cattle showed that farmers lost USD111.73 per head. Farmers spent more money on

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variable costs in production, accounting for 97.81 percent of the total cost, and the fixed cost represents 2.19 percent of the total cost. The stocker calve was found to have the highest expense (52.78%), followed by roughage cost (27.44%) and labor cost (12.20%). Fixed costs occupied a small portion of total production costs (2.19%). The return from the stocker cattle farming business was found to have an average total return of USD1,058.05 per head, which consists of income from selling stocker cattle to farmers who are members of the Phon Yang Kham Livestock Cooperative Limited, Sakon Nakhon Province, equal to USD987.40 per head and income from manure USD70.65 per head.

Table 3 - Economic costs and returns of raising cattle for 18 months

Component	Cash (USD/ Head)	(%)	Non Cash (USD/ Head)	Total (USD/ Head)	(%)
1. Total cost	**610.06**	**100.00**	**559.72**	**1,169.78**	**100.00**
1.1 Variable cost	**598.15**	**98.05**	**546.03**	**1,144.18**	**97.81**
Stocker calves	445.75	73.07	171.60	617.35	52.78
Concentrate feed	33.78	5.54	–	33.78	2.89
Roughages	73.30	12.01	247.65	320.95	27.44
Molasses	1.92	0.31	–	1.92	0.16
Mineral supplement	0.41	0.07	–	0.41	0.03
Transportation	6.01	0.99	–	6.01	0.51
Breeding	6.22	1.02	–	6.22	0.53
Labor	26.60	4.36	116.11	142.71	12.20
Electricity, water, and gasoline	4.17	0.68	–	4.17	0.36
Opportunity of variable cost	–	–	10.67	10.67	0.91
1.2 Fixed cost	**11.91**	**1.95**	**13.68**	**25.59**	**2.19**
Interest	11.91	1.95	–	388.17	1.02
Land use	–	–	0.71	23.17	0.06
Property and equipment depreciation	–	–	12.97	422.73	1.11
2. Total income	**1,058.05**			**1,058.05**	
2.1 Selling price	987.40			987.40	
2.2 Manure	70.65			70.65	
3. Net profit	**447.99**	**73.43**		**–111.73**	**–9.55**

* Exchange rate: 32.59 THB/USD on January 3, 2018 (Bank of Thailand, 2024).

Source: Own survey computation, 2018.

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The results are consistent with Ruff *et al.* (2016), reporting that stocker cash costs per person include the purchase of stocker calves USD786,983, feeding USD42,625, gathering, trailing, trucking, sorting USD33,944, marketing USD33,560 and other 40,427. According to Peel (2006), it was found that stocker costs of production consisted of a purchase price of 75 to 8 percent, feed and forage cost of 8 to 15 percent, the interest cost of 2 to 3 percent, marketing costs of 2 to 3 percent, veterinary and medical cost 2 to 3 percent, death loss 1 to 3 percent and labor and equipment 1 to 2 percent, respectively. Consistent with Langemeier *et al.* (1992a) the total cost of raising fattening cattle per head was USD888.22, with the highest cost being the feeder cost of USD612.57 followed by the feeding cost of USD251.70. Consistent with Anderson *et al.* (2004), the highest cost was calf USD84.61, followed by forage USD73.88 and hay USD55.00, respectively. This finding is inconsistent with Miller *et al.* (2001). The top three economic costs are feed cost of USD239, family labor cost of USD50.98, and capital charge of USD50.89, respectively. Inconsistent with Jobirov *et al.* (2022) reported that the top 3 costs per cow of fattening cattle were feeds of USD44.51, followed by medicines (treatment), which was USD19.85 and husbandry labor of USD9.95, respectively.

4.3. *Factors affecting the economic profits of the stocker cattle farming business*

Before running the regression, this research employed the Pearson product-moment correlation to test whether there is any multicollinearity issue among the predicting variables. Grove *et al.* (2012) state that the correlation coefficient (r) criteria between two predicting variables of less than 0.65 meet no multicollinearity issues. The correlation test results revealed that the variables used in this research are not highly correlated, as the correlation coefficient is less than 0.65. Therefore, there is no issue of multicollinearity in this research model. The fitness test of the variables in the model is equal to 185.319, which is greater than 15.51 ($\chi^2_{(0.058)}$), at 0.000 significant level, which is less than 0.01. These results indicate that at least one variable in the research model affects the economic profitability of the stocker cattle farming business. Nahelkerke's pseudo-R^2 prediction coefficient was 0.561. The goodness of fit test (Vanichbuncha, 2011) using the Hosmer and Lemeshow method, the value was 7.956, which was less than 15.51 ($\chi^2_{(0.05,8)}$), and the p-value was 0.438. Therefore, it can be concluded that the research model is appropriate.

Binary logistic regression analysis with the enter method was employed to determine factors influencing the stocker cattle farming business. The results

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revealed that membership in an association (MA), cattle herd size (CS), feed cost (FC), labor cost (LBC), and selling price (SP) were significantly affecting the economic profit of the stocker cattle farming business ($p < 0.01$) (see Table 4).

Table 4 - Results of the binary logistic regression analysis

Variables	B	SE.	Wald	df	Sig.	Exp(B) Odds Ratio	95% C.I. for EXP(B)	
							Lower	Upper
Constant	–9.984	2.698	13.696	1	0.000	0.000		
ED	0.035	0.056	0.386	1	0.534	1.036	0.927	1.157
HS	0.099	0.120	0.684	1	0.408	1.104	0.873	1.395
OF	0.367	0.607	0.364	1	0.546	1.443	0.439	4.745
PE	0.045	0.025	3.419	1	0.064	1.047	0.997	1.098
MA	–0.880	0.333	6.974	1	0.008***	0.415	0.216	0.797
CS	0.256	0.075	11.517	1	0.001***	1.292	1.114	1.497
LO	–0.024	0.028	0.735	1	0.391	0.976	0.924	1.031
PA	–0.144	0.784	0.034	1	0.854	0.866	0.186	4.023
FC	–0.020	0.003	50.920	1	0.000***	0.980	0.975	0.985
LBC	0.011	0.004	7.650	1	0.006***	1.989	0.982	0.997
TOC	0.048	0.027	3.093	1	0.079	1.049	0.995	1.106
SP	0.015	0.003	34.961	1	0.000***	1.015	1.010	1.020

***, **, * Significant at 0.01 and 0.05 level, respectively.
Note: Chi^2 (12) = 185.319; Prob > chi2 = 0.00 **; Pseudo R^2 = 0.561.
Source: Own survey computation, 2021.

The results of the binary logistic regression analysis for the variables found to be statistically significant, as indicated in Table 4, will next be discussed.

Membership in an association: being a member of an association (MA) has a significant and negative impact on the economic profit of the SCFB ($\beta = -0.880$, $p < 0.01$, Exp(B) = 0.415). The finding suggests that farmers recognized as association members had 0.415 times less chance of making an economic profit from the SCFB than unincorporated or non-member farmers. This outcome aligns with Dang (2017) research, which noted that membership in a farmer's group yielded a negative regression coefficient that was statistically significant at the 0.05 level.Hence, when farmers participate

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as group members, their likelihood of achieving higher profits in the stocker cattle farming business diminishes. Joining an economic group may require farmers to allocate time to group activities. Consequently, farmers had reduced the time available to raise stocker cattle.

Cattle herd size: stocker cattle herd size (CS) positively and significantly influences the economic profit of the stocker cattle farming business ($\beta = 0.256$, $p < 0.01$, Exp(B) = 1.292) The finding indicates that stocker cattle farmers with larger stocker cattle herd sizes were 1.292 times more likely to earn economic profit from the stocker cattle farming business. The findings align with Apasedanya *et al*. (2023), demonstrating that herd size in fattening operations significantly influences profitability, as a larger population correlates with enhanced production efficiency and reproductive rates. An analysis of the fattening business indicates profitability, demonstrated by a benefit-cost ratio of 1.9. This finding aligns with Roessali *et al*. (2011), who identified the number of cattle as the primary factor influencing the income of cattle farmers in Central Java province. The findings align with Mumba *et al*. (2012), indicating that the herd size of dairy cows (milk cows) was statistically significant ($p < 0.01$). The profits of small dairy enterprises increased as a result. Consequently, farmers must be incentivized to optimize cattle size to sustain stocker production efficiency.

Feed cost: feed cost (FC) has a significant negative impact on the economic profit of the stocker cattle farming business ($\beta = –0.020$; $p < 0.01$; Exp(B) = 0.980). The results suggest that farmers facing higher feed costs have 0.989 times lower chances of achieving economic profit in the stocker cattle farming business. The findings align with Bandara & Dassanayake (2006), who identified feed price as a significant factor influencing the profitability of small-scale chicken farms, exhibiting a negative coefficient at the 0.01 statistical significance level. The findings align with Lumenta *et al*. (2024), indicating that the feed cost in the beef cattle sector for farmers in North Bolaang Mongondow Regency has a significant impact on the profits of calf farmers ($p < 0.01$). Sumaryanto *et al*. (2024) asserted that animal feed prices significantly positively influence the income of beef cattle business farmers ($p < 0.05$). Similarly, research by Muyasaroh *et al*. (2015) indicates that feed cost significantly affects the profitability of beef cattle, as demonstrated by the analysis of income over feed cost in beef cattle fattening. In Bantul District, the feed cost per unit of weight gain was Rp15,193.47, whereas in Sleman District, it was lower at Rp9,615.67. The higher feed cost in Bantul District contrasts with the income over feed cost in Sleman District, which is Rp10,094.44, compared to Rp9,892.32 in Bantul District. This suggests that effective feed cost management is crucial for enhancing profitability.

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Labor cost: labor cost (LBC) determined the economic profit of the stocker cattle farming business positively and significantly ($\beta = 0.011$; $p < 0.01$; Exp(B) = 1.989). The results suggest that farmers with raised labor costs are 1.989 times more likely to achieve economic profit in the stocker cattle farming business. The possible reason is that efficient use of labor results in higher productivity and profits. This finding aligns with Popescu (2014), who identified material and labor costs as critical factors influencing the total cost of milk production, demonstrating a strong positive correlation with income from milk sales. Similarly, research conducted in North Minahasa Regency, Indonesia, revealed that labor wages and feed prices significantly impact the profitability of beef cattle farming, highlighting the necessity of effective labor cost management to sustain profitability (Otampi *et al*., 2017). In addition, a study in North Bolaang Mongondow Regency indicated that labor, feed, and calves significantly influenced the profit margins of cattle farmers, highlighting the importance of efficient labor management for enhancing profitability (Lumenta *et al*., 2024).

Selling price: the selling price (SP) has positively and significantly affected the economic profit of the stocker cattle farming business ($\beta = 0.015$; $p < 0.01$; Exp(B) = 1.015). The results showed that farmers with a higherselling price of stocker cattle had a 1.015 times chance of making more economic profit from the stocker cattle farming business.This finding aligns with the research conducted by Elfadl *et al*. (2015), which examined the association between the profitability of beef farming and the selling price of live animals, revealing that profitability rises as live animal prices increase. Langemeier *et al*. (1992a) reported that the selling price positively correlates with the profit of feedlot steers. In their study, Mintert *et al*. (1993) identified the price of fed cattle as the primary determinant of the profitability of weight-placed steers. Prasetyo *et al*. (2012) asserted that the selling price should be established to guarantee the profitability of the beef cattle farming enterprise. Villanueva (2022) emphasized that the study of the Mexican beef market demonstrates that price transmission from international to domestic markets influences local selling prices, thereby affecting profitability.

Conclusions

The stocker cattle farming business (SCFB) plays a vital role in the cattle production system among farmers in Thailand. Raising stocker cattle independently allows for a reduction in costs related to fattening. Economic profit analysis allows farmers to assess their business's long-term viability, yet research on the factors influencing the economic profit of the SCFB remains limited. Therefore, it is essential to identify the factors that may influence the economic profit of farmers' SCFB.

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This study enhances the existing scientific literature by examining factors influencing the economic profit of stocker cattle farming in Thailand. It extends economic profit theory through descriptive statistics and binary logistic regression analysis to identify and assess factors impacting economic profit in the SCFB. The findings indicated that the majority of stocker cattle farmers were male, with an average age of 52.78 years, and had attained education at the primary school level. Farmers had an average of 11.78 years of experience in stocker cattle farming, with at least one family member participating in this activity. The economic analysis of the SCFB revealed negative profits, indicating that small-scale stocker cattle farming should be phased out in the long term. The analysis emphasized that the economic profit of the SCFB among farmers was influenced by factors such as cattle herd size, labor costs, selling prices, association membership, and feed costs. Therefore, these factors could actively lead to variation in economic profit for the SCFB among farmers.

Findings suggested that for the long-run stocker farming business, farmers ought to incorporate additional household agricultural activities to support family income. Furthermore, it is crucial to promote the involvement of a new generation of young farmers in household agricultural activities. Regarding managing the stocker cattle farming business, government institutions ought to provide education to farmers about the benefits of establishing farmer groups and disseminate information concerning the economic scale of the SCFB. Furthermore, it should prioritize reducing feed costs by utilizing local raw materials for animal nutrition. Conduct training sessions to improve productivity in stock cattle farming for farmer associations, enhancing their negotiation skills for better cattle pricing. This approach can potentially increase the incomes of farmers engaged in stocker cattle farming and enhance the long-term stability of their livelihoods. This study theoretically enhances the existing literature on factors affecting the economic profitability of stocker cattle farming among smallholder farmers in Thailand. Future research should concentrate on cow-calf production and fattening systems across the country, as this study is limited to Thailand Acknowledgments.

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Innovative behavior of family farmers in Brazil in the face of innovations in the agricultural sector

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Abstract

Innovation in family farming plays a critical role in regional economic and social development by introducing new products, technologies, processes, and attitudes. This article aims to evaluate the innovative behaviors of family farmers in southern Brazil concerning agricultural sector innovations. We conducted a quantitative survey of 442 family farmers, employing partial least squares structural equation modeling and multi-group analysis as our analytic methods. Our results reveal both direct and indirect relationships among the dimensions of the innovative behavior scale, tailored to family farming, and the moderating role of organic production on the model. Comparative analysis showed no significant difference in the intensity of the dimensions between organic producers and non-producers. This study offers valuable insights into innovative behavior in family farming, which could inform strategic planning and more effectively direct public policies to support family farmers, ultimately leading to technological advancement and innovation within the sector.

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Multi-group analysis

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Introduction

Understanding how family farmers adopt innovation is crucial for improving agricultural policies and development interventions. This research offers socio-economic benefits such as enhanced agricultural productivity, food security, and increased family income (Al-Obadi *et al*., 2022). Understanding farmers' innovative behaviors is essential for the sustainability of the agricultural sector. It promotes the adoption of innovative practices that improve natural resource management and reduce the negative environmental impacts of agriculture (Blakeney, 2022).

Family farming significantly contributes to employment in rural areas, income distribution, social inclusion, and poverty reduction in Brazil. Studying the innovative responses of Brazilian family farmers to agricultural innovations can provide insights into their adaptation to new technologies and practices (Fuestsch, 2022), highlighting the sector's role in socio-economic development (Gonzaga *et al*., 2019; Fernandes & Hallewell, 2016).

Innovation behavior, which involves identifying, articulating, and implementing new ideas to improve performance, can offer competitive advantages (Zhu *et al*., 2022; Jin *et al*., 2022; Walter & Au-Yong-Oliveira, 2022). However, innovation in rural areas faces structural, sociocultural, and psychosocial barriers and challenges in business succession and entrepreneurship within family farming (Tomei & Souza, 2014; Suess-Reyes & Fuetsch, 2016).

Family farmers play a crucial role in food production, supplying a significant portion of the food in large cities. The family farming sector in Brazil contributes notably to agricultural employment and output. Public food purchases, like the National School Feeding Program, are essential for sector development and transitioning to a more sustainable food system (Zahaikevitch *et al*., 2022; IBGE, 2019; Cavalli *et al*., 2020; Gaitán-Cremaschi *et al*., 2022).

This study aims to evaluate the innovative behavior of family farmers regarding agricultural sector innovations, emphasizing the need for public policy actions that meet the realities of family farming. By exploring the innovative behavior of Brazilian family farmers, this research intends to inform strategic actions, contribute to the literature on innovation and rural development, and enhance understanding of innovation generation and adoption in these settings. Innovations that promote resilience in agricultural practices can offer valuable insights into sustainability theory.

The study advances understanding of innovative behavior among family farmers and provides insights for developing public policies that promote sustainable and organic practices. It contributes to the scientific literature on innovation, sustainable rural development, and agricultural public policies.

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Despite the relevant role of innovation in the economic and social development of the agricultural sector, family farmers face significant challenges in consistently and effectively adopting innovative practices. The central problem of this study is to understand the factors that influence the innovative behavior of these farmers, particularly in the Brazilian context, where structural, cultural, and market barriers hinder the adoption of new practices and technologies. The lack of understanding of these specific challenges, such as the influence of participatory leadership and external contacts, represents an obstacle to the development of more effective public policies.

Given these challenges, the study aims to investigate the innovative behavior of family farmers within the context of agricultural innovations, focusing on both organic and conventional practices. While innovation is crucial for sustainable development and agricultural competitiveness, research exploring the influence of participatory leadership and external contacts on family farmers' innovative outcomes is limited. This study seeks to offer practical insights for policy formulation and expand knowledge on innovative behavior in rural settings, thus being relevant for both theoretical development and practical applications in innovation and agricultural sustainability programs.

While previous studies have explored innovative behavior in large-scale agricultural sectors, there is a significant research gap concerning family farmers, who play a fundamental role in food security and sustainability in Brazil. Knowledge about the influence of participatory leadership and external networks on the innovative behavior of family farmers remains limited. This study seeks to fill this gap by investigating how these factors contribute to innovation within the context of Brazilian family farmers, providing insights for policies that can boost sustainable and organic practices.

1. Theoretical background and hypotheses

In family farming, participatory leadership involves engaging all family members and possibly other stakeholders in decision-making. This democratic approach ensures that diverse perspectives are considered, leading to more comprehensive and sustainable farming practices.

The proposed relationship (H1) suggests that participatory leadership in family farming significantly influences innovative outcomes. This assumption is based on the idea that the participative and collaborative leadership style, necessitated by family farms' operational and organizational structure, enhances their innovative capacity. By examining the role of participative

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leadership in family farming, this hypothesis highlights the potential of collaborative decision-making and autonomy in driving innovation in the agricultural sector, especially among small rural producers.

The micro-AKIS approach emphasizes the importance of localized, farmer-centric knowledge and information systems in enhancing agricultural innovation and sustainability. Within this framework, participative leadership plays a key role in creating a micro-environment conducive to innovation among family farmers by facilitating information exchange, knowledge sharing, and fostering trust and engagement among stakeholders involved in agriculture (Madureira *et al*., 2022).

Awang *et al*. (2020) illustrate how participative leadership can make the interaction environment more favorable for generating innovative ideas through improved information sharing and the development of trust-based relationships and engagement at work. This view is consistent with the belief that innovative behavior includes idea generation and the actions necessary for implementation and performance improvement in professional contexts (De Jong & Den Hartog, 2008).

Developing ideas as a precursor to creating new products, services, and processes, which initiate innovation, is fundamental. External contacts are essential catalysts for innovative behavior. By promoting frequent external contact, individuals encounter new stimuli, alternate perspectives, and diverse viewpoints, stimulating creativity and leading to innovation (De Jong & Den Hartog, 2010). This is particularly relevant in agriculture, where exchanging knowledge and practices significantly influences productivity and sustainability.

The micro-AKIS framework underlines the significance of localized and farmer-centric approaches, showcasing the role of participatory leadership in enhancing these external contacts. Participatory leadership broadens the horizon of external contacts by encouraging meetings and interactions within and beyond the farming community, facilitating the flow of information and knowledge crucial for innovation. Thus, the second hypothesis (H2) asserts that participatory leadership greatly affects external contacts, indicating that the leadership style of family farmers can directly impact the extent and quality of their interactions with external stakeholders, forging an environment conducive to innovation.

This hypothesis acknowledges the micro-AKIS approach by emphasizing the role of social and informational networks in agricultural innovation. It suggests that how family farmers lead and engage with their community and external actors significantly affects their ability to innovate and adapt to changes, underscoring the link between leadership, knowledge exchange, and innovation in family farming (Madureira *et al*., 2022). The concept of social capital, defined as the networks of relationships among people in a

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society that enable it to function effectively, provides a useful perspective for assessing the impact of external contacts on innovation.

Cofrè-Bravo *et al.* (2019) and Vecchio *et al.* (2022) provide insights into how social capital within rural and agricultural communities significantly influences innovative outcomes. These studies suggest that through dimensions such as trust, norms, and networks, social capital facilitates the sharing and exchange of knowledge, resources, and support, which is critical for fostering innovation.

De Jong and Den Hartog (2008) emphasize the importance of social interaction and the exchange of experiences external contacts provide, including relationships with clients, competitors, suppliers, and researchers. Such interactions expose individuals to diverse perceptions and ideas, stimulating creativity and new idea generation, crucial for innovation. However, Lyons *et al.* (2019) note that geographical isolation in rural areas often limits these interactions, highlighting the need to create additional opportunities for family farmers to proactively engage and form connections aligned with their interests.

The challenge in rural areas, marked by geographical distances and infrequent encounters, underscores the importance of leveraging social capital to overcome these barriers. By fostering stronger networks and relationships within and outside the agricultural community, family farmers can access a wider range of external contacts more frequently, enhancing their exposure to new ideas and perspectives that drive innovation.

Therefore, H3 should be refined to incorporate the role of social capital in enhancing the relationship between external contacts and innovative outcomes. Specifically, it suggests that a farmer's social capital quality and extent can moderate the impact of external contacts on innovation, implying that stronger social networks and relationships facilitate greater exposure to diverse ideas and experiences, which, in turn, promotes innovative outcomes. This hypothesis highlights the challenges faced by family farmers due to geographical isolation and proposes a pathway through which these challenges can be mitigated. Enhancing social capital within rural communities can provide a supportive environment for innovation, suggesting that interventions aimed at building and strengthening social networks play a crucial role in enhancing the innovative capacity of family farming.

Participative leadership plays a key role in this process. This leadership style, marked by a collaborative approach to decision-making and a focus on engaging team members in the innovation process, significantly affects the generation of innovative ideas and practices. Alblooshi *et al.* (2021) and Azeem *et al.* (2021) highlight the positive impact of participative leadership on innovation, noting that it promotes skill development, networking, and

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knowledge exchange. These activities enable family farms to establish and maintain essential external contacts for innovation.

Nonetheless, the relationship between participative leadership, external contacts, and innovative outcomes is complex. Maharous and Genedy (2019) point out that several factors influence this relationship, including organizational culture, technological advancements, and market dynamics. These factors can affect the efficacy of participative leadership in fostering external contacts and, consequently, innovative outcomes. Given these factors, the next hypothesis explores this relationship further: Participatory leadership influences innovative outcomes through external contacts (H2 and H3).

This hypothesis suggests that by enhancing external contacts, participatory leadership plays a crucial role in achieving innovative outcomes in family farming. It asserts that the leadership style within these operations significantly affects the quality and extent of external interactions, which, in turn, drives innovation. The hypothesis aims to examine the mediating role of external contacts in the participatory leadership-innovation relationship, offering a thorough understanding of how family farms can overcome geographical isolation and enhance innovation through strong social capital and participative leadership practices.

The moderating effect of organic production on innovative behavior examines how the choice between organic and conventional farming practices influences the relationship between family farmers' characteristics and their level of innovative behavior. Deciding to adopt organic or conventional methods may alter the strength of the relationship between innovative behavior dimensions.

Thus, exploring the moderating effect of organic production sheds light on the factors that affect innovative behavior and helps producers develop more effective innovation strategies. This focus underscores how specific production practices – organic versus conventional – influence innovation in the family farming sector. The hypothesized relationship should, therefore, make a direct comparison, considering the possible differences in innovative behaviors between organic and conventional producers (Hussain *et al*., 2020; Tandon *et al*., 2021; Marin-Garcia *et al*., 2022). Organic production influences the relationship between scale dimensions (H4).

For a clearer understanding and visualization of these hypotheses and their interconnections, Figure 1 presents the structural model proposed in this study. H1: Participatory Leadership influences Innovative Results. H2: Participatory Leadership influences External Contacts. H3: External Contacts influence Innovative Results. H4: The relationship between Participatory Leadership, External Contacts, and Innovative Results is moderated by the type of production (Organic vs. Conventional).

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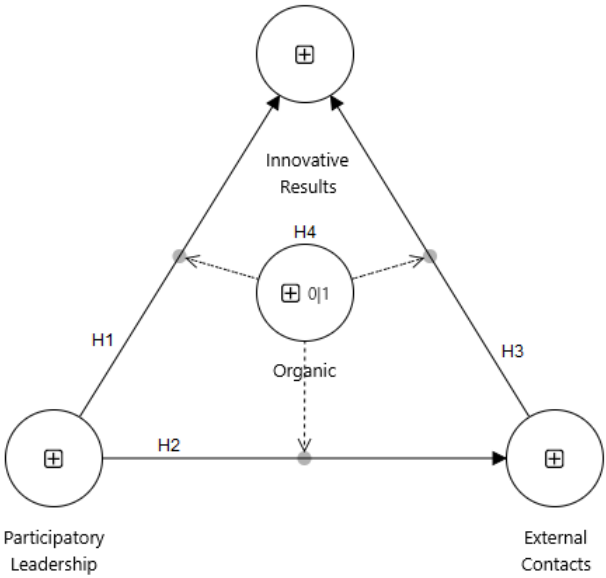
Figure 1 - The research model of this study



2. Materials and methods

A quantitative study involving 442 family farmers in southern Brazil was conducted from March 2021 to October 2022. This time frame was chosen to gather a robust and reliable sample sufficient for modeling and analyzing results. The study utilized a non-probabilistic, convenience sampling method with data collection at fairs, family farming exhibitions, and direct visits to properties; it adhered to ethical and legal standards, receiving approval from a research ethics committee (opinion no. 4.761.535; CAEE no. 46804621.7.0000.5346). Participants were given a detailed consent form explaining the study's purpose, guaranteed data confidentiality, and assured of their right to withdraw.

The research was carried out in person at family farming fairs (52 cities) and agricultural exhibitions (10 cities) across the three states of southern Brazil: Rio Grande do Sul (RS), Santa Catarina (SC), and Paraná (PR). In RS, data were gathered from 62 municipalities, including feedback from 27 exhibitors in the capital Porto Alegre and 373 exhibitors across 59 other cities. In SC and PR, data collection occurred in the capitals Florianópolis and Curitiba from 14 and 8 exhibitors, respectively. Data collection included the capitals Florianópolis and Curitiba, with 14 and 8 exhibitors, respectively.

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These cities were chosen because they are capitals of their respective states, allowing researchers access to farmers participating in family farming fairs in the capitals.

Data collection instrument included a scale with three dimensions to measure innovative behavior: Participative Leaders, adapted from Robbins (2005), Pires *et al*. (2014), and De Jong and Den Hartog (2008); External Contacts, adapted from Pugas *et al*. (2017) and De Jong and Den Hartog (2008); and Innovative Results, adapted from Jong and Hartog (2008) and Axtell *et al*. (2020). These dimensions were contextualized for the rural setting and utilized a 4-point Likert scale (1 = rarely, 2 = sometimes, 3 = often, 4 = always).

For data analysis, descriptive statistics were applied to sociodemographic data, and the score standardization method by Lopes (2018, p. 35) was used to analyze the innovative behavior scale dimensions (Equation 1).

$$Ss_i = 100 * \frac{(Sum - Minimum)}{(Maximum - Minimum)}, \quad (1)$$

where Ss_i is the standardized score for dimension i, Sum is the sum of valid scores for dimension i, minimum is the lowest possible score for dimension i, and maximum is the highest possible score for dimension i. The scores developed by the scale's authors were adapted to a standardized score (Ss_i), as listed in Table 1.

Table 1 - Adaptation of scores originally proposed by the authors of these scales with the standardized score

Score of the original instrument	Proposed score (Ss_i)	Classification
All dimensions	0.00-20.00	Very low
	20.01-40.00	Low
	40.01-60.00	Moderate
	60.01-80.00	High
	80.01-100.00	Very high

Dimension scores were standardized as very low, low, moderate, high, and very high. This standardization allowed us to develop a model to evaluate the relationships and test the hypotheses outlined using partial least squares structural equation modeling (PLS-SEM). The method followed these steps: a) analysis of the structural model, b) analysis of the measurement

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model, c) estimation of the path model and evaluation of the measurement model, d) analysis of the moderating variables, e) multi-group analysis, and f) evaluation of the structural model (Hair *et al*., 2017). Analyses were conducted using the SmartPLS® software (version 4.1.0.5) (Ringle *et al*., 2022).

To compare dimensions between groups, we applied a normality test to the standardized data (Shapiro-Wilk test). If the data were not normally distributed, we used a non-parametric test, the Mann-Whitney test, to compare two independent groups (Lopes, 2018). The significance level was set at 5%. The SPSS® software (version 26) was used for comparative analyses.

3. Results

Sociodemographic information

Of the 442 farmers surveyed, the mean age was 46 years old, with a standard deviation of 16.64%. The most common age group was over 50, comprising 44.34% of respondents. Most respondents (n = 273; 61.76%) were male, and 95.02% resided in Rio Grande do Sul. Additionally, 163 participants (36.88%) had a high school education, and 315 (71.72%) engaged solely in farming. The survey found that a majority of 234 farmers (52.98%) produced organic products. However, only 28 (6.33%) had certified their products as organic. Furthermore, 252 respondents (57.01%) reported not having any employees, and 246 (55.66%) were members of a producer or credit cooperative, as detailed in Table 2, which outlines the sociodemographic characteristics of the producers.

Model fit tests

The model stabilized after seven iterations. This study employed various criteria to assess the fit of the PLS-SEM, including *standardized root mean square residuals* (SRMR), squared Euclidean distance (d_{ULS}), geodesic distance (d_G), and normed fit index (NFI). The results confirmed that the proposed structural model provided a good fit to the data, with acceptable indices such as SRMR = 0.078, dULS = 0.834, dG = 0.192, and NFI = 0.898 (Henseler *et al*., 2016). The SRMR value was below the threshold of 0.08 (Henseler *et al*., 2016), and the NFI value exceeded the recommended threshold of 0.8 (Hu & Bentler, 1998; Stone, 2021), indicating that the structural model is satisfactory and adequate.

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Table 2 - Sociodemographic and social characteristics of family farmers (n = 442)

Variables	**n (%)**
Age, mean (SD)	46.01 (16.64)
Residents, mean (SD)	4.31 (5.510)
Age range (years)	
Young (<30)	72 (16.29)
Mature (30–50)	174 (39.37)
Old (> 50)	196 (44.34)
Gender, n (%)	
Female	169 (38.24)
Male	273 (61.76)
Brazilian state, n (%)	
Rio Grande do Sul	420 (95.02)
Santa Catarina	14 (3.17)
Paraná	8 (1.81)
Level of education, n (%)	
High school level	163 (36.88)
Elementary school level	118 (26.70)
Undergraduate level	127 (28.73)
Graduate level	34 (7.69)
Any other professional activity?	
No	315 (71.72)
Yes	125 (28.28)
Do you produce organic products?	
No	208 (47.06)
Yes	234 (52.94)
Are you certified?	
Unemployed	208 (47.06)
Not certified	159 (35.98)
Seeking certification	47 (10.63)
Certified	28 (6.33)
Do you have employees?	
No	252 (57.01)
Yes	190 (42.99)
Are you a member of a cooperative?	
No	196 (44.34)
Yes	246 (55.66)

SD = standard deviation

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Measurement model evaluation

The measurement model was evaluated using PLS-SEM, aimed at confirming the hypotheses proposed in the study (Hair *et al*., 2027). Three measurement criteria were assessed: internal consistency analysis, convergent validity, and discriminant validity. The criteria include average variance extracted (AVE > 0.5), Cronbach's alpha, and composite reliability (0.7 < q < 0.95). Discriminant validity was assessed through the Fornell-Larcker criterion and the heterotrait-monotrait ratio (HTMT) using the bootstrapping technique with 5,000 subsamples. For the Fornell-Larcker criterion, a criterion must be abovegiven AVE must surpass the corresponding values in the correlation matrix, and for the HTMT criterion, the upper limits of the estimated HTMT values must remain below 1.0 (Hair *et al*., 2017).

Internal consistency reliability

The internal consistency among the indicators of each dimension was analyzed using CA and CR. Table 3 shows CA values ranging from 0.744 to 0.810 and CR values from 0.789 to 0.863, which are above the minimum threshold of 0.7 and below the maximum of 0.95 (Hair *et al*., 2017). The AVEs ranged from 0.515 to 0.517, aligning with the recommendation that values should exceed 0.5. These indicators confirm the reliability of the internal consistency within the model's dimensions. Additionally, the model exhibits factor loadings (FL) above 0.6.

Table 3 - Model evaluation

Dimensions/indicators	**FL**	**CA**	**CR**	**AVE**
Participatory leadership (PL)		0.786	0.855	0.515
PL01 - Do family, friends, the community in general or other people ask your opinion?	0.824			
PL02 - When they talk to you, do they ask for suggestions on the best way to carry out certain tasks or business?	0.845			
PL03 - Have these people ever consulted you about important changes in their lives?	0.811			
PL04 - Have these people ever allowed you to influence long-term decisions on tasks/business in their lives?	0.792			

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PL05 - When you needed them, did they support your decision to set your own goals?	0.670			
PL06 - On your property or when you were in charge of a management position (union or community), were you able to carry out your ideas/ tasks with independence and freedom?	0.694			
External contacts (EC)		0.744	0.789	0.517
EC01 - Do you keep in touch with your main customers (those who buy your products)?	0.695			
EC02 - Do you look for new (potential) customers for your products?	0.835			
EC03 - Do you usually attend lectures, courses, trade fairs, and exhibitions?	0.681			
EC04 - Do you often exchange ideas with other producers who sell the same products as you?	0.656			
EC05 - Do you keep in touch with teachers or services offered by any university?	0.601			
Innovative results (IR)		0.810	0.863	0.515
IR01 - How often do you think of new ideas to improve the products you produce?	0.751			
IR02 - How often do you apply these ideas to improve working practices?	0.735			
IR03 - How often do you seek out new knowledge?	0.797			
IR04 - How often do you actively develop new working methods, techniques, or tools?	0.737			
IR05 - How often do you look for new partners to buy/sell inputs/products?	0.689			
IR06 - How often do you optimize the organization of your work?	0.679			

Discriminant validity

Discriminant validity was evaluated using the Fornell-Larcker criterion and HTMT to assess the distinctiveness of a dimension from others, as shown in Table 4 (Fornell & Larcker, 1981). The square root of the AVE for the dimensions was higher than the values in Pearson's correlation matrix. The HTMT criterion's upper limits were below 1.0 (95% confidence), indicating that the discriminant validity between the dimensions fulfilled

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the established criteria. Consequently, the measurement model's assessments for internal consistency reliability, convergent validity, and discriminant validity were satisfactory, empirically substantiating the appropriateness of the measurement model for the studied model.

Table 4 - Fornell-Larcker and HTMT criterion of the factor model

Dimensions	**Mean**	**SD**	**AVE**	**Pearson's correlation matrix**		
				1	**2**	**3**
1. External contacts	3.63	1.277	0.719	1.000		
2. Innovative results	3.87	1.012	0.718	0.483	1.000	
3. Participatory leadership	3.05	1.192	0.718	0.350	0.380	1.000
				Upper limit (HTMT)$_{97.5\%}$		
2. Innovative results				0.729		
3. Participatory leadership				0.610	0.572	

SD = standard deviation

Structural model, hypothesis testing, and path relationship evaluations

The direct and indirect relationships and moderating effects between the dimensions were assessed using regression coefficients (b) (Table 5). The bootstrapping method was also employed to evaluate the significance of the values (based on the value of using the t-test). According to Hair *et al*. (2017), a path relationship was deemed significant at a 5% significance level when the t-test value exceeded 1.96.

Regarding the primary hypotheses derived from direct relationships, all were confirmed (i.e., H1, H2, and H3), including mediation (H2 and H3). Table 5 indicates that H4, involving organic vs. conventional production, was moderated, necessitating a multi-group analysis (Tables 6 and 7) based on a subsequent hypothesis (H5).

The results of the multi-group analysis (MGA) are presented in Table 6, utilizing the Henseler method (a non-parametric approach) and a permutation test for evaluation. Within Henseler's MGA approach, a $p < 0.05$ indicates significant differences in path coefficients between organic and conventional producers (Lopes *et al*., 2024).

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Table 5 - Results of the direct effects among dimensions

Hyp.	Path relation	β	SD	t-stat.	p-value	Result
H1	PL→IR	0.240	0.047	5.079	0.000	Supported
H2	PL→EC	0.350	0.044	7.920	0.000	Supported
H3	EC→IR	0.399	0.040	9.971	0.000	Supported
H2-3	PL→EC→IR	0.196	0.067	2.965	0.003	Supported
H4a	O*PL→IR	0.053	0.098	0.542	0.588	Not Supported
H4b	O*PL→EC	0.175	0.092	1.902	0.011	Supported
H4c	O*EC→IR	0.172	0.088	1.944	0.006	Supported
H4d	O*PL→EC→IR	0.134	0.048	2.801	0.000	Supported

O = organic; SD = standard deviation.

H5: Organic vs. conventional production differs in the relationships proposed in H1 to H4:
H5-1. Participatory leadership affects innovative results compared to organic vs. conventional producers;
H5-2. Participatory leadership affects the external contacts compared to organic vs. conventional producers;
H5-3. External contacts affect innovative results compared to organic vs. conventional producers;
H5-4. Participatory leadership affects innovative results mediated by external contacts compared to organic vs. conventional producers.

Table 6 - Multi-group analysis results: organic vs. conventional

Hyp.	Path relation	β (O - C)	p-value (difference)		Results
			Henseler's MGA	Permutation test	
H5-1	PL→IR	–0.076	0.504	0.620	No/No
H5-2	PL→EC	–0.117	0.007	0.008	Yes/Yes
H5-3	EC→IR	–0.140	0.004	0.005	Yes/Yes
H5(2-3)	PL→EC→IR	–0.129	0.017	0.020	Yes/Yes

PC = path coefficient.

Table 7 and Figure 2 show the analyses that separate the groups and evaluate H6 and H7 by type of producer. Despite differences in the structural coefficients between organic and conventional producers, the model's hypotheses were significant for both groups.

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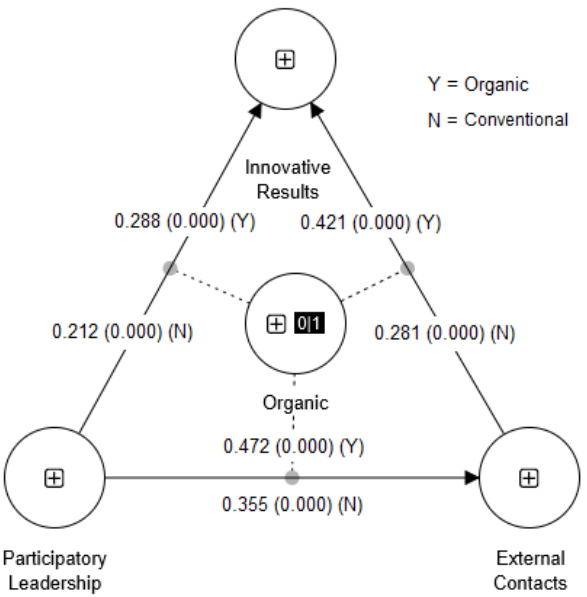
Table 7 - Results of the multi-group analysis among dimensions

Hyp.	Path relation	β	SD	t-stat.	p-value*	Result
			Organic			
H6-1	PL→IR	0.212	0.062	3.419	0.000	Supported
H6-2	PL→EC	0.355	0.068	5.221	0.000	Supported
H6-3	EC→IR	0.281	0.057	4.928	0.000	Supported
H6-4	PL→EC→IR	0.128	0.030	4.267	0.000	Supported
			Conventional			
H7-1	PL→IR	0.288	0.072	4.645	0.000	Supported
H7-2	PL→EC	0.472	0.057	8.281	0.000	Supported
H7-3	EC→IR	0.421	0.060	7.017	0.000	Supported
H7-4	PL→EC→IR	0.257	0.032	8.031	0.000	Supported

PC = path coefficient; SD = standard deviation; * $p < 0.001$

Figure 2 - The final structural equation model



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Predictive capability evaluation

One of the important aspects of evaluating a PLS-SEM is to test the model's predictive relevance. Predictive relevance is assessed using the explanation coefficient, which measures the degree of variability in the data accounted for by the endogenous dimensions (Hair *et al*., 2017). According to these authors, the R^2 value ranges from 0 to 1. An R^2 value above 0.19 indicates a high level of predictive accuracy (strong effect), while a value ranging from 0.075 to 0.19 indicates a moderate effect.

Table 8 shows the R^2 values for the External Contacts dimension for organic producers at $R^2 = 0.138$ ($p < 0.001$) and for conventional producers at $R^2 = 0.112$ ($p < 0.001$). This suggests a moderate predictive accuracy for both groups, with organic producers exhibiting 2.6% more predictive power. For the Innovative Results dimension, organic producers had an $R^2 = 0.389$ ($p < 0.001$), and non-producers an $R^2 = 0.312$ ($p < 0.001$), indicating a high level of predictive accuracy; organic producers had 7.7% more predictive power (Henseler *et al*., 2009; Lopes *et al*., 2020; Obregon *et al*., 2024).

Another method for assessing the predictive relevance of a structural model is by calculating Q^2 using the blindfolding technique in SmartPLS® software. This technique allows the endogenous dimensions to predict future values based on the information provided by the exogenous dimensions (Fang *et al*., 2022). Following the recommendations of Hair *et al*. (2017) and Lopes *et al*. (2020), a Q^2 value greater than 0.075 indicates that the model's predictions are reliable. The statistical results demonstrated that all the Q^2 values for each dimension are significant (Table 8), with $Q^2 > 0.075$, underscoring the predictive relevance of the proposed model.

Table 8 - Evaluation of predictive accuracy and predictive relevance

Predictive dimension	**Organic**		**Conventional**	
	R^2 (p-value)	**Q^2**	**R^2 (p-value)**	**Q^2**
External contacts	0.138 (0.000)	0.121	0.112 (0.000)	0.086
Innovative results	0.389 (0.000)	0.116	0.312 (0.000)	0.155

Table 9 presents the normality test results for the dimensions using the Shapiro-Wilk test. The scale (innovative behavior) exhibited normal distribution ($p > 0.05$), while the dimensions did not ($p < 0.05$). Consequently, we employed the Mann-Whitney non-parametric test to compare the groups of organic and conventional producers. The analysis revealed no significant

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differences in the scale and dimensions of innovative behavior between the two types of producers ($p > 0.05$).).

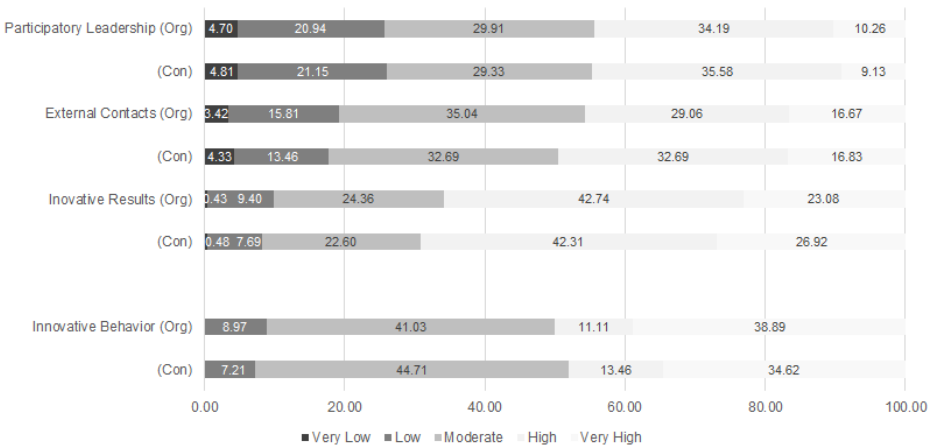
Table 9 - Comparative test of standardized dimensions between producers

Dim.	Organic (n = 234)			Conventional (n = 208)			Mann-Whitney test
	Normality test*	Mean	SD	Normality test*	Mean	SD	
EC	0.013	58.82	21.366	0.003	59.67	22.163	0.539
PL	0.018	54.55	20.997	0.029	55.58	20.098	0.459
IR	0.006	66.18	18.447	0.001	67.89	18.185	0.539
IB	0.586	61.11	15.300	0.303	62.29	14.955	0.362

* Shapiro-Wilk test; SD = standard deviation; IB = innovative behavior.

The characteristics associated with innovative behavior are illustrated in Figure 3. This figure indicates that 50.00% of organic producers and 48.08% of conventional producers exhibit high levels of innovative behavior. Specifically, of the producers surveyed, 217 (49.10%) demonstrate high innovative behavior, 197 (44.57%) exhibit high participatory leadership, 210 (47.51%) have frequent external contact, and 298 (67.42%) achieve high levels of innovative results.

Figure 3 - Classification of innovative behavior of producers



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4. Discussion

The findings of this study align with and extend prior research on innovative behavior and leadership in the context of family farming and rural development. De Jong and Den Hartog (2010) emphasized the critical role of participatory leadership in fostering innovative work behavior. Consistent with their conclusions, our study confirms that family farmers exhibiting participatory leadership are more inclined towards engaging in innovative practices, leading to improved product development and process innovation outcomes. Additionally, this study supports the significance of external interactions, showing that external contacts markedly influence innovation outcomes, particularly in agricultural settings.

Previous research highlighted the importance of external contacts in promoting innovation. Cofré-Bravo *et al*. (2019) found that social capital, especially through external networks, plays a vital role in innovation among farmers. Our findings corroborate this, demonstrating that family farmers who actively engage with customers, suppliers, and other external agents gain better access to innovative ideas and practices. This underlines that innovation capacity is not solely reliant on internal leadership but also effective interactions with and learning from external sources.

The influence of organic farming practices on innovative behavior has also been documented. Marin-Garcia *et al*. (2022) discovered that organic farming systems enhance innovative outcomes due to the unique challenges and knowledge exchange required in sustainable farming. Our study reinforces this argument by indicating that organic farmers, compared to conventional farmers, benefit more from participatory leadership and external contacts, resulting in higher innovation rates. Madureira et al. (2022) further emphasize the importance of localized, farmer-centric knowledge systems (micro-AKIS) in promoting innovation and sustainability, noting that these systems support organic farmers by fostering tailored knowledge exchange and strengthening community-based networks, which are essential for overcoming the specific challenges of organic production.

Our findings revealed a slight predominance of family farmers who produce organic products without the help of an employee. A minority of these farmers are certified, albeit they are cooperative members, which ends up helping them somehow. Organic production, a product without chemical pesticides and with management that does not harm the local ecosystem, has been growing considerably. In 2020, production grew by 30%, but the number of registered family farmers is still small, with around 25,000 registered with the responsible body (Ministério da Agricultura, Pecuária e Abastecimento, 2021).

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Moreover, it was possible to identify a relationship between the dimensions of innovative behavior, namely participative leadership, external contacts, and innovative results, within a sample of family farmers. The results indicate that participative leadership affects innovative results (H1), which shows that farmers whose characteristic is participative leadership with openness to new ideas and suggestions from other people may increase engagement and favor the creation of a fertile environment for innovative ideas and, consequently, innovative results (Awang *et al*., 2020). It should be noted that the farmer's profile differs from other groups of entrepreneurs, as they have characteristics that are peculiar to their working environment, so the way they lead differs from the conventional leader since, in the family environment, this hierarchy is not present (Tomei & Souza, 2014).

Since leadership in the family farming environment is still considered a barrier or challenge to the development of rural entrepreneurship (Tomei & Souza, 2014), it is important to identify those who indicate that they have these characteristics and seek to develop this potential to develop family farming as a whole (Souto & Brose, 2022). This corroborates H2, which identified that participatory leadership affects external contacts; this means that in the same way that leadership can provide innovative results, it also affects the farmer's relationship with people, groups, or cooperatives and events outside their daily life, facilitating the exchange of experiences and contact with different products, actions, and activities, expanding their knowledge and their network of contacts. Hence, this can bolster the development of their products and the creative process in search of innovation (Jong & Hartog, 2010), a fact that was verified when supporting H3, which identified the relationship between external contacts and innovative results.

Furthermore, these dimensions are completely linked to the innovative behavior of family farmers, and H2-3 demonstrates this relationship. External contacts mediate the relationship between participatory leadership and innovative results, showing that there is a relationship in which participatory leadership, through engagement and collaboration between farmers in the same family, has a positive impact on the innovative results mediated by the external contacts made by the farmer, reinforcing the understanding of Alblooshi *et al*. (2021).

Chen *et al*. (2016) reported that social relationships between members of the same work team, in this case, adapted and considered members of the same family, and with external individuals and bodies, provide information, insight, experience, and conversations that increase knowledge and, therefore, help develop organizational innovation. This reinforces the importance of developing participatory leadership, which allows the people who work alongside the farmer to participate in decisions, motivating them, instigating

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creativity, and ultimately driving innovation since people will feel part of that environment (Azeem *et al*., 2021).

Of the hypotheses tested regarding the moderating effect of the variable 'organic producers', three out of four proposed hypotheses were confirmed. The relationship between participative leadership and external contacts, the relationship between external contacts and innovative results, and the mediation of external contacts in the relationship between participative leadership and innovative results showed a moderating effect on the organic production variable. The other moderating variables (gender and age) did not significantly differ in the innovative behavior of the rural producers surveyed.

A multi-group analysis was conducted to assess the difference between organic and conventional producers (i.e., H5), revealing that H5-2, H5-3, and H5(2-3) confirmed significant differences in the structural coefficients of the model between organic and conventional producers (Table 6).

Differences between organic and conventional producers have been highlighted in various studies, demonstrating that organic farmers often possess unique characteristics that influence their approach to innovation and production. Mazzoleni and Nogueira (2006) found that organic producers tend to have higher educational levels and are more likely to employ updated technologies and modern management tools, such as digital software for tracking and optimizing farm activities. Similarly, Marin-Garcia *et al.* (2022) emphasize that the unique demands of organic farming push these producers toward sustainable innovations, which are supported by continuous knowledge exchange within organic farming communities.

Saénz *et al.* (2024) identify that external relational capital, especially horizontal and vertical connections, plays an essential role in promoting innovation on organic farms. The study observes that relationships with knowledge institutions, such as universities and research centers, as well as with governmental associations, enhance the capacity for innovation in production processes and methods, which is particularly relevant in the organic context. Through these connections, farmers not only gain access to advanced technologies but also strengthen practices of social learning and knowledge co-creation, which are fundamental for overcoming the sustainability and productivity challenges characteristic of organic agriculture.

Aghabeygi *et al.* (2024) underscore that organic farmers are often more inclined to adopt sustainable soil management practices, encouraged by supportive policy incentives and certification programs. These external supports play a critical role in offsetting economic and technological barriers, which are particularly challenging in organic systems. Such programs provide financial resources, knowledge sharing, and technical assistance, making it feasible for organic farmers to implement practices that enhance soil health,

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improve biodiversity, and align with ecological goals. Consequently, this policy support not only fosters environmental sustainability but also enhances the economic resilience of organic farming by reducing dependency on synthetic inputs and promoting a circular approach to soil fertility and crop health.

These distinctions suggest that organic producers, through continuous engagement with both agricultural and non-agricultural networks, cultivate an environment more receptive to adopting sustainable practices and innovations, as compared to their conventional counterparts. This alignment with broader networks and higher education levels provides organic farmers with greater resources to navigate the unique challenges of organic agriculture, contributing to their capacity for adaptive and innovative practices.

Given the above, when we carried out a separate analysis (Table 7), we found that organic producers had more significant structural coefficients, as seen in Figure 2. When we analyzed the predictive capacity of the models, we observed that for organic producers, the external contacts dimension is 2.6%. The innovative results dimension is 7.7% higher in predictive power (Table 8).

Other researchers have also reported other differences. Mazzoleni and Nogueira (2006) identified differences between producers certified to produce organic products and those in the certification process, namely in education levels, hired labor, and use of technology, highlighting that certified farmers more frequently utilize up-to-date techniques and tools, including Microsoft Excel. Notably, 65% of certified farmers versus 35% of non-certified farmers indicated involvement in other professional activities, supporting our findings regarding external contacts. In addition, 50% of organic producers exhibit a high potential for innovative behavior compared to 48% of non-organic producers (Figure 3). In the dimensions of the scale, the innovative results dimension stood out, with 74% of organic producers demonstrating high behavior compared to 69% of non-organic producers.

This study confirms and corroborates other research on the relationship between participatory leadership, external contacts, and innovative results, proving that participatory leadership influences innovative results and is mediated by external contacts (Pugas *et al*., 2017). Leadership is essential in driving innovation (Alblooshi *et al*., 2021), and in this study, as it is a sample of farmers with their particular work characteristics, it is understood that rural producers will play the role of the leader and that sometimes there will be no leaders but rather members of the same family. In this sense, the farmer's role as a leader will be demonstrated by encouraging and promoting innovation in the workplace, which is crucial for developing the property, region, and organic production domestically and through exports (Lima *et al*., 2020).

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The theoretical implications include identifying differences in innovation behavior between organic and conventional family farmers, suggesting that the working context influences their perspectives and behaviors regarding innovation. This is vital for understanding family farmers' characteristics, addressing the data gap on this subject, and assisting in developing targeted programs and public policies aimed at family farmers to promote innovation adapted to their specific needs (Cele & Wale, 2020).

Conclusions

The research aimed to assess the innovative behavior of family farmers in the context of agricultural sector innovations, providing insights relevant for shaping public policies and development strategies for family farming. The key findings illustrate a complex interplay between participatory leadership, external contacts, and innovative outcomes, emphasizing the role of social capital and networking in fostering innovation within this sector.

A significant finding is the slight predominance of family farmers engaging in organic production without employee assistance. Despite a low certification rate among these producers, their membership in cooperatives provides support, highlighting the benefits of collective action and shared resources in overcoming innovation barriers and market access challenges. The 30% increase in organic production in 2020 suggests a significant shift towards sustainable farming practices, although the number of registered family farmers remains small. This gap between adopting organic practices and formal certification suggests policies are needed that simplify the certification process and support organic farming expansion.

The study's findings on participatory leadership, external contacts, and innovative results suggest these elements collectively contribute to the innovative behavior of family farmers. Participatory leadership, characterized by openness to new ideas and collaborative decision-making, not only facilitates innovation but also enhances the farmer's ability to form beneficial external contacts. These external relationships, in turn, act as conduits for new ideas, knowledge exchange, and innovative outcomes. However, the role of organic production as a moderating variable shows that the farming context can significantly affect these dynamics.

The low certification rate among organic producers highlights a challenge in the development and innovation process within family farming. The bureaucracy and difficulties associated with certification deter many farmers from formalizing their organic practices, limiting their market access and benefits. This underscores the need for policy interventions to reduce these barriers and encourage broader participation in organic farming.

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The research emphasizes the critical role of government support policies, regulations, and social functions in facilitating innovation within family farming. By providing more data on this farmer group, the study contributes to targeted strategies for investment and research to enhance the sector's innovation capacity. Strategies could include subsidizing new technology adoption, offering training programs, investing in research and development, and promoting rural entrepreneurship and economic diversification.

In conclusion, this study identifies critical factors influencing the innovative behavior of family farmers and offers evidence-based recommendations for public policies supporting organic production, simplifying the certification process, and promoting sector innovation. By addressing the unique challenges faced by family farmers, especially those engaged in organic farming, these policies can contribute to a more sustainable, productive, and resilient agricultural sector.

Limitations and recommendations for future research

Despite the relevance and quality of the information generated, this study has its limitations. One such limitation is its lack of focus on a single group of producers according to their production specialty. Instead, it encompasses a diverse group, including pluri-active family farmers and producers involved in various crops. Another limitation is the need to adapt the questionnaire for a rural audience, which involved simplifying the vocabulary and eliminating ambiguous interpretations.

The research methodology employed was non-probabilistic convenience sampling. This method was chosen for its practicality and ease of accessing and engaging with participants. Data collection took place in environments where family farmers are most active and accessible, such as agricultural fairs, family farming exhibitions, and direct visits to farming properties.

For future research, we recommend evaluating monoculture producers, assessing innovation behavior in specific niches, and exploring the impact of additional variables not examined in this study. Furthermore, research should include those who are difficult to reach, such as producers not involved in farmers' markets or related activities. These individuals often miss out on the exchange of information that can enhance knowledge and tend to be more isolated in terms of external contacts.

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Understanding consumers' willingness to use omega-3 enriched eggs

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Abstract

One of the most important consumer trends in the food sector is the increasing popularity of nutritionally enriched food product consumption, especially omega-3 enriched foods. This study examines the consumers' willingness to consume omega-3 enriched eggs and applies the Health Belief Model (hereinafter: HBM). An online survey was conducted on a representative sample of 524 Croatian consumers who do grocery shopping for their households and purchase eggs. The data was collected from a representative panel using quota sampling by gender and age and analyzed using SEM by Partial Least Square. The results show that almost 3/4 of the respondents do not know what omega-3 enriched eggs are. The perceived benefits, self-efficacy, cue to action and health motivation have a positive impact on the willingness to use omega-3 enriched eggs. Contrarily, the effects of threat perception variables (perceived severity and perceived susceptibility) and barriers on the willingness to use omega-3 enriched eggs are not significant. The results could support the efforts of the producers and the authorities to develop strategies that promote the consumption of omega-3 enriched foods, especially eggs.

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Introduction

Eggs are an affordable and widely available food worldwide (Lesnierowski & Stangierski, 2018). Their quality is significantly influenced by the animal feed (Sharma *et al.*, 2020). In order to improve the nutritional value of eggs, the producers need to modify the hens' feed by adding fish and/or flaxseed oil and flaxseed (Kassis *et al.*, 2010). This has led to the development of omega-3 fatty acid-enriched eggs, a functional food that boosts the intake of essential nutrients – particularly omega-3 fatty acids often scarce in the modern Western diet (Fraeye *et al.*, 2012). Omega-3 fatty acids are known for their health benefits, including the protection of the cardiovascular system, supporting cognitive abilities, reducing inflammation, maintaining muscle and improving insulin resistance (Yashodhara *et al.*, 2009; Mozaffarian & Wu, 2011; Pistollato *et al.*, 2018). As confirmed by previous research, the acceptance of functional foods largely depends on the perceived link between nutrition and health (Vecchio *et al.*, 2016; Baker *et al.*, 2022), with particular stress on health benefits as their strongest driver (Verbeke, 2005). The growing health awareness has further fueled the demand and made functional foods a major trend in the food industry (Baker *et al.*, 2022).

Despite the growing demand for functional foods, the empirical research on consumer acceptance and willingness to use certain products such as omega-3 fatty acid-enriched eggs is still limited – especially in the lower income EU countries. The existing studies (e.g. Mesías *et al.*, 2011; Palmieri *et al.*, 2022), conducted mainly in higher income countries, focus on identifying the factors that influence willingness to pay (WTP) and consumer preferences for functional eggs compared to organic or conventional eggs. However, a comprehensive analysis of the psychological predictors influencing consumers' willingness to use omega-3 enriched eggs is scarce, especially in economically constrained EU markets such as Croatia's, where both the supply and the demand for such products are still emerging.

To address this gap, this study applies the Health Belief Model (HBM), which takes into account important psychological determinants like perceived barriers, perceived benefits, self-efficacy, perceived susceptibility, perceived severity, cue to action, and health motivation (Rosenstock, 1974). This study aims to test the HBM and identify the key psychological predictors of consumers' willingness to use omega-3 enriched eggs. In addition, the model will be examined in a lower income EU market where economic constraints may further influence consumer behavior.

Understanding these psychological predictors can help policy makers, producers and marketers develop more effective strategies to promote functional foods, address consumer concerns, and increase their uptake in price-sensitive markets. In particular, these findings can support targeted

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marketing strategies, public health initiatives and policy recommendations to improve the uptake of functional foods. Additionally, identifying the strongest predictors of consumers' willingness to use omega-3 enriched eggs can help producers refine their messaging, optimize pricing strategies and develop more effective educational campaigns to increase awareness and confidence in functional foods.

1. Background

1.1. *Functional food studies*

Martirosyan *et al.* (2021) define functional foods as (1) manufactured foods to which bioactive compounds have been added during processing, (2) foods that naturally contain bioactive compounds, and (3) modified foods that have been altered to have more bioactive compounds. Studies by Wang *et al.* (2022) have identified new sources of bioactive molecules for the development of functional foods. Namely, algae contain large amounts of proteins also rich in essential amino acids, unsaturated fatty acids, and vitamins. They can be added as a functional ingredient in meat and meat-based products to obtain healthier foods.

People are more willing to consume functional beverages if they feel they can reduce the risk of contracting diseases, especially after a pandemic (Natarajan *et al.*, 2024). The research findings of Fasakin and von Massow (2024) show a general consumer interest in immune-boosting dairy products and that the presence of children under the age of fifteen in households is an important factor in increasing consumer receptivity to these products. According to previous studies, several key factors influence consumers' decisions to consume functional foods in an emerging market economy (Nguyen *et al.*, 2019).

One of the most important factors for the acceptance of functional foods is the various perceived barriers (Ozen *et al.*, 2012; Ozen *et al.*, 2014). Embling *et al.* (2024) investigated consumer beliefs regarding fortified (functional) foods, and found that taste and texture generally ranked first, and that a positive perception of health benefits increased the consumers' willingness to purchase them, while both cost and uncertainty about using the product were potential barriers. Additionally, price seems to be a major barrier to the consumption of functional foods. Thus, Ares *et al.* (2010) found that price negatively influenced the consumption of functional yogurts. Other barriers to the consumption of functional foods include convenience, lack of knowledge about the appropriate amounts to consume and preparation methods (Moutinho *et al.*, 2022). Nystrand and Olsen (2020) concluded

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that functional foods were not widely available in the Norwegian market. Therefore, low availability may also pose a barrier to the consumption of functional foods.

There are other factors that positively impact people's willingness to use functional foods – namely, the perceived benefits such as improved health, enhanced well-being, improved functioning of physiological processes, interest in healthy diets, and beliefs about the properties of functional foods (Siegrist *et al.*, 2008; Siegrist *et al.*, 2015; Pappalardo and Lusk, 2016; Bimbo *et al.*, 2017). The findings of Osunsanmi *et al.* (2024) show the importance of understanding consumer motivations and attitudes to enable food producers to implement the best marketing strategy to increase sales, and to enable dietitians and health professionals to share information creating more awareness of the health benefits of consuming functional foods. Siegrist *et al.* (2015) showed that people with stronger interest in health were more willing to purchase functional foods than people with lower health motivation. In addition, Bimbo *et al.* (2017) found that the acceptance of functional dairy products is more pronounced among the consumers with high overall interest in health. In Italy, health-conscious shoppers are more likely to buy eggs rich in omega-3 fatty acids than other consumer segments (Yeh *et al.*, 2020).

Rezai *et al.* (2017) give several examples of cues for action, including a family member's illness, parental advice, recommendations from elders and close friends, as well as the influence of doctors and experts as well as health campaigns – all of whom are likely to motivate or coerce consumers into purchasing functional foods. Febian and Annuar (2021) found no direct effect of cue to action on intention to consume functional foods.

Conroy *et al.* (2021) seek to understand how functional foods and well-being intersect and find that perception of the severity of health problems could also influence consumers' decisions regarding the functional foods they consume for disease prevention. Kim *et al.* (2012) found that perceived severity had a significant positive impact on behavioral intention to consume healthy foods among college students. However, Vassallo *et al.* (2009) stated that perceived severity was not a significant predictor of willingness to eat functional bread.

Some previous studies indicate that consumers are generally willing to pay more for products with superfluous claims. In their study, Nagy *et al.* (2024) indicated that both younger and older consumers were willing to pay higher prices for organic and functional redundantly claimed apple juices. The perceived health was a significant factor to increase preferences for all value-added products among the younger participants, but with the older participants it only influenced their preferences for organic and functional apple juice. The perceived susceptibility had no significant effect on consumers' intention to accept synthetic functional foods according to

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Rezai *et al.* (2017). Previous studies have shown that self-efficacy is a strong predictor of health intention (Terry and O'Leary, 1995; Rodgers *et al.*, 2008) and dietary behavior (Armitage and Conner, 1999; Povey *et al.*, 2000). Nystrand and Olsen (2020) found that the motivation to consume functional foods depends largely on the consumers' confidence in their ability to do so. Other studies (Park *et al.*, 2011; Salleh *et al.*, 2016) have concluded that self-efficacy positively influences the Malaysian consumers to consume functional foods. Additionally, the study by Krutulyte *et al.* (2011) showed that self-efficacy played a major role in the selection of omega-3/fish oil-fortified foods.

1.2. *Heath belief model*

The HBM was developed in the early 1950s by a group of social psychologists from the U.S. Public Health Service to understand the widespread rejection of preventive measures or screening tests for the early detection of asymptomatic diseases (Rosenstock, 1974). Since then, the HBM has been widely used in health behavior research as a conceptual framework both to explain the change and maintenance of health-related behaviors and as a guiding framework for health behavior interventions (Abraham and Sheeran, 2005). The model is based on an individual's motivation to perform a particular behavior, and its main strength is the use of simplified health-related constructs that allow for ease of implementation, application and testing (Conner, 2010). Some of the limitations of the HBM are the lack of explicitly stated relationships among the variables, the absence of clear rules for combining the formulated variables (Armitage and Conner, 2000; Abraham and Sheeran, 2005), and their low predictive ability (Orji *et al.*, 2012). The HBM contains several key concepts that anticipate the likelihood of individuals to take preventive, screening or control measures against the diseases which are related to the (perceived) susceptibility, severity, benefits and barriers, as well as to the cues to action, self-efficacy and health motivation (Champion *et al.*, 2008).

1. **Perceived Susceptibility** (beliefs about the likelihood of getting a disease or condition). For instance, a consumer must believe there is a possibility of contracting coronary heart disease before he/she becomes interested in the consumption of foods high in omega-3s.
2. **Perceived Severity** (feelings about the seriousness of contracting a disease or of leaving it untreated). It includes evaluations of both medical and clinical consequences like pain and possible social consequences such as the effect on social relations.

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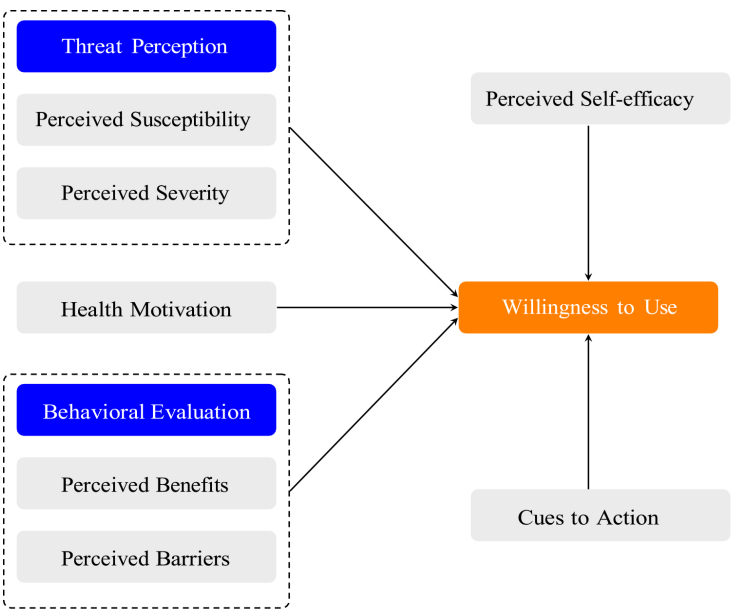
3. **Perceived Benefits** (a person's beliefs regarding the perceived benefits of the various available actions for reducing the disease threat, such as better taste.
4. **Perceived Barriers** (belief about the tangible and psychological costs of the advised action, such as high price).
5. **Cues to Action** (a trigger for health behavior when appropriate beliefs are held). Cues to action include external cues such as mass media campaigns, social influences, or internal cues, e.g. negative change in body state or perception of symptoms.
6. **Self-Efficacy** (an individual's perception of the facility or difficulty of performing an intended behavior, or the extent to which an individual has conscious control of a behavior).
7. **Health motivation** (readiness to be concerned about health matters).

The HBM focuses on two main aspects of individual health beliefs: threat perception (perceived susceptibility and perceived severity) and behavioral evaluation (perceived benefits and perceived barriers). Cues to action can activate health behaviors when beliefs are present (Abraham and Sheeran, 2005) and perceived barriers are low (Champion *et al.*, 2008). Motivation is the key determinant of behavior, while increasing motivation is the focus of most health behavior change interventions (Knittle *et al.*, 2018).

Figure 1 shows the HBM.

Figure 1 - The Health-Belief model – HBM



Source: Adapted from Rosenstock, 1974.

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Since its development, the HBM has been used in a variety of public health related studies over the years. For example, it was applied to improve breast cancer screening practices among women (Ghaffari *et al.*, 2019), to prevent osteoporosis among health volunteers (Panahi *et al.*, 2021), to predict intentions for protective sexual behavior among college students (Xu *et al.*, 2024), and to explore the acceptance of the COVID-19 vaccine (Wong *et al.*, 2021). However, the HBM was also used in studies related to eating behavior such as the consumption of functional bread (Vassallo *et al.*, 2009), organic food (Yazdanpanah *et al.*, 2015), fruit and vegetable (Soltani *et al.*, 2017) and functional food (Febian and Annuar, 2021), and the customers' use of menu labels in restaurants (Jeong and Ham, 2018). The model has demonstrated its capacity to validate and predict a diverse range of health-related behaviors across various domains and among a wide range of populations (Janz and Becker, 1984; Carpenter, 2010).

Previous studies have also shown that the HBM is a good theoretical model for predicting willingness to use functional foods. For example, Vassallo *et al.* (2009) used the HBM to predict the willingness to use functional bread in four European countries: UK, Italy, Germany and Finland. They found that the perceived benefits, perceived barriers and health motivation were reliable predictors of willingness to consume functional bread, while the perceived susceptibility and perceived severity failed as predictors, and the role of cues to action was marginal. Febian and Annuar (2021) conducted a survey of 250 older consumers in Malaysia and found that the perceived barriers and perceived benefits directly influenced the intention to consume functional foods. However, the perceived susceptibility and cue to action did not have a direct influence on the intention to consume functional foods. Zainuddin (2019) applied the HBM to study consumer purchase intentions for functional foods the UK focusing on two different types of products, live culture yoghurt and cholesterol-lowering margarine. The analysis applied a comprehensive approach, dividing the respondents for each product into a user group and a non-user group for comparison. The perceived benefit, perceived susceptibility, perceived barrier, self-identity and cues to action determined the behavioral intention for the live yoghurt user group, while cue to action, perceived benefit and perceived barrier determined the behavioral intention for the non-user group of live yoghurt. Regarding the models for cholesterol-lowering margarine, four constructs (i.e. perceived benefit, cue to action, perceived barrier and self-identity) defined the behavioral intention for the group of cholesterol-lowering margarine users, while only the cue to action defined the behavioral intention for the group of cholesterol-lowering margarine non-users. Consequently, the conclusion is drawn that the predictors of willingness to use a product are also product-specific.

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2. Materials and methods

2.1. *Materials*

The first section of the questionnaire contained an explanation of the survey and explicit written consent. The respondents then completed the socio-demographic questions and all variables of the HBM (willingness to use omega-3 enriched eggs, perceived barriers, perceived benefits, self-efficacy, perceived susceptibility, perceived severity, cue to action and health motivation). The items and sources for all variables of the HBM are listed in Table 1. All constructs of the study were assessed using a 5-point Likert scale, with responses ranging from "strongly disagree" (1) to "strongly agree" (5).

In addition, subjective knowledge was assessed by a question (Do you know what omega-3 enriched eggs are?) and yes/no answers. The participants who answered affirmatively were asked to define the term "omega-3 enriched eggs". The original questionnaire is reproduced in Appendix A. Only socio-demographic questions, subjective knowledge questions, and the HBM variables were used in this study.

Table 1 - Items for all variables of the Health Belief Model

Construct	Item	Source
WTU1	I would be willing to buy omega-3 enriched eggs if they were more available on the market.	Adopted from Yazdanpanah *et al.* (2015)
WTU2	I would intend to buy omega-3 enriched eggs if they were more available on the market.	
WTU3	I would buy omega-3 enriched eggs if they were more available on the market.	
WTU4	I would try to buy omega-3 enriched eggs if they were more available on the market.	
BARRIER1	Buying omega-3 enriched eggs for me is time-consuming.	Adopted from Yazdanpanah *et al.* (2015)
BARRIER2	Buying omega-3 enriched eggs for me is costly.	
BARRIER3	Buying omega-3 enriched eggs requires forming new habits, which is difficult.	

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BARRIER4	I do not know where to buy omega-3 enriched eggs.	Adopted from Çapık and Gözüm (2011)
BENEFIT1	Omega-3 enriched eggs are tastier than non-enriched eggs.	Adopted from Deshpande *et al.* (2009)
BENEFIT2	Omega-3 enriched eggs are healthier than non-enriched eggs.	Adopted from Yazdanpanah *et al.* (2015)
BENEFIT3	Eating omega-3 enriched eggs decreases my risk of getting a coronary heart disease and blood vessel disease.	Adopted from Yazdanpanah *et al.* (2015)
EFFICACY1	Buying omega-3 enriched eggs is easy for me.	Adopted from Yazdanpanah *et al.* (2015)
EFFICACY2	Buying omega-3 enriched eggs is under my control.	
EFFICACY3	I understand the information related to omega-3 enriched eggs on the egg packaging.	Adopted from Arimbawa *et al.* (2021)
SUSCEPTIBILITY1	I feel that my chances of getting coronary heart diseases in the future are high.	Adopted from Yazdanpanah *et al.* (2015)
SUSCEPTIBILITY2	My lifestyle (eating habits, physical activity) increase chances of getting coronary heart diseases.	
SUSCEPTIBILITY3	I think I could die from a coronary heart disease.	Adopted from Çapık and Gözüm (2011)
SEVERITY1	If I get coronary heart disease, it would have a negative influence on my life quality.	Adopted from Yazdanpanah *et al.* (2015)
SEVERITY2	Having a coronary heart disease would negatively influence my social relations.	Adopted from Deshpande *et al.* (2009)
SEVERITY3	Having a coronary heart disease would negatively influence my family relations.	
CUE1	I would buy more omega-3 enriched eggs, if the doctor recommended it.	Adopted from Deshpande *et al.* (2009)
CUE2	I would buy more omega-3 enriched eggs, if friends suggested it.	
CUE3	I would buy more omega-3 enriched eggs, if family members suggested it.	

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HEALTH1	Nothing is as important as good health.	Adopted from Ataei *et al.* (2021)
HEALTH2	Having good health is more valuable than financial capital.	
HEALTH3	I am motivated to use healthy products for good health.	

2.2. *Methods*

The online survey was conducted via a market research agency on a representative sample of 524 Croatian consumers selected from a representative panel using quota sampling by gender and age. The respondents were selected by screening the questions prior to the start of the questionnaire excluding those who were not responsible for food shopping in their households or who had not bought eggs in the previous month. The Qualtrics survey program was used to create and conduct an online survey that took between 7 and 10 minutes to complete and was conducted from March 20, 2023, to April 12, 2023.

Univariate statistics (frequencies) were performed in SPSS (Statistical Package for Social Science, version 21) to describe the sample and subjective knowledge. Descriptive statistics (mean, standard deviation) were calculated for all items used in the HBM. The relationships between the variables of the HBM were analyzed using the multivariate analysis technique Partial Least Square – Structural Equation Modelling (PLS-SEM) by applying SmartPLS 4 software. The suitability of the proposed model was confirmed by factor loadings, which indicate the strength of the different construct indicators and must be greater than 0.70.

The most commonly used measure of internal consistency is Cronbach's alpha and composite reliability (Rho A). According to Joseph *et al.* (2022), the values of composite reliability/Cronbach's alpha between 0.60 and 0.70 are acceptable. Convergent validity is determined by the average variance extracted (AVE), which should be equal to or greater than 0.7. Discriminant validity was measured by the Fornell-Larcker criterion. According to this method, the square root of the average variance extracted (AVE) is compared with the correlation of the latent constructs. A latent construct should better explain the variance of its own indicator than the variance of other latent constructs. The square root of the AVE of each construct should have a greater value than the correlations with other latent constructs. The extent of collinearity was assessed by the variance inflation factor (VIF) with values below 3.3 to indicate an acceptable level of correlation (Joseph *et al.*, 2022).

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2.3. *Sample description*

The characteristics of the sample are listed in Table 2. The sample comprised 279 female and 245 male respondents, most of whom had a secondary school degree, 3-4 household members, were employed, and had a monthly household income of over €1,500 (64.9%).

Table 2 - Sample characteristics

		N	**%**
Gender	Male	245	46.8
	Female	279	53.2
Age	18-25	49	9.4
	26-35	125	23.9
	36-45	122	23.3
	46-55	122	23.3
	56-65	106	20.2
Number of households members	1	46	8.8
	2	131	25.0
	3	129	24.6
	4	145	27.7
	>4	73	13.9
Education	Elementary school	2	0.4
	Secondary school	231	44.1
	Bachelor programme	90	17.2
	Master programme	185	35.3
	PhD	13	2.5
	Other	3	0.6
Household monthly income	<500€	19	3.6
	500-1000€	43	8.2
	1001-1500€	122	23.3
	1501-2000€	117	22.3
	2001-2500€	90	17.2
	2501-3000€	73	13.9
	>3000€	60	11.5
Employment status	Employed	414	79.0
	Unemployed	30	5.7
	Student	23	4.4
	Retired	46	8.8
	Other	11	2.1

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3. Results

3.1. *Subjective knowledge*

As many as 72.6% of the respondents said they did not know what omega-3 enriched eggs were, while 27.4% answered affirmatively. However, in the latter group, 4.8% of the participants could not explain what omega-3 enriched eggs are (omega-3 enriched eggs are organic eggs, healthy eggs, nutritious eggs). The respondents who stated that they knew what omega-3 enriched eggs were more likely to choose omega-3 enriched eggs (Table 3).

Table 3 - Influence of subjective knowledge on the willingness to use omega-3 enriched eggs

	Do you know what omega-3 enriched eggs are?	**Mean**	**S.D.**	**p**
I would be willing to buy omega-3 enriched eggs if they were more available on the market.	Yes	3.86	0.81	<0.01
	No	3.26	0.94	
I would intend to buy omega-3 enriched eggs if they were more available on the market.	Yes	3.81	0.80	<0.01
	No	3.17	0.91	
I would buy omega-3 enriched eggs if they were more available on the market.	Yes	3.76	0.84	<0.01
	No	3.18	0.94	
I would try to buy omega-3 enriched eggs if they were more available on the market.	Yes	3.80	0.87	<0.01
	No	3.17	0.96	

3.2. *Descriptive statistics*

Table 4 contains the descriptive statistics for each item included in the HBM. The respondents displayed low perceived barriers, moderate willingness to use omega-3 enriched eggs, perceived benefits, self-efficacy, perceived susceptibility and cue to action, while the perceived severity and especially health motivation were higher.

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Table 4 - Descriptive statistics

		Mean	S.D.
WTU1	I would be willing to buy omega-3 enriched eggs if they were more available on the market.	3.43	.95
WTU2	I would intend to buy omega-3 enriched eggs if they were more available on the market.	3.34	.93
WTU3	I would buy omega-3 enriched eggs if they were more available on the market.	3.34	.95
WTU4	I would try to buy omega-3 enriched eggs if they were more available on the market.	3.34	.98
BARRIER1	Buying omega-3 enriched eggs for me is time-consuming.	2.28	.91
BARRIER2	Buying omega-3 enriched eggs for me is costly.	3.52	.92
BARRIER3	Buying omega-3 enriched eggs requires forming new habits, which is difficult.	2.57	.99
BARRIER4	I do not know where to buy omega-3 enriched eggs.	3.02	1.19
BENEFIT1	Omega-3 enriched eggs are tastier than non-enriched eggs.	2.91	.70
BENEFIT2	Omega-3 enriched eggs are healthier than non-enriched eggs.	3.55	.85
BENEFIT3	Eating omega-3 enriched eggs decreases my risk of getting a coronary heart disease and blood vessel disease.	3.56	.86
EFFICACY1	Buying omega-3 enriched eggs is easy for me.	3.35	.92
EFFICACY2	Buying omega-3 enriched eggs is under my control.	3.40	.95
EFFICACY3	I understand the information related to omega-3 enriched eggs on the egg packaging.	3.71	.87
HEALTH1	Nothing is as important as good health.	4.26	.77
HEALTH2	Having good health is more valuable than financial capital.	4.36	.72
HEALTH3	I am motivated to use healthy products for good health.	4.08	.75

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SUSCEPTIBILITY1	I feel that my chances of getting coronary heart diseases in the future are high.	3.13	.94
SUSCEPTIBILITY2	My lifestyle (eating habits, physical activity) increase chances of getting coronary heart diseases.	2.95	1.03
SUSCEPTIBILITY3	I think I could die from a coronary heart disease.	2.80	.97
SEVERITY1	If I get coronary heart disease, it would have a negative influence on my life quality.	3.93	.83
SEVERITY2	If I get coronary heart disease, it would have a negative influence on my social relations.	3.67	.92
SEVERITY3	If I get coronary heart disease, it would have a negative influence on my family relations.	3.73	.92
CUE1	I would buy more omega-3 enriched eggs, if the doctor recommended it.	3.27	.98
CUE2	I would buy more omega-3 enriched eggs, if friends suggested it.	2.93	.94
CUE3	I would buy more omega-3 enriched eggs, if family members suggested it.	3.20	.98

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3.3. *Measurement model*

As shown in Table 5, the Cronbach's alpha values and composite reliability (Rho A) for willingness to use omega-3 enriched eggs, perceived benefit, self-efficacy, perceived susceptibility, perceived severity, cue to action, and health motivation are higher than 0.70. These results mean that the reliability of the model is satisfactory (Joseph *et al*., 2022). Two items on the perceived barriers were dropped ("Buying omega-3 enriched eggs is too expensive for me" and "I do not know where to buy omega-3 enriched eggs") as they had low Cronbach's alpha and composite reliability (Rho A). However, the other two items measuring the perceived barriers had satisfactory Cronbach's alpha (0.63, which is acceptable according to Joseph *et al*., 2022 and Ursachi *et al*., 2015) and Rho A. Therefore, further analysis was conducted with these two items to measure the perceived barriers. The value of the average variance extracted (AVE) for each of the constructs should be at least 0.7. The construct of willingness to use omega-3 enriched eggs recorded the highest AVE value (0.889). Moreover, the results show strong relationships between the latent constructs and the items with factor loadings > 0.7, ranging from 0.584 to 0.989. The results of the Fornell-Larcker criterion show that the discriminant validity of the constructs is given (Table 6). Finally, the variance inflation factors (VIF) showed no collinearity between the constructs as all VIF values were below 3.3 (Table 7).

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Table 5 - Factor loadings, Cronbach's α, Rho A, and AVE of the measurement model

Factor loadings, Cronbach's α, Rho A, and AVE of the measurement model								
Item	**WTU**	**Barriers**	**Benefits**	**Efficacy**	**Health**	**Susceptibility**	**Severity**	**CUE**
WTU1	0.927							
WTU2	0.958							
WTU3	0.953							
WTU4	0.934							
BARRIER2		1.000						
BENEFIT1			0.673					
BENEFIT2			0.904					
BENEFIT3			0.881					
EFFICACY1				0.853				
EFFICACY2				0.828				
EFFICACY3				0.795				
HEALTH1					0.786			
HEALTH2					0.811			
HEALTH3					0.888			
SUSCEPTIBILITY1						0.886		
SUSCEPTIBILITY2						0.845		
SUSCEPTIBILITY3						0.814		
SEVERITY1							0.853	
SEVERITY2							0.876	
SEVERITY3							0.901	

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CUE1							0.854
CUE2							0.889
CUE3							0.902
Cronbach's α	0.958	0.760	0.769	0.791	0.813	0.853	0.857
Rho A	0.959	0.795	0.784	0.918	0.867	0.883	0.862
AVE	0.889	0.682	0.682	0.688	0.721	0.768	0.778

Table 6 - Discriminant validity

	Barriers	**Benefits**	**Cue**	**Efficacy**	**Health**	**Severity**	**Susceptibility**	**WTU**
Barriers	1.000							
Benefits	–0.127	**0.826**						
Cue	–0.269	0.518	0.882					
Efficacy	–0.181	0.403	0.235	**0.826**				
Health	–0.014	0.243	0.173	0.251	0.830			
Severity	0.114	0.330	0.271	0.202	0.298	**0.877**		
Susceptibility	0.049	0.191	0.243	0.036	–0.018	0.286	0.849	
WTU	–0.296	0.601	0.549	0.364	0.282	0.213	0.184	**0.943**

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Table 7 - VIF

	WTU
Barriers	1.267
Benefits	1.618
Cue	1.437
Efficacy	1.410
Health	1.213
Severity	1.291
Susceptibility	1.164

Notes: Values below 3.3 indicate an acceptable level of correlation among constructs.

Figure 2 shows the direct effects between the considered constructs. The results confirm that most of the variables from the original HBM (perceived barriers, perceived benefits, self-efficacy, cue to action and health motivation) have a significant influence on the willingness to consume omega-3 enriched eggs, with the perceived benefits being the strongest predictor. The perceived benefits ($\beta_{BEN-WTU} = 0.373$; $t = 7.609$; $p = 0.000$) and cue to action ($\beta_{CTU-WTU} = 0.314$; $t = 6.975$; $p = 0.000$) had a direct and positive affect on the willingness to consume omega-3 enriched eggs. Self-efficacy ($\beta_{SE-WTU} = 0.110$; $t = 2.628$ $p < 0.01$) was found to be a weak but significant predictor of willingness to use. Health motivation ($\beta_{HM-WTU} = 0.125$; $t = 3.466$; $p < 0.01$) was positively and significantly associated with willingness to use omega-3 enriched eggs. However, there was no significant effect of the threat perception variables (the perceived severity and perceived susceptibility) and the perceived barriers on the willingness to use the omega-3 enriched eggs ($p > 0.05$).

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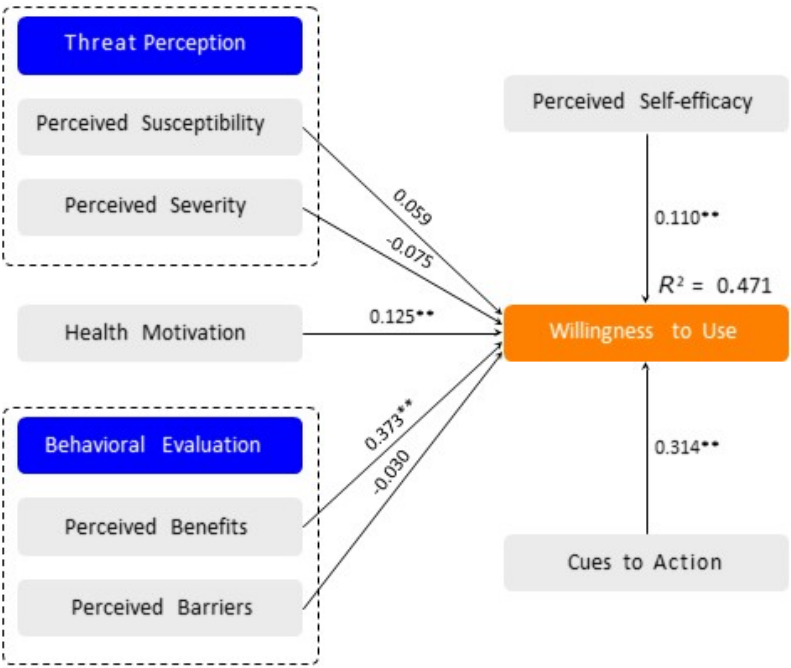
Figure 2 - The estimated Health-Belief model – HBM



Notes: * p < 0.05, ** p < 0.01

4. Discussion

Despite the growing interest in functional foods, there is a lack of research investigating the psychological predictors of consumers' willingness to use omega-3 enriched eggs. Furthermore, to our knowledge, there are no previous studies that used the HBM specifically to predict the willingness to use omega-3 enriched eggs, particularly in lower income EU countries. The present study fills these gaps by providing new insights into the factors influencing consumer acceptance in this under-researched context.

The results suggest that the HBM (HBM) is applicable in the context of the omega-3 enriched eggs, explaining 47.1% of the variance in consumers' willingness to use and consume them. This is similar to Yazdanpanah *et al.* (2015), who found that the HBM explained 42% of the variance in young adults' willingness to consume organic foods. An R-squared between 0.10 and 0.50 (or 10-50 percent when expressed as a percentage) is acceptable in social science research when some or most of the explanatory variables are statistically significant (Ozili, 2023). Considering that most of the variables

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are statistically significant, it can be concluded that the HBM is acceptable for predicting the consumption of omega-3 enriched eggs. A lower R-squared could be related to the low level of knowledge about omega-3 enriched eggs with the Croatian respondents since as many as 72.6% of the respondents did not know what omega-3 enriched eggs were. Similarly, Sass *et al.* (2018) found that consumer knowledge of the benefits of these products is limited, while Baba *et al.* (2017) found that consumers may have little familiarity with the omega-3 enriched eggs. Therefore, it is suggested for future studies to include this knowledge in the model to test the predictive power of the extended model. The results of our structural model are consistent with the previous studies and emphasize the strong influence of the perceived benefit and cue to action on the willingness to consume omega-3 enriched eggs. Specifically, the perceived benefit was found to be the strongest predictor of willingness to use, which is in line with the previous findings (Verbeke, 2005; Siegrist *et al.*, 2015; Alagarsamy and Mehrolia, 2023) highlighting that health-related benefits significantly influence consumers' acceptance of functional foods. Individuals who recognize the benefits associated with the consumption of omega-3 fatty acid-enriched eggs are more likely to consume these products. Therefore, from the policy and commercial perspectives, communicating the benefits of functional foods could support the increase of the perceived benefits. These findings are in line with the study by Osunsanmi *et al.* (2024) who claim that food producers should emphasize the health benefits of functional foods in marketing materials and refer to government agency approval when functional foods have demonstrated health benefits and have been authorized by the relevant government agency. This will facilitate the consumers' perceptions of the products as more effective. Furthermore, the cue to action has a significant positive effect on the willingness to use them, suggesting that specific triggers or sources of information play crucial roles in promoting the consumption of omega-3 enriched eggs. This is consistent with the broader literature on health-related behavior, which suggests that cue to action can be a motivator for an individual's health behavior (Vassallo *et al.*, 2009). It is important to identify which sources of cue for action (besides doctors, friends and family members) can exert a strong influence on consumers' willingness to use omega-3 enriched eggs. According to Rezai *et al.* (2017), the examples of cue include advice from parents, the elderly, close friends, doctors and lecturers that can influence, motivate or compel the consumers to purchase functional foods. Other important sources that can motivate consumers are advertising, media incentives and health campaigns.

As expected, perceived barriers have a negative (but not significant) influence on the willingness to consume omega-3 enriched eggs. To enhance the knowledge about functional foods and save the consumers' time

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(which are the main barriers to consumption), it is important to organize information campaigns about the benefits of consuming functional foods through different media channels. In addition, the availability of functional foods should be increased by ensuring that they are foods offered in all grocery stores. As the previous research regarding the effects of barriers on the willingness to use functional foods is inconsistent, new studies are needed to understand why the presence or lack of barriers have a significant impact on the willingness to consume omega-3 enriched eggs. Additionally, new studies should include more items to measure the specific barriers in relation to a particular product.

The positive association of health motivation with the willingness to consume omega-3 enriched eggs is consistent with the literature suggesting that a general interest in health contributes to the acceptance of functional foods (Siegrist *et al.*, 2015). It is important to develop strategies that can increase consumer motivation for health and lead to increased demand for functional foods such as omega-3 enriched eggs.

While self-efficacy showed a weaker but still significant association with willingness to use omega-3 enriched eggs, this suggests that consumers' confidence in their ability to incorporate these eggs into their diets influences their willingness to consume, albeit to a lesser extent. The results of our study are consistent with the previous studies (Cox *et al.*, 2004; Henson *et al.*, 2010; Salleh *et al.*, 2016). Nystrand and Olsen (2020) found that the motivation to consume functional foods largely depends on the consumers' confidence in their ability to do so. Self-efficacy could be enhanced by reducing identified barriers such as low knowledge (Sass *et al.*, 2018) and availability as well as familiarity (Baba *et al.*, 2017) with omega-3 enriched eggs.

Interestingly, perceived severity and perceived susceptibility (threat perception variables) had no significant effect on the willingness to use omega-3 enriched eggs. This is consistent with a previous study using the HBM for functional bread (Vassallo *et al.*, 2009), suggesting that the lack of influence of threat perception variables may be due to the fact that consumers do not consume functional foods to lower their cholesterol levels or avoid certain diseases. In addition, a large proportion of Croatian respondents did not know what omega3-enriched eggs were, which points to a possible reason for the threat perception variables showing no influence on the willingness to use omega-3 enriched eggs in Croatia. The respondents did not associate the consumption of omega-3 enriched eggs with the decrease of coronary heart diseases. Furthermore, the supply of and demand for omega-3 enriched eggs in Croatia is low, which indicates that this market is still in the development phase.

The research findings have practical implications for policy makers as well as for the producers and marketers of omega-3 enriched eggs (who aim to

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promote healthier food choices among the consumers). Public campaigns by national and local authorities should aim to raise consumer awareness of the importance of a healthy and balanced diet and warn of the risk of various diseases that can be attributed to unhealthy diets, particularly the diseases that have serious consequences and high social costs, such as coronary heart diseases. This includes the recommendations for the consumption of foods rich in and/or fortified with omega-3 fatty acids to enhance heart protection. Public information campaigns should include theoretical lectures, educational workshops and educational visits, in addition to advertising via the mass media, the Internet and social networks. Experience shows that non-governmental organizations funded by public programs are particularly successful in promoting healthy lifestyle. Endorsements by influential people (doctors and nutritionists) are recommended for information campaigns, especially through the mass media. Public information campaigns can increase consumer fear (threat perspective – severity and susceptibility) of coronary heart diseases and their consequences and raise consumer awareness of the need to consume omega-3 fatty acid rich foods. Commercial advertising campaigns should aim to increase the consumers' knowledge of omega-3 enriched eggs and their motivation to purchase them. For people with stronger health interest, advertising should be based on presenting the facts about the health benefits of consuming omega-3 enriched eggs and rational consumer activation. For the people with less pronounced health interest, advertising should be based on negative appeals that trigger the fear of the consequences of coronary heart diseases. These advertising campaigns are recommended to be conducted by a combination of television advertising, internet and social networks.

While this study contributes to the existing literature on functional foods and to a better understanding of the psychological predictors of willingness to use omega3-enriched eggs, it has some limitations. Firstly, the respondents were recruited from online market panels, which indicates a possibility of selection bias. Secondly, two items were excluded from the construct of barriers due to low reliability and this has resulted in the construct's consisting of only two statements. Thirdly, omega-3 enriched eggs are not yet widely available in the studied market, which may have influenced the respondents' willingness to use them. Fourthly, the sample consists of the consumers from a single low-income EU country, which limits the generalizability of the results to other regions or economic contexts.

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Conclusions

This study extends the application of the HBM to the food sector by providing new evidence on the predictors of willingness to use omega-3 enriched eggs in a developing country, filling a gap in the literature that focuses predominantly on high-income countries and health-related sectors. The results confirm that the HBM (HBM) is a valuable theoretical framework to understand the factors that influence consumers' willingness to use omega-3 enriched eggs. Specifically, the findings show that perceived benefits, cues to action, health motivation and self-efficacy positively influence willingness to consume omega-3 enriched eggs, with perceived benefits having the strongest positive effect. Conversely, perceived barriers were found to have a negative but non-significant effect, while threat perception variables – perceived severity and perceived susceptibility – had no significant effect on willingness to use omega-3 enriched eggs. The HBM explained 47.1% of the variance in consumers' willingness to use omega-3 enriched eggs.

These results highlight the importance of targeted communication strategies that emphasize the health benefits of omega-3 enriched eggs to increase consumer acceptance. Highlighting these benefits could help ensure their inclusion in consumers' diets as functional foods. The study adds to the growing body of research on functional food acceptance and provides actionable insights for marketers and policy makers pursuing to promote healthier eating habits.

Future research could strengthen the HBM framework by incorporating additional constructs, such as socio-demographic variables, past behavior, or objective knowledge. Investigations into the simultaneous application of different theoretical models could also facilitate identifying the most effective predictive approach for functional food choices.

Future research could extend these findings by investigating other functional foods since their acceptance is often influenced by specific combinations of carriers, ingredients, price, taste, branding, and health information. In addition, investigating the reasons for the lack of significant effects of perceived severity and susceptibility could provide insights that could refine health communication strategies.

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Appendix A

Omega 3 eggs final questionnaire

Start of Block: Introduction

Dear, we invite you to participate in research about eggs consumption, which is carried out as part of the AgriFoodBoost HORIZON 2020 project. The aim of the research is to determine the opinion and knowledge of consumers about egg production and their behavior in buying and consuming eggs, The research is completely anonymous, voluntary and carried out solely for scientific purposes, so it is very important to provide honest and true answers. The questionnaire takes about 10 minutes. The project leader is prof. Marija Cerjak from the Faculty of Agriculture, University of Zagreb. You have the right to withdraw from the survey at any time and for any reason. Therefore, we ask for your consent to the processing of personal data, reminding you that your participation is voluntary.

○ I give my consent and declare that I am 18 years old and older. (1)
○ I do not give consent and refuse to participate in the survey. (2)

End of Block: Introduction

Start of Block: Sociodemographics

SD1 Gender
○ Male (1)
○ Woman (5)
○ I don't want to make a statement (6)

---

*

SD2
Age

SD3 Number of household members including you?

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SD4 Education level

- ○ Primary school (1)
- ○ High school (2)
- ○ University Bachelor degree (3)
- ○ University Master degree (4)
- ○ PhD (5)
- ○ Other (6)

SD5 Total household income

- ○ Up to 500 EUR (1)
- ○ 500-1000 EUR (2)
- ○ 1001-1500 EUR (3)
- ○ 1501-2000 EUR (4)
- ○ 2001-2500 EUR (5)
- ○ 2501-3000 EUR (6)
- ○ More than 3000 EUR (7)

SD6 Where do you currently live?

- ○ Place with less than 5 000 inhabitants
- ○ Place with 5 000-10 000 inhabitants
- ○ Place with 10 000-100 000 inhabitants
- ○ Place with 100 000-500 000 inhabitants
- ○ Place with more than 500 000 inhabitants

X→

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SD6a Mark the county where you live

- ○ Zagreb county (1)
- ○ Krapina-Zagorje county (2)
- ○ Sisak-Moslavina county (3)
- ○ Karlovac county (4)
- ○ Varaždin county (5)
- ○ Koprivnica-Križevci county (6)
- ○ Bjelovar-Bilogora county (7)
- ○ Primorje-Gorski Kotar county (8)
- ○ Lika-Senj county (9)
- ○ Virovitica-Podravina county (10)
- ○ Požega-Slavonija county (11)
- ○ Brod-Posavina county (12)
- ○ Zadar county (13)
- ○ Osijek-Baranja county (14)
- ○ Šibenik-Knin county (15)
- ○ Vukovar-Srijem county (16)
- ○ Split-Dalmatia county (17)
- ○ Istria county (18)
- ○ Dubrovnik-Neretva county (19)
- ○ Međimurje county (20)
- ○ City of Zagreb (21)

SD7 Occupation

- ○ Employed full time (1)
- ○ Employed part-time (2)
- ○ Unemployed) (3)
- ○ Student (4)
- ○ Retired (5)
- ○ Others (6) _____

End of Block: Sociodemographics

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Start of Block: Screening

A1 How often do you shop food for yourself or for your household?

- ○ Once a week or more frequently (4)
- ○ Two to three times a month (3)
- ○ Once a month or less frequently (2)
- ○ Never (1), thank you for your participation but in this research we want to include only food buyers

Display This Question:
If How often do you shop food for yourself or for your household? != never

E2 Have you bought eggs in the last one month?

- ○ Yes (1)
- ○ No (2)

End of Block: Screening

Start of Block: Behavior in purchasing and consuming Omega 3 eggs

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P15 Please mark the following statements as true or false.

	True (1)	False (3)
Omega-3 fatty acids increase the risk factor in the development of heart disease (1)	○	○
Omega-3 fatty acids contribute to balancing blood cholesterol levels (4)	○	○
Omega-3 fatty acids in eggs are concentrated in the yolk (5)	○	○
Omega-3 enriched eggs provide about 20 times more omega-3 fatty acids than regular eggs (6)	○	○

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D01 Do you buy Omega-3 enriched eggs?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Do you buy Omega-3 enriched eggs? = No

D02 Where do you usually buy Omega 3 - enriched eggs?

- ○ Supermarkets (1)
- ○ Local stores (6)
- ○ Specalized stores (7)
- ○ Others (5) _____

D03 How many Omega-3 enriched eggs your household consume per week?

- ○ Less than one eggs per week. (1)
- ○ 1-4 eggs (2)
- ○ 4-7 (3)
- ○ 7-10 (4)
- ○ 10 or more (5)

DO4 Are Omega-3 enriched eggs available at your local market?

- ○ Yes (1)
- ○ No (4)
- ○ I don't know (5)

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End of Block: Behavior in purchasing and consuming Omega 3 eggs

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Start of Block: Behavior in purchasing eggs

P1 How often do you buy eggs?

- ○ Once a week or often (1)
- ○ 2-3 times per month (2)
- ○ Once a month (3)
- ○ Once in two month (4)
- ○ Several times in year (5)

P2 How many eggs do you usually buy per purchase?

- ○ 1 packaging of 6 eggs (1)
- ○ 1 packaging of 10 eggs (2)
- ○ 1 packaging of 15 eggs (3)
- ○ 2 packaging of 6 eggs (4)
- ○ 2 packaging of 10 eggs (5)

P3 Where do you usually buy eggs? Select all that apply

- ○ Supermarkets (1)
- ○ City markets (Dolac) (8)
- ○ Local stores (9)
- ○ Specialized stores (10)
- ○ Directly from the producers (11)
- ○ Machine with the eggs (12)
- ○ Others (7) _____

P4 How do you usually use eggs in meals preparation/cooking? Select all that apply

- ○ For preparing sweets (e.g. cakes, pancakes, pies) (1)
- ○ For preparing pasta (e.g. gnocchi, tagliatelle) (5)
- ○ For direct consumption (e.g. fried egg, boiled egg, scrambled eggs) (6)
- ○ Others (4) _____

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P5 How many eggs does your household consume per week?

- ○ Less than one egg per week (1)
- ○ 1-4 (2)
- ○ 4-7 (3)
- ○ 7-10 (4)
- ○ More than 10 (5)

P6 Do you know what Omega 3 enriched eggs are?

- ○ Yes, please define the term Omega 3 enriched eggs (1)

_____

- ○ No (2)

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P7 Definition. Omega Omega-3 enriched eggs are produced by changing the diet of laying hens. The hens are fed a special feed that contains a higher concentration of omega-3 fatty acids. Through the animals' metabolism, the omega-3 fatty acids are absorbed into the composition of the eggs, naturally creating a product rich in this important element for human health.

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Hypothetical scenario
Imagine that you are in the grocery store or market to buy eggs. You will soon see 8 different packages of eggs, where you should indicate which product you would like to purchase. Just like in the grocery store and market you can see the price of the packages. You will also see the production type and if the eggs are enhanced with omega-3. There are four different production types: Free range – eggs are produced in a rearing system where laying hens have continuous daytime access to open-air run. Floor rearing – eggs are produced in a rearing system where laying hens are housed in a house on a floor (litter). Cage – eggs are produced in a rearing system where laying hens can move freely between different levels. Organic – eggs come from free range laying hens kept in accordance with organic production standards. The eggs can be enhanced with omega-3. This is indicated as "Enhanced" on the packages, while if it is absent, a "Non enhanced" is indicated. Other than the indicated aspects, the eggs are the same, i.e. they are all produced in Croatia, and all have the same packaging type and include 10 eggs. The price varies between 1.70 EUR/packaging to 5.30 EUR/packaging.

End of Block: Behavior in purchasing eggs

Start of Block: A1

A1 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide2 (1)
○ Image: Slide3 (2)
○ Image: Slide4 (3)

End of Block: A1

Start of Block: A2

A2 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide6 (1)
○ Image: Slide7 (2)
○ Image: Slide4 (3)

End of Block: A2

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Start of Block: A3

A3 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide9 (1)
- ○ Image: Slide10 (2)
- ○ Image: Slide4 (3)

End of Block: A3

Start of Block: A4

A4 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide12 (1)
- ○ Image: Slide13 (4)
- ○ Image: Slide4 (3)

End of Block: A4

Start of Block: A5

A5 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide15 (1)
- ○ Image: Slide16 (2)
- ○ Image: Slide4 (3)

End of Block: A5

Start of Block: A6

A6 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide18 (1)
- ○ Image: Slide19 (2)
- ○ Image: Slide4 (3)

End of Block: A6

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Start of Block: A7

A7 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide21 (1)
○ Image: Slide22 (4)
○ Image: Slide4 (3)

End of Block: A7

Start of Block: A8

A8 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide24 (1)
○ Image: Slide25 (2)
○ Image: Slide4 (3)

End of Block: A8

Start of Block: B09

B09 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide27 (1)
○ Image: Slide28 (2)
○ Image: Slide4 (3)

End of Block: B09

Start of Block: B10

B10 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide30 (1)
○ Image: Slide31 (2)
○ Image: Slide4 (3)

End of Block: B10

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Start of Block: B11

B11 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide33 (1)
- ○ Image: Slide34 (2)
- ○ Image: Slide4 (3)

End of Block: B11

Start of Block: B12

B12 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide36 (2)
- ○ Image: Slide37 (1)
- ○ Image: Slide4 (3)

End of Block: B12

Start of Block: B13

B13 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide39 (1)
- ○ Image: Slide40 (2)
- ○ Image: Slide4 (3)

End of Block: B13

Start of Block: B14

B14 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide42 (1)
- ○ Image: Slide43 (2)
- ○ Image: Slide4 (3)

End of Block: B14

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Start of Block: B15

B15 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide45 (1)

○ Image: Slide46 (2)

○ Image: Slide4 (3)

End of Block: B15

Start of Block: B16

B16 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide48 (1)

○ Image: Slide49 (2)

○ Image: Slide4 (3)

End of Block: B16

Start of Block: C17

C17 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide52 (1)

○ Image: Slide53 (2)

○ Image: Slide4 (3)

End of Block: C17

Start of Block: C18

C18 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

○ Image: Slide55 (1)

○ Image: Slide56 (2)

○ Image: Slide4 (3)

End of Block: C18

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Start of Block: C19

C19 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide58 (1)
- ○ Image: Slide59 (2)
- ○ Image: Slide4 (3)

End of Block: C19

Start of Block: C20

C20 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide61 (1)
- ○ Image: Slide62 (2)
- ○ Image: Slide4 (3)

End of Block: C20

Start of Block: C21

C21 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide64 (1)
- ○ Image: Slide65 (2)
- ○ Image: Slide4 (3)

End of Block: C21

Start of Block: C22

C22 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide67 (1)
- ○ Image: Slide68 (2)
- ○ Image: Slide4 (3)

End of Block: C22

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Start of Block: C23

C23 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide70 (1)
- ○ Image: Slide71 (2)
- ○ Image: Slide4 (3)

End of Block: C23

Start of Block: C23

C23 Imagine that you are in the grocery store or market to buy eggs. Which of the following three options would you choose?

- ○ Image: Slide73 (1)
- ○ Image: Slide74 (2)
- ○ Image: Slide4 (3)

End of Block: C23

Start of Block: Health belief model

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HB1 Please indicate how much you agree or desegree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
I am willing to buy Omega - 3 enriched eggs if they were more available on the market (1)	○	○	○	○	○
I intend to buy Omega-3 enriched eggs if they were more available on the market (4)	○	○	○	○	○
I plan to buy Omega-3 enriched eggs if they were more available on the market (5)	○	○	○	○	○
I will try to buy Omega -3 enriched eggs if they were more available on the market (6)	○	○	○	○	○

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HB2 Please indicate how much you agree or desegree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Buying Omega-3 enriched eggs for me is time-consuming (1)	○	○	○	○	○
Buying Omega-3 enriched eggs for me is costly (7)	○	○	○	○	○
Buying Omega-3 enriched eggs would require starting a new habit, which is difficult (8)	○	○	○	○	○
I don't know where to buy omega 3 eggs (9)	○	○	○	○	○

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HB3 Please indicate how much you agree or desegree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Omega-3 enriched eggs are tastier than non-enriched eggs (1)	○	○	○	○	○
Omega-3 enriched eggs are healthier than non-enriched eggs (2)	○	○	○	○	○
Eating Omega-3 enriched eggs decreases my risk of getting a coronary heart disease and blood vessel disease (3)	○	○	○	○	○

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HB4 Please indicate how much you agree or desegree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Buying Omega-3 enriched eggs is easy for me (1)	○	○	○	○	○
Buying Omega-3 enriched eggs is under my control (2)	○	○	○	○	○
I understand the information related to omega 3 eggs on the egg packaging (3)	○	○	○	○	○

HB5 Please indicate how much you agree or disagree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Nothing is as important as good health (1)	○	○	○	○	○
Having good health is more valuable than money (2)	○	○	○	○	○
I am motivated to use healthy products for good health (3)	○	○	○	○	○

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HB6 Please indicate how much you agree or desegree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
I feel my chances of getting coronary heart disease in the future are high (1)	○	○	○	○	○
My lifestyle (eating habits, sport) makes me believe that I am not under the risk of getting coronary heart disease (13)	○	○	○	○	○
I think I might die of heart disease (14)	○	○	○	○	○

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HB7 Please indicate how much you agree or desegree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
If I get coronary heart disease, it would have a severe negative influence on my quality of life (1)	○	○	○	○	○
If I get coronary heart disease, it would have a negative influence on my social relations (2)	○	○	○	○	○
If I get coronary heart disease, it would have a negative influence on my family relations (3)	○	○	○	○	○

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HB8 Please indicate how much you agree or disagree with the following statements:

	Strongly disagree (1)	Disagree (2)	I neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
I would buy more Omega-3 enriched eggs, if recommended by a doctor (1)					
I would buy more Omega-3 enriched eggs, if my friends suggested it (2)					
I would buy more Omega-3 enriched eggs, if my family members suggested it (3)					

End of Block: Health belief model

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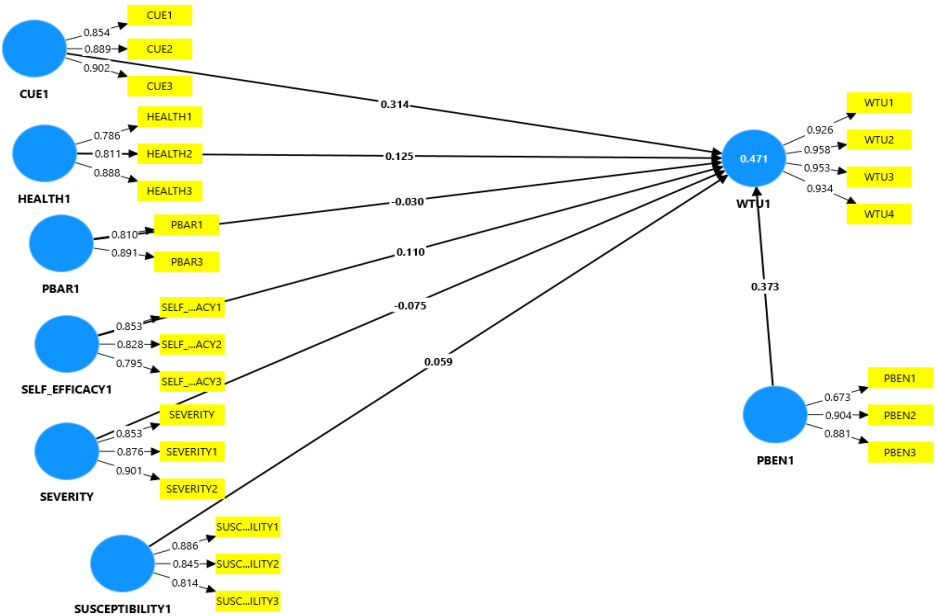
Appendix B

Smart-PLS results of the research model



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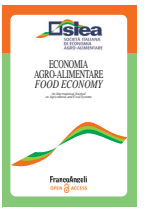

Incorporating social dimensions and sustainable marketing into an agri-food company's development strategy

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Abstract

Including sustainability in the corporate strategy is the main way for a company to be competitive and thrive in the long term. In this scenario, sustainable marketing is a strategic and evolutionary approach that is gaining considerable importance. It is focused on developing future-oriented solutions in the market while considering environmental, social, and ethical aspects to generate effects on entire systems in terms of institutions, value chains, or sectors. The agri-food sector experiences growing awareness and concern among stakeholders about not only the environmental but also the social and ethical aspects. This can translate into market opportunities for companies that differentiate themselves from competitors by offering products that reassure and comfort the consumer. This paper aims to investigate the role of the social dimension expressed in its leading indicators within an agri-food company's sustainable marketing strategy and the benefits or risks that can be recognized within a growth strategy with local and international markets. Specifically, using the qualitative, in-depth single case study methodology, the research explores how a medium-sized dairy company located in a geographical area characterized by high limitations integrated its social dimension within its business philosophy and how this

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integration is at the basis of its strategy of covering historical markets, commercial development in the Italian market and expansion towards foreign markets. Considering the new market scenarios, the study significantly contributes to policymakers, practitioners, and academic debate on the social sustainability dimension in agriculture.

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Introduction

Nowadays, companies that want to increase or even maintain their value must achieve sustainability objectives (Rodríguez-Olalla & Avilés-Palacios, 2017) and integrate them into the management philosophy, rethinking, redesigning and redeveloping activities in a more sustainable way (Ajmal *et al.*, 2018; Maas *et al.*, 2018). This is because in an increasingly globalized market, including sustainability in a company's business strategy is the only way to survive and thrive in the long term (Epstein, 2008; Trivedi *et al.*, 2018).

What is becoming increasingly evident is that companies must adopt both a broad vision that includes the environment and society beyond the market – aligning internal organizational processes and organizational resources that generate value not only for corporate stakeholders but also for the environment and society –, and an orientation aimed at building long-term relationships with customers based on their ecological and social needs and values (Belz & Peattie, 2009). In fact, traditionally, organizations were seen as black boxes that consumed resources and made profits for shareholders; now, the focus is on sustainable value creation in the long run for all stakeholders in a way that contributes to a sustainable society (Chandler, 2016). According to Hart and Milstein (2003, p. 57), sustainable value is "strategies and practices that contribute to a more sustainable world while simultaneously driving shareholder value". In such activities, businesses are called to balance two sources of creative tension: the temporal (short vs. long terms) and spatial (grow and protect internal organizational skills vs. new perspectives and knowledge from the outside).

In this environment, the value of integrity is also crucial because it is about efforts to engage stakeholders, align words and actions, and make business principles and practices adhere to sound moral and ethical principles. Integrity underlies good corporate citizenship and implies that companies adhere to constructive core values that underpin value-driven behaviors toward stakeholders and live up to high standards and principles (Waddock, 2001).

When the value of an organization's integrity – usually included in statements outlined in its mission – is rooted in its deep and superficial

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layers, it shapes its culture and identity of heart and soul and can determine its success or failure (Giudici *et al.*, 2013). However, the integrity must be extended to encompass also the company's external context (social, environmental, and economic), showing its interconnections with sustainability since they both call for behaviors based on respect for social, economic, and environmental standards (Giudici *et al.*, 2013).

Moreover, recognising the close connection between a company's competitiveness and the well-being of its surrounding community, that is, the business concept of creating shared value, is paramount. According to Porter and Kramer (2011), businesses can create economic value and enhance their competitiveness through policies and practices that promote both social and economic conditions in the communities where they operate. Further, creating shared value is defined as "a strategic process through which corporations can solve a social problem which is relevant to its value chain while making economic profits" (Menghwar & Daood, 2021, p. 467). To create shared value, businesses should offer products and services that address societal needs. It can enhance efficiency and generate social value by improving their supply chains, reducing waste, and adopting better environmental practices. Additionally, these efforts can lower costs and increase long-term profitability. Moreover, businesses can invest in education, infrastructure, and workforce development, benefiting both companies and the community.

Recent years have seen consumers' increasing engagement with ethical issues, and in the aftermath of the Coronavirus pandemic, a put into the forefront of ethical consciousness health issues and pro-social concerns (Hesse & Rundau, 2023). It is now well established that consumers increasingly use their consumption choices as a 'vote with the wallet' to award companies and brands considered seriously and honestly engaged in the integration of the creation of economic value with social and environmental sustainability (Becchetti & Salustri, 2019).

In this respect, for organizations, (*i*) sustainable value creation is a moral obligation and a unique opportunity to differentiate, innovate, reduce cost and risk, and enhance reputation, legitimacy, and competitiveness (Hart & Milstein, 2003, p. 57), and (*ii*) integrity building and maintenance is pivotal to survival, development, and success in the today market characterized by multiple ethical challenges.

In this scenario, a holistic, structured, and innovative marketing approach emerges: sustainable marketing, definable as "the marketing within, and supportive of, sustainable economic development" (van Dam & Apeldoorn, 1996, p. 46). Sustainable marketing is a macromarketing concept because it affects entire systems, such as institutions, value chains, or sectors (Belz & Peattie, 2009). Moreover, it is the strategic business approach that creates

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customer value and seeks to build customer loyalty by (*i*) integrating environmental, social, and ethical considerations and values that consumers and businesses hold in common into their marketing efforts and (*ii*) contributing so to the well-being of the planet and society and a prosperous economy (Spychalska-Wojtkiewicz, 2020; Sujanska & Nadanyiova, 2023). In this framework, consumers expect sustainable marketing strategies from companies, as well as goods and services, that align with their values and satisfy their growing demand for morally, environmentally, and socially responsible alternatives (Park *et al*., 2022).

The agri-food sector is experiencing a growing awareness and concern among stakeholders about the environmental, social, and ethical aspects of this production sector, which, actually, can translate into market opportunities for those companies that, by offering products that reassure and comfort the consumer, can differentiate themselves from competitors (Henchion *et al*., 2017). When talking about agri-food goods, in addition to talking about "experience goods" or "trust goods" (concerning their quality), one must also remember they are also the outcome of a governance model organized on supply chains (long and/or short) and on territories from which a series of material and immaterial values created by the business arise, and business's market positioning and social role is built. For this reason, the agri-food sector is under the lens of professionals, academics, and institutional managers in terms of analyzing its contributions to developing the environmental and social dimensions of sustainability.

With particular regard to the social dimension, it is often overlooked in studies on the sustainability of agri-food businesses (Massuça *et al*., 2023), maybe because there is still no clear and universally shared definition, and it appears as an open, indefinite, and elusive concept (Allen *et al*., 1991; Boström, 2012; Janker & Mann, 2020). In this uncertainty, anyhow, widespread consensus is found in the relevant indicators to be considered, divided into aspects inherent to the business community and society in general (Diazabakana *et al*., 2014).

What emerges is that sustainable marketing is a concept gaining more and more importance (Gong *et al*., 2023). However, it is still at an early stage of research (Park *et al*., 2022), and there is a lack of studies investigating the role of the social indicators above within a sustainable marketing strategy of an agri-food company and the benefits or risks that this approach can generate within the overall business strategy.

This research arises from the desire to move away from the various contributions relating to the environmental dimension of sustainability in the agri-food sector. Specifically, this study aims to shed light on how the inclusion of the social dimension within sustainable marketing strategies could make what can be defined as "corporate philosophy" a competitive

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strategic factor able to produce "distinctive qualities" that allow agri-food companies to pursue growth strategies successfully.

Those qualities (or competencies) are unique, superior, and strong attributes developed by an organization that (*i*) set it apart from competitors because no one else in the market is doing it, (*ii*) cannot be easily replicated, and (c) enable the organization to address market problems, satisfy customer needs and deliver value to its markets. Several benefits derive from them, including competitive advantage due to unique offerings that are tricky to replicate, improved value proposition (derived, i.e., from innovation, quality, or efficiency), diversification and expansion (by exploiting the strengths points), brand recognition, equity and customer loyalty (i.e., to build brand identity and equity thanks to the relation the business' brand to its unique attributes by customers, in turn, build customers' loyalty), resist to market changes, strategic focus (on areas with the greatest top-class perspective and value for customer).

Specifically, this study seeks to answer the following research questions:

RQ1: How can an agri-food company include the social dimension in its sustainable marketing strategy?
RQ2: What are the effects of this inclusion on the main stakeholders?
RQ3: What is the impact of this inclusion on achieving company objectives?

The qualitative, in-depth single case study methodology (Harrison *et al.*, 2017; Noor, 2008; Stake, 2013; Yin, 2017) was chosen to answer the research questions as (*i*) it was widely used in business, agriculture and the social sciences research, (*ii*) it is useful for deeply exploring complex issues from multiple perspectives, examining contemporary events, and (*iii*) it can be used to provide in-depth knowledge of complex phenomena (Crowe *et al.*, 2011).

This paper aims to provide an answer to these questions through the description of how a medium-sized dairy company located in a geographical area characterized by high limitations has integrated its social dimension within its business philosophy and how this integration is at the basis of its strategy of covering historical markets, commercial development in the Italian market and expansion towards foreign markets.

Section 1 describes the literature review on sustainable marketing and the social dimension in the agri-food business. Section 2 presents the methodology, the research setting, and the data source. Section 3 shows the single case study investigated. The conclusion and explanation of the implications of this study are included in Section 4.

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1. Background

Sustainable marketing

Over time, marketing, in a context of ever greater consumer involvement, has evolved to adapt to society's evolution and its new requirements. There was a transition from the Product-centric era (Marketing 1.0), the Customer-oriented era (Marketing 2.0), to the Values-driven era (Marketing 3.0), and then to digital-centric marketing (Marketing 4.0) (even if we are already talking about marketing 5.0 - Kotler *et al*., 2021). In this new era – which inevitably binds to the previous one – businesses are required to be more transparent in their marketing and communication processes since it is much easier now for consumers to make informed purchases, and it is not enough for businesses to reiterate their value proposition to keep it in consumers' mind, but they keep that promise; otherwise, they cannot achieve customer loyalty (Kotler *et al*., 2016). As a result, business objectives are achieved by ensuring economic, environmental, and social sustainability, considering the long-term impacts of production and consumption. In other words, businesses should provide value to customers, ensuring society's and the consumer's well-being are preserved or improved: it is the shared value (which recognizes both economic and social needs, so also creating value for society) to define markets (Kotler *et al*., 2016). Sustainable marketing is a broad marketing concept that includes environmental marketing, green marketing, and societal marketing (Trivedi *et al*., 2018) and is essential for creating a sustainable company (Rudawska, 2018b).

Despite not being a novelty (Murphy, 2005), sustainable marketing is still in its infancy (Park *et al*., 2022), although it is gaining more and more importance (Gong *et al*., 2023).

Two twenty-year-old definitions of sustainable marketing appear particularly significant as they show two different perspectives, the first American with a more managerial approach and the other European with a broader viewpoint. According to Fuller (Fuller, 1999, p. 4) "sustainable marketing is defined as the process of planning, implementing, and controlling the development, pricing, promotion, and distribution of products in a manner that satisfies the following three criteria: (1) customer needs are met, (2) organizational goals are attained, and (3) the process is compatible with ecosystems". European approach sees sustainable marketing as "the next natural step forward, with an emphasis on progress towards greater sustainability. It is a broader management concept which focuses on achieving the 'triple bottom line' through creating, producing and delivering continuously satisfying customers and other stakeholders" (Charter *et al*., 2002, p. 12). Summarising, "Sustainable market orientation is connected with

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the continuous process of environment analysis as well as the design and implementation of strategies that ensure sustained growth, consistent with the assumptions of sustainable development" (Rudawska, 2018b, p. 58).

Market orientation toward sustainability involves constant external expectations analysis and formulating and implementing strategies that pursue economic business performance compatible with sustainable development postulations (Rudawska, 2018b). It is essential to highlight that a marketing strategy of long-term success is a process that involves pairing the internal resources and capabilities of a business with external environmental opportunities (Day, 1994, 2014; Kozlenkova *et al.*, 2014; Kuwu & Gakure, 2014). The strategy implementation requires incorporating the sustainable development objectives into the organizational structure, and, as the concept of sustainable marketing should apply to the entire organization, it is necessary to look at the internal resources and capabilities to shape marketing strategies.

It is important to underline that some authors (Belz & Peattie, 2009; Quoquab *et al.*, 2021; Rudawska, 2018a) have made a difference between sustainable marketing and sustainability marketing. They argue that the first term refers to building long-term customer relationships without specifically referencing sustainability issues. In contrast, the second term relates more precisely and clearly to the sustainable development agenda and focuses on creating and maintaining sustainable relationships with customers, as well as the social and natural environments. It should be noted, however, that the two terms are used interchangeably in the literature due to the very thin difference between these two terminologies (B. Kumar, 2018; Quoquab *et al.*, 2021).

For the successful integration of the environmental and social dimensions into business strategy and consumers' reassurance about the value deriving from the products of the company and the benefits of sustainable consumption, the company must include the values of sustainability within four fundamental strategies of marketing, that are innovation, collaboration, communication, and commitment (Obermiller *et al.*, 2008; Trivedi *et al.*, 2018).

While *innovations* in production processes imply significant investments, sustainable processes provide better returns and, together with sustainable packaging, distribution, and promotion, allow lower costs and increased efficiency (Martin & Schouten, 2012; Reutlinger, 2012).

Collaboration with other bodies/NGOs/organizations on sustainability issues positively benefits consumers' purchasing decisions – which will value the business' interest in local development issues and its sustainable investments for the territory – and also generates value for the environment and the company (Trivedi *et al.*, 2018).

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The success of sustainable marketing and maintaining long-term relationships between a business and its stakeholders is closely connected to its *commitment* to the community's well-being and the empowerment of employees and other stakeholders (Emery, 2012; Lubin & Esty, 2010; Rondinelli, 2004). In this sense, the business will see added value recognized for its products, a premium price, the development of brand loyalty, a reduction in costs, and an improvement in efficiency and organizational performance (Oliveira & Sullivan, 2008; Reutlinger, 2012; Trivedi *et al.*, 2018).

Communication, intimately linked to the concept of business' longevity, allows it to provide transparent information about its sustainability performances and demonstrate its congruity with the new culture of sustainability (Drempetic *et al.*, 2020; Iannuzzi, 2017; Montero-Navarro *et al.*, 2021), playing a fundamental role in ensuring that it has a "license to operate" and building and consolidating reputational capital (Drempetic *et al.*, 2020; Lim & Greenwood, 2017; Schultz *et al.*, 2013).

The results of such strategies will create value for the organization, the environment, customers, and the community as a whole.

Social dimension in the agri-food business

The agri-food system, lying "at the center of a global nexus of social, environmental, and economic problems" (El Bilali, 2019, p. 354), holds enormous responsibilities in overcoming the challenges of sustainability and faces public demands and expectations change and clashing goals that pose complex dilemmas and trade-off (Testa *et al.*, 2022). In such a scenario, an integrated and holistic approach to sustainable agriculture and food systems is needed (United Nations, 2020). In fact, sustainable food systems must achieve positive outcomes in all three dimensions of sustainability, involving favorable environmental and economic impacts and more equitable distribution of benefits for society (FAO, 2018).

Even though sustainability encompasses a three-pillar conception, the social dimension in general and specifically in the food system suffers from being overlooked and sometimes ignored by literature (Massuça *et al.*, 2023; Whitelock, 2019). Although there are numerous contributions regarding the environmental impacts or environmental sustainability of agriculture, the number of studies on the social dimension is decidedly smaller (Ballet *et al.*, 2020; Orou Sannou *et al.*, 2023; Toussaint *et al.*, 2021), mainly focused on the reason for its integration into business practices and not on what it is based on in the agri-food sector (Sidhoum, 2018).

This is attributable to the lack of an integrated approach but also to the complexity of the very concept of social sustainability in the food industry,

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leading to an ongoing discussion about what constitutes social sustainability (Toussaint *et al*., 2022) and, in turn, to its still unclear definition (Ajmal *et al*., 2018; Allen *et al*., 1991). The social pillar is deemed the most arduous to explain due to its subjectivity and context-dependency, requiring a definition that is as inclusive of all potential aspects as possible, allowing the difficulties in interconnectivity among its scope, measurement, and information to be overcome (Toussaint *et al*., 2022).

In effect, although previous literature on Agenda 2030 includes significant social sustainability implications of food systems (due to its direct or indirect effects, particularly on SDGs 1, 2, 5, 8, 10, and 17) and businesses are gradually incorporating social sustainability concerns, further research is required in the agribusiness sector (Massuça *et al*., 2023; Parrilla-González & Ortega-Alonso, 2022). While literature is increasingly recognizing the need to measure the sustainability of the agri-food sector and the agricultural system in both European and international contexts (Castillo-Díaz *et al*., 2023), the social impact measurement still remains a challenge also because of the complexity of stakeholders[1] (Kelley & Simmons, 2015).

Recent studies examined social sustainability often about working conditions, but the concept should extend to living conditions, human rights, having regard to communities and ethical issues, food security, and so on (Agyemang *et al*., 2022; Massuça *et al*., 2023; Zorzini *et al*., 2015).

To address a key emerging research question concerning "How does agribusiness integrate social aspects into its management?" (Massuça *et al*., 2023, p. 240), this study focuses on two significant factors in the agricultural context that previous literature generally agrees upon: the engagement on the business community and the society as whole (Diazabakana *et al*., 2014; Lebacq *et al*., 2013; Sidhoum, 2018). The first is related to the well-being of employees, such as education, working conditions, including gender equality, and quality of life. The second encompasses three main groups: quality of rural areas, contribution to employment, and product responsibility. Specifically, we do not proceed to measure the impacts of the company's operations in the aspects above, nor the level of integration between the three

1. It should be pointed out that companies have access to various tools that are crucial in helping them measure and disclose their impacts, some of which are mandatory depending on the size of the company, while others are optional. Notable tools include the Corporate Sustainability Reporting Directive (Directive 2022/2464/EU) and the Corporate Sustainability Due Diligence Directive (Directive 2024/1760/EU), ISO standards – including SA 8000 for Social Accountability and ISO 15075:2024, which relates to the social life cycle assessment of products –, the Global Reporting Initiative (GRI) – a valuable resource for understanding and reporting on economic, environmental, and social business impacts –, and the Sustainability Balanced Scorecard (SBSC) which serves as a comprehensive measurement tool that helps companies assess their economic, environmental, and social performance.

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dimensions of sustainability. Still, through an in-depth single case study, we bring out some points that describe how the social dimension of sustainability has been included in a business's sustainable marketing strategy.

2. Materials and methods

Methodology

Researchers and practitioners in fields such as public health, agriculture, education, psychology, and the social sciences have widely used case studies as a methodological approach, as it helps them gain a deeper understanding of complex social phenomena and retain the holistic and meaningful characteristics of actual events (Rogers, 2003; Sellnow *et al*., 2009; Yin, 2013). In effect, in situations where researchers have little control over events, posit "how" or "why" questions, and want to investigate current phenomena in real life, case studies appear to be the best-suited research strategy (Yin, 1981).

According to the cognitive objective of this study, the use of the qualitative in-depth single case study method (Eisenhardt, 1989; Yin, 2013) was appropriate as (*i*) it allows for investigation and understanding of complex problems in real-world contexts by using a multidimensional approach, (*ii*) it is advantageous when the objective is to understand a specific problem or situation in depth, and there is a significant amount of available information, (*iii*) it provides insights into successful managerial experiences offering concrete courses of action, and (*iv*) although there is more emphasis on the particulars of the cases than on their representativeness, which makes generalizing its results difficult, it offers significant theoretical propositions which can be tested in a broader quantitative study (Flick, 2009; Harrison *et al*., 2017; Noor, 2008; Stake, 2013; Yin, 2017).

Research setting

The single case selection process involves four criteria: (*i*) location in a region characterized not only by strong geographical limitations but also by a low economy (low GDP per capita), (*ii*) long-standing company, (*iii*) medium or large-sized enterprises, and (*iv*) access to rich, substantial, and relevant data.

The first selection principle originates from the goal of providing an example of developing a successful marketing strategy in a region that faces substantial geographical limitations and has a low economy. This criterion compelled us to focus on southern Italy.

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The second criterion led to choosing a company that should have been operational for no less than ten years. This choice comes from the fact that (*i*) sustainability is a long-term vision that involves the development of a strategy grounded in ethical and moral principles, (*ii*) marketing strategies deal with long-term marketing goals, and (*iii*) strategic plan has a lifespan of more than five years (Karam *et al*., 2018; V. Kumar *et al*., 2012; Yalo *et al*., 2019).

The third criterion arises from the need to examine a company with a structure dedicated to the marketing function, usually present only in medium/large companies. The marketing department, which arises for planning and carrying out marketing activities, has become increasingly important and has a crucial role in making businesses successful because it supports corporate strategy (Kotler *et al*., 2019), for example, making the company able to measure on the "mega-trends" shaking the market, rethinking its position or re-processing its value proposition closely. Moreover, in medium/larger companies, it is possible to have a sustainability department or internal dedicated figures who deal directly with its sustainability, developing and implementing strategies that enable them to achieve sustainability targets in environmental and social dimensions and report on them. Due to the presence of this department, specific sustainability issues are better integrated into the company's strategies and daily operations. This integration enhances the credibility and importance of sustainability disclosure (Ruhnke & Gabriel, 2013).

The fourth criterion addressed the assertion that "the quality and credibility of your study starts with the data" (Charmaz, 2014, p. 18). The company to investigate should allow satisfying the general rule of data trustworthiness to be achieved – understood as credibility, transferability, dependability, and confirmability (Guba & Lincoln, 1989) –, as well as explicitness, vividness (which involves the production of detailed and thick description), creativity, thoroughness (which indicates a phenomenon' full exploration, that is, thorough data collection), congruence, and rich rigor, which implies careful attention to detail (Tracy & Hinrichs, 2017; Whittemore *et al*., 2001)

Among the possible companies that exhibit the previously mentioned characteristics, this study selected the Assegnatari Associati Arborea s.c.a.p.a. Società Benefit (3A SB), a company with unique features, which main is working over around 90% of the entire cow's milk sector in a region insular, reflecting its roots in the territory. It is a cooperative that became one of the largest Italian production companies in the production of milk and its derivatives, and the principal promoter of the development of the territory where it is headquartered, Arborea, near Oristano (Sardinia, Italy) (Giudici *et al*., 2013). The Cooperative dates back to 1956, competes in the regional and national markets, and has entered the Chinese market, has 162 Sardinian

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producer members and four production sites, each characterized by different production and technologies. In 2020, it recorded a 10 million turnover increase since 2019. In 2022, it obtained revenues of 211 million euros (+11% vs. 2021) and a production of 211 million liters of milk, of which 195 million were destined for dairy production for consumption (189 million bovine, 5.7 million goat's milk, 0.8 million sheep's milk), and 16 million destined for the marketing of industrial raw milk. The 3A SB, in addition to looking at the economic and environmental dimensions of sustainability, has always had the social dimension at heart, as evidenced by the statement of its previous president: "The Arborea miracle is called work, seriousness, mutual respect. We are proud to hand over economic benefits to our children, but also social and ethical ones, and we are proud to have created a model based both on social and entrepreneurial rules" (Giudici *et al.*, 2013, p. 241). The 3A SB also has a sustainability department, and its commitment to the three dimensions of sustainability manifested itself in 2021 with the modification of its Statute, which has made it a benefit company.

Data source

To comply with the fourth criterion of the company selection, this study collected data from several sources to generate more robust results (Eisenhardt, 1989; Yin, 2013), that is, primary (semi-structured interviews with top management and members of the sustainability department[2]) and secondary (social networks, institutional website, scientific publications, internal reports, and impact report) data. Specifically, in May 2023, a meeting was held with members of the Sustainability Department – who, according to previous literature (Ali *et al.*, 2024; Corsi & Arru, 2021; Eccles *et al.*, 2014; Ruhnke & Gabriel, 2013), were deemed the most appropriate interlocutor for expounding the company's sustainability policies and their impacts at various levels – during which a semi-structured interview occurred. This

2. Eccles *et al.* (2014) found that sustainability-oriented companies are likely to have a separate board subcommittee responsible for overseeing sustainability. In point of fact, sustainability department is an attribute of the Sustainability governance policies and structures (Ali *et al.*, 2024), and within it, the skills and abilities of managers come together and are reconfigured to create new strategic value, incorporate sustainability into corporate strategic and operational planning, as well as pursue positive and sustainable performance, providing a genuine commitment to sustainability rather than a superficial interest driven solely by reputational concerns (Corsi & Arru, 2021; Eccles *et al.*, 2014; Ruhnke & Gabriel, 2013). The sustainability department is primarily responsible for developing, implementing, and monitoring sustainability strategies, and its main role is to create a systematic approach that reflects the organization's sustainability performance and boosts the disclosure of this information to achieve corporate objectives (Ali *et al.*, 2024).

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meeting provided an opportunity to explore different aspects related to the declarations made in the 2023 impact report concerning 2022. Additionally, it addressed the organisation's sustainable value, integrity, and shared value.

3. Case study

To address the first research question, the following subsection will outline the Company's values of sustainability and integrity, and how it fosters the creation of shared value within its business approach. The subsequent four subparagraphs will focus on the relationships with the company's four categories of key stakeholders. The final two subsections will highlight how the Company answers to the research questions 2 and 3.

Sustainable value, integrity value, and shared value

The company embarked on the path of sustainability since its origins. The choice to be a cooperative, aimed at enhancing and pursuing the mutualistic purpose, has made it possible to achieve the inherent objectives of this social form, which, directly and indirectly, has a social and economic impact on shareholders and stakeholders. The Company aims to allow members to grow together, helping each other to obtain something that they otherwise could not achieve independently (such as better working conditions, better prices for services, and lower costs for the purchase of equipment and materials) by putting the well-being of members and people at the center and, thus, becoming an instrument of the development of local communities in the territories in which it operates.

Concerning the sustainable value creation, the Company has always tried to balance short-term objectives with medium/long-term ones, operating with the primary aim of "creating the conditions for maintaining sustainable and satisfactory economic results in the interest of the entire community and, in particular, of stakeholders […], such as workers, customers, suppliers, members and non-members, financiers, creditors, public administration and civil society" (3A SD, 2023, p. 25). Moreover, through an outside-in strategic approach aimed at analyzing external market dynamics and an inside-out strategic approach focused on specific Company resources and capabilities (Frau & Cabiddu, 2016), the business has managed to preserve its position in its historical market over time, keeping its relationship and commitment with the territory, innovating its products and making responsible production its philosophy.

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This Company is an organization, meaning a community of individuals who collaborate for defined objectives (Melé, 2003), since it was established by farmers with "the aim of transforming and marketing their product in an associated form, perfectly aware that to achieve satisfactory results they could not operate individually". Its goals, however, are broader in scope and look at the performance as a whole, recognizing that economic, environmental, and social aspects are connected and essential to each other and setting measurable objectives that generate a positive, tangible impact for all stakeholders, as indicated in the new Statute.

The value of integrity of 3A SB is well evident in its mission and vision, which "guarantee the fair remuneration for farmers, preserving the territory of origin and offering high-quality products that meet the consumer preference" and "generate profitable and sustainable development with excellent products that give satisfaction and well-being to people and fair remunerate the milk of our farmers" (3A SD, 2024). Respect for ethical principles and adherence of the Company's operations to its core values is guaranteed by the administration of the Cooperative, which consists of a group of members elected directly by all members that have the task of guiding the Company in compliance with the cooperative mission and vision and of generating well-being for all members, as well as for all stakeholders identified by the Statute. In carrying out his task, corporate governance ferried the Company in changing its statutes to integrate into its corporate goals, in addition to profit, to bring about benefits both for society and the environment and become a Benefit Corporation (in Italian Società Benefit)[3]. It is a new legal tool that provides solid bones for aligning

3. Italy was the first country in the European Union to introduce the Benefit Corporation into its corporate law through Law No. 208 on December 28, 2015 (Article 1, paragraphs 376 to 384, and Annexes 4-5). This law does not define the Benefit Corporation as a new type of company: it appears as a hybrid organization that pursues both profit and social objectives while operating in a responsible, sustainable, and transparent manner towards the community, the environment, and other stakeholders.

According to Bertarini (2016), a Benefit Company is a type of corporation that aims for economic efficiency and effectiveness while also focusing on generating positive societal outcomes. In essence, this type of company retains all the traditional characteristics of a corporation but is also legally bound to pursue social responsibilities. This means that, in addition to focusing on profits for shareholders, it must actively seek to promote the common benefit (Hiller, 2013).

In this context, "common benefit" refers to achieving positive outcomes or reducing negative impacts through economic activities. Common benefits should be specified in the company's statutes and pursued through a management strategy that seeks to balance the members' interests with the effects of the company's activities on society.

The Benefit Company is required to maintain transparency regarding its commitments. Each year, it prepares a report on its efforts to achieve the common benefit, which is included

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missions and creating value in the long term. Therefore, it manages the Company, pursuing the common benefit by considering the interests of shareholders and all stakeholders. This legal form makes an annual report mandatory to attach to the annual financial statement to report the overall social and environmental performance to all stakeholders. In this legal form (a traditional corporation with modified duties that mandate higher standards of purpose, accountability, and transparency), sustainability is an integral part of the corporate business model aimed at creating conditions favourable to social and environmental prosperity today and in the future.

The Arborea SD indicates embracing shared value creation concept through its statements in the Annual Benefit Report 2022, declaring to operate to "satisfy the customer with an offer of quality products that respond to the need for modern, healthy, and balanced lifestyles, capable of creating a lasting relationship through the value of its brands. (This) has always been the pact of trust with which the Cooperative has built its growth and reputation in the market" (3A SD, 2023, p. 77). Furthermore, aware that the creation of shared value must also be seen from a value network perspective (Shafer *et al.*, 2005), 3A SB confirms its commitment to the creation of value along the entire supply chain, supporting it in its sustainability path, also by investing in control tools and the managerial and entrepreneurial growth of the various operators. In this regard, "There are many actions aimed at combating the phenomena of impoverishment of environmental characteristics, guaranteeing a fair income for economic actors, and fostering and intensifying social cohesion in the local community" (3A SD, 2023, p. 54).

Such evidence suggests that 3A SB's business approach is characterized by a particular form of relationship with four categories of key stakeholders: the local community and territory, suppliers, employees and customers, towards which the Company directs its sustainable marketing strategies, as shown in the Figure 1.

in the company's financial statements. The Antitrust authority is responsible for ensuring that the designation of the Benefit Company is not misused.

Companies that intend to transform themselves into Benefit Companies must modify their statute and transform into a Benefit Company.

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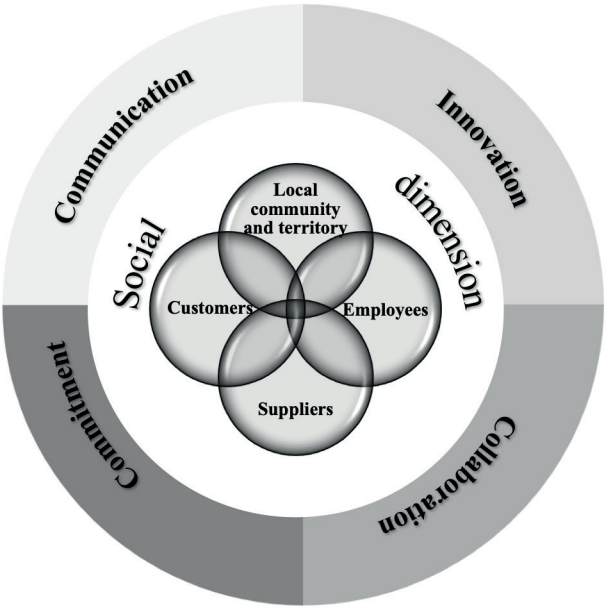
Fig. 1 - Sustainable marketing strategies strived at key stakeholders



Local community and territory

Concerning this category of stakeholders, the Company is engaged in all four sustainable marketing strategies.

This kind of stakeholder highlights, inter alia, the Company's inside-out marketing strategy approach, that is, its focus on its specific internal resources and capabilities to shape its marketing strategies. We referring to its connection with the territory.

The Company's commitment manifests in different ways: it feels like a responsible citizen and invested with a crucial role in the development of its region. Therefore, 3A SB states in its first annual benefit report "a concrete commitment towards achieving the common well-being of the community" and "the goal of restoring value to the territory and generating new ones" (3A SD, 2023, p. 7). It underlines its very close relationship with the territory for over 60 years and being "placed in a typical context from an economic, political and social point of view" (3A SD, 2024) and its awareness that its actions can influence the territory and the entire community, especially considering the impacts that concern the whole dairy supply chain. For this reason, it "constantly adopts good practices for the protection of the territory because it is only by respecting the environment and animals that it can

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guarantee a sustainable future for tomorrow's generations" (3A SD, 2024). In this regard, several activities have been carried out aimed at (*i*) rebalancing the agroecosystem in its main components to guide the strategies of the stakeholders present with a view to the circular economy, at combating the phenomena of impoverishment of environmental properties, (*ii*) guarantying a fair income for economic actors, and (*iii*) promoting and intensifying social cohesion in the territorial community. The way the Company calls itself, frequently simply "Arborea", also indicates this deep connection with the territory.

This constant attention and commitment to the community are the basis of its long collaboration with all the territory's actors and crucial role in establishing new norms, values, and forms of relationships, creating a shared common framework, and promoting regional development. The 3A states, "Our strength is cooperation, which is why we support educational projects and social activities that positively impact the territory" (3A SD, 2024). For this reason, it carried out several projects with non-profit organizations and institutions (including a pediatrics project, projects for nutritional education, active lifestyle, sport and music, projects aimed to intensify social cohesion in the local community and strengthen synergies with the local rural production systems of the entire territories[4]).

On the front of the innovations carried on by the Company to improve the conditions of the community and the territory, it is possible to include, but

4. Among the various projects promoted by the Company, we mention:
- "Food education in schools". For several years, the Company has collaborated with the world of schools and, under a regional school protocol, sends nutrition experts to primary school classes to talk to children about how they grow better by eating with awareness. It provides teachers and families with educational books on food education so that they can continue the path of knowledge autonomously and progressively.
- "Guided tours" is a project aimed at transmitting the passion that drives the Company in milk production. Every year, the Company welcomes schools and visitors by offering knowledge paths to discover the milk supply chain, starting from the farm and ending with a visit to the dairy.
- "Pediatrics project". It concerns a partnership with the Neonatal Pediatric Clinic of Cagliari that is particularly dear to the Company, which made available its laboratories to carry out specialist analyses on breast milk intended for premature babies so that it can be integrated and fortified in a targeted way in case of deficiencies.
- "Cagliari calcio". In addition to sponsoring Cagliari Calcio, the Company works closely with the Cagliari Calcio Fan School. It organizes co-marketing activities to illustrate to young athletes the benefits of physical activity and a correct and balanced diet.
- "Time in jazz". The Company supports "Time In Jazz", a week-long summer event that hosts internationally renowned musicians and music enthusiasts in Sardinia.
- "Kindness Days" concerns volunteering days carried out in collaboration with various Sardinian non-profit organizations. The Company's employees dedicate time and resources to projects ranging from assisting people with difficulty to dealing with the social fragilities afflicting local communities.

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are not limited to, the adoption of new technologies for the optimization of nitrogen flows and the "pallet pooling" which led to the reduction of 249 t CO_2e, 20.3 tons of waste, and wood saved equal to 212 648 dm^3 equivalent to 205 trees.

The territory and community elements have a preponderant character even in the Company's external communication strategy. With the new national advertising campaign "The Gentle Revolution of Milk", the Company aims to show and make its origins recognizable, somewhat undermining the stereotype of harsh and wild Sardinia: "There is an island that they haven't told you about yet, a land as sweet as its milk". The Company's president states, "Our history is closely connected to the island's territory, and the area that 100 years ago was unsuitable for cultivation and livestock now represents the most lush and productive territory in the region. Due to the unique qualities of the agri-food district, Arborea is one of the leading players in the Sardinian and national dairy market and (…) always respectful of the territory that hosts it. Ours is an island within an island, which unites diversity and becomes the bearer of a great inclusion project" (GDOWEEK, 2023).

Employment and working conditions

The Company declares its commitment to women's full and effective participation in corporate life and the promotion of decent work and a safe and protected working environment, in line with SDGs 5 and 8 of the 2030 Agenda. The Company's commitment toward its employees is stated in its Statute, which declares its "support of agricultural entrepreneurs and employees and their respective families". This statement is accompanied by the numbers: 421 workers with permanent contracts, of which 45% of office workers are women; 14 years old is the average length of time an employee stays in the Company. The Company that obtains the voluntary certification UNI ISO 45001:2018 (Occupational Health and Safety Management System) is structured and organized with key employees capable of giving value to the Company product: they are aware of truly giving that added value to the products. Several are the 3A SD's LinkedIn posts, where its employees declare that the "human dimension is an added value of Arborea, where there is a strong sense of belonging" and that "working at Arborea means embarking on a path of growth and continuous training". Indeed, "Arborea represents the territorial identity and enhances the professional growth path of all its collaborators". This commitment manifests itself in an organizational efficiency that the Company believes to be a source of competitive advantage.

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The Company has estimated that 6.5 jobs are generated for each milk worker, 5.9 of which result from activating the supply chain and 0.6 from stimulating consumption. In other words, through Istat input-output tables, the Company estimates just under 2,700 indirect and induced employees for a value of 49.8 million euros. The 3A SD's commitment to other companies that turn around it is inherent in its corporate structure and is at the basis of its competitive advantage. But good relationships with companies inside and outside the supply chain are not just a desire to be "a good citizen" but also a strategy: the Company recognizes the ever-growing need for an integrated production chain capable of synchronizing and directly controlling all its phases to compete successfully on the markets.

Suppliers and members

The Cooperative has always aimed to enhance the dairy sector in Sardinia by acquiring members who represent approximately 90% of the entire Sardinian cow's milk sector, and it continues to grow thanks to the careful planning of the breeding and production phases.

The Company's objective is to obtain the best remuneration for milk for its members. The advertising campaign aimed at conveying the proper value of the dairy product, perhaps underestimated in past years, and at bringing out the proper consideration of the work behind that liter of milk should also be read in this sense.

The Company is highly committed to training its members in purely zootechnical, economic, and financial fields. It aims to build a sustainable supply chain in the triple economic, social, and environmental dimensions, and it knows that investing in the managerial and entrepreneurial growth of the people who work in livestock farms is necessary. The attention paid to breeders is one of the company's pillars, as it (*i*) allows it to present products on the market that communicate the typicality, history, and culture that distinguishes it, (*ii*) has enabled it to obtain the certification for Animal Welfare according to ClassyFarm for 100% of the stables of the contributing members, and in turn, (*iii*) to offer 100% of the Arborea brand milk and cheeses with this prestigious certification from 2023.

The aim of expanding the members' well-being also involves increasing the innovations introduced in their businesses, holding that the "*innovation allows you to better manage production both in terms of efficiency and sustainability*". The 3A SD supports its members with the "EcoStalla" project (a management system capable of supporting members in the traceability of the supply chain and generating economically helpful information for acquiring management control competencies to manage the breeding, stables

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and land better), "Mitiga" project (to collect, categorize and correctly report the key data for the priority actions development, especially those necessary to address environmental critical issues promptly), "Climalat" project (for monitoring the impact of heat stress on both dairy cattle and corn crops), assistance for participation in energy efficiency tenders, among others. 3A SD believes that innovation in the management approach is important from the environmental sustainability perspective and contributes to improving animal welfare.

All innovations introduced in the members' business helped to improve milk production in terms of quality and quantity and provided data on the reproductive animals' tendencies. This has led to improving the economic sustainability of the members' businesses, and consequently of 3A SD, and being able to continue investing in innovation. The dimension of social sustainability also benefits from introducing such innovations since the quality of work is improved and encourages the entry of new generations into local businesses. The end result is an increase in efficiency using the same production factors, consequently increasing the environmental sustainability of 3A SD.

Adopting the outside-in approach (aimed at meeting the needs of external stakeholders by providing value-added offerings, Frau *et al.*, 2020; Holmemo *et al.*, 2018; Schulz *et al.*, 2018), the Company has a monitoring program of the supply chain to capture changes that occur in suppliers (old and new) and distributors.

Customers and product responsibility

Concerning the customers, the 3A SD reveals its outside-in marketing strategy approach, monitoring both the health of the brand and customer needs and possible new market segments.

The demand-pull approach of the Company is evident, and several actions have been taken in response to new health, well-being, and sustainability consumption trends.

The Company – which has always aimed at the quality of its products, with constant internal laboratory analyses – has been awarded a series of certifications to guarantee its "responsible production" (ISO 22005, IFS, BRC, Halal, supply chain certification, animal welfare certifications).

About the new needs of consumers in terms of saving environmental resources, the Company has launched important projects:

- Production of fresh milk in bottles with 30% recycled plastic, with a project of further increase expected to 100% R-pet;

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- Reduction in the weight of the yogurt jars, avoiding the use of 6 tons of plastic, and transition from polystyrene to polypropylene packaging, which entails a lower environmental impact during the production phase;
- Completely recyclable packaging for the A-Yo line;
- Zero waste project, a new trade policy aimed at minimizing food waste associated with commercial returns due to poor or limited shelf-life, enabled a 30% waste reduction (specifically, 50% milk, –51% cream, and –24% dairy).

Product innovations are also driven by consumer trends that the Company detects in the market. It is declared to be attentive and anticipative of consumer needs and to perform research and development activities that capitalize on product innovation. Looking to the past, just think about the kick-start for customers' changing habits in 1966, replacing the sale of loose milk with the sale in triangular cartons (technology push) due to the Company's powerful internal resources and capabilities to change the market, as well as the launch of a crude cow cheese when customers used to consume aged pecorino cheese, changing their tastes. In more recent times, it is possible to count:

- The offer of several lactose-free products to accommodate lactose-intolerance consumers;
- The use of microbial rennet in various productions to make them suitable for a vegetarian diet;
- The development of the A-Yo product, the first cow's and sheep's milk yogurt, which combines the flavor of traditional yogurt with the protein qualities of sheep's milk;
- The new pack for on-the-go consumption for the Kefir;
- A traceability system that allows the Company to improve the information flow efficiency between processes involved and to monitor and control all the parameters of the milk and related products (drinking milk or dairy products) to guarantee the final consumer.

The Company's aim of being responsible in its production manifests also in its willingness to contribute to goals 12.2-12-6 of Agenda 2030, besides goal 9.4, i.e., increasing efficiency in the use of resources by updating and modernizing its infrastructures and adopting more clean and environmentally friendly technologies. For example, through a circular economy project that transforms the livestock by-products into biogas (convertible into electricity and/or fuel and to power agricultural vehicles or vehicles of the Cooperative's milk collection fleet) and green composted fertilizer (usable as an alternative to chemical fertilizers of crops) reducing emissions, the energy costs of the Arborea plant and members' expenses for fertilizers.

This greater efficiency strategy, a core element of the inside-out approach (Carter *et al.*, 2011; Williamson, 1991), positively impacts the environmental and economic Company's sustainability dimensions.

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The Company's strategic communication to its consumers is clear: to make known the genuineness of the Company's products, strengthen trust in the brand, convey the connection with the territory, a symbol of purity and sun, to evoke intangible attributes such as values and history of the land of origin and the link with the territorial brand.

In light of Brila's view (2019) on "regional ethnocentrism", this communication strategy is paramount, considering the significant group of consumers who highly value the food products of its region. According to the Author, the concept of "regional ethnocentrism" highlights the significance consumers place on products from their region compared to those from other areas, approaches the definitions of local food, as consuming local products supports the sustainable development of regions, and may be considered a pattern of sustainable consumption. For the regional ethnocentric consumer, brand trust and quality signs play a crucial role; moreover, he places the "local attribute" as a priority even over the "organic" attribute. Therefore, emphasizing the product's local origin and quality in marketing communications appeals to many consumers (Bryła, 2019).

In its latest advertising campaign, "The gentle revolution of milk", 3A SD aims to evolve "the image of the brand and its packaging without however distorting its identity. It enhances its origin and raw material and maintains the key elements of recognizability and uniqueness on the shelf" (3A SD, 2024). The advertising aims to promote the brand, grow awareness, and develop another product series.

Effects of inclusion of social dimension in its sustainable marketing strategy on the main stakeholders.

The 3A SD has developed a strong brand identity to convey its values and supply chain vision. In addition to being a leader in its region of origin, the Operations Director of Arborea also declares high loyalty to the brand in the rest of the Italian territory: "Hearing that our milk 'tastes like milk' is the most important recognition that the work of our partners and employees has received and continues to receive from the consumer. The seal on this recognition is the finding that our products in the Peninsula have the highest repurchase rate. Therefore, this confirms the relationship of loyalty that we manage to build with our consumers" (CLAL News, 2024). The Company's distinctive capabilities have allowed it to focus on the areas of greatest value, leading it to reduce its references by 50%. "This has allowed us to concentrate resources and energy in the lines with the highest added value, i.e., those which most of all embody the value of the supply chain and which, with the goodness of the raw material, allow us to consolidate and expand a relationship of trust with consumers who are looking for good, quality products" (CLAL News, 2024).

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The Company notes that its long-standing relationship with its consumers, based on their trust in the quality of the products and the Company's values, relies on the great efforts made towards the social and environmental dimensions of sustainability, which are the basis of the quality of its products. Quality that consumer associations have attested: the laboratory research commissioned by the journal *Il Salvagente* at the Federico II University of Naples and Valencia decreed the full-cream Arborea milk as the best Italian milk without pesticides: "The product comes from healthy farms that have livestock's well-being at heart. Arborea milk is distinguished by the quite high quality and a unique taste, which makes it perfect even for the little ones" (Impact Report 2022); Altroconsumo (2024) has declared that 3A's white yogurt is the best, even if it is tied with Granarolo's Yogurt Cremoso Bianco Dolce, which, however, costs more.

Concerning the suppliers/members, they feel supported by the cooperative on various fronts: (*i*) social, with investments aimed at improving their entrepreneurial skills to support them in increasing productivity; (*ii*) environmental, given the investments in green innovations that create synergies between productive growth and saving of natural resources (as required by new European policies); (*iii*) economic, since the increase in the price paid for milk and the renewed industrial plan guarantee them a fair remuneration in the short term and positive outlook for the future, throwing away the thought of to give in to the lure of other national players.

The 3A SD's employees feel they can make a concrete contribution to the families that, for generations, have carried on the tradition of the dairy supply chain. The very low employee turnover evidences the sense of belonging to the business community and the sharing of values that structured training and professional growth paths foster. According to Lillis & Lane (2007), the attention to human resources and its constant enhancement has made them grow and become a key employee in the firm that put at the service of the company their skill and professionalism beyond a profound knowledge of the internal production dynamics.

The result is a very efficient organizational structure that allows constant growth without interruption, even during unpredictable external dynamics such as the COVID-19 pandemic (Impact Report 2022).

Impacts of inclusion of social dimension in its sustainable marketing strategy on Company objectives achievement

The case investigated shows how a Company operating in a rural context has strengthened and consolidated a first-rate role in its territory by integrating environmental and, inter alia, social dimensions into its values,

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daily operations and medium-long term strategies. Including the social dimension in innovation, collaboration, communication, and commitment strategies has been the key to Company success. This inclusion is the basis of the Company philosophy, which has always allowed it to mediate the trade-off between short and long-term objectives.

Moreover, 3A SD shows the link between corporate identity, corporate image, and the organization's reputation. According to Zinkhan, Ganesh, Jaju, & Hayes (2001) and Westcott Alessandri (2001), the corporate identity, i.e., the way (ideal image) in which the organization decides to identify itself with all its audiences (that, when communicated, becomes a corporate brand), affects corporate image (the general impression of its audience), which, in turn, builds the organization's reputation over time, in a given context. The constant adherence to the Company's culture, values, and mission (crucial elements of the corporate brand - Maurya *et al.*, 2015) that have guided the Cooperative since its foundation can be interpreted as respect for the social pact between the Company and its stakeholders and being a "good citizen".

In particular, the Company's commitment was manifested along both categories of relevant social dimension indicators in the agri-food sector. It is precisely this match that has generated positive effects, mainly seen in the advantages derived from high social equity and brand loyalty which arising from trust in the quality of the Company's products. The value of social equity was fueled by the commitment and relationships established with the business community and society in general, particularly with local institutions and suppliers. The Company declares that its commitment to its suppliers is the basis of its success and that its social role in the territory is recognized as a value by the community and consumers. Furthermore, the attention towards employees allows for the creation of an efficient structure that permits it to compete successfully in the national market despite the objective limitations deriving from operating in an island context. The high brand equity results from constant attention to the authenticity and quality of the products and the recognition (at a regional level) of the contribution to territorial development deriving from the purchase of the Company's products.

All this happens in an unforeseeable market upstream and subject to promotional pressures downstream. The milk market is sometimes governed by speculative pressures, sometimes dominated by the shocks of an evolving production system, which, on the one hand, sees producers' solid conviction in pursuing the production efforts and, on the other, is stimulated by the propensity to invest in terms of prospective improvement. In addition, the decline in consumption has not supported the recognition of the great value of the raw material, milk, and, therefore, the entire supply chain, which guarantees quality to the final consumer (CLAL News, 2024).

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The economic results are clear: third national player in the milk market, immediately after Granarolo. The operations director indicates continued growth in results for 2023: a turnover of almost 233 million euros, 191.8 million liters of milk processed, payout to members €0.625/lt, an export share equal to 5% of the turnover, and the aim of establishing new positions in Asia, Europe and North America (CLAL News, 2024).

The impact of the Company's implemented strategies becomes even more apparent when we compare the above data with national and European averages. According to ISMEA, the average price of raw milk at the farm gate in Italy in 2023 is €0.529/lt (2024b). In comparison, the average prices are €0.461 per liter in France and €0.523 per liter in Germany (ISMEA, 2024a). Additionally, the milk market observatory of the European Commission (2024) reports an average EU price of €0.469/lt for 2023.

4. Conclusions

In a moment of strong questions about the prospects and trajectories of the agri-food industry, this research shows how sustainable value creation in the long run for all stakeholders to contribute to a sustainable society and the organization's integrity values can be the keys to the company's success in its markets since it traces the course between short and long terms challenges, and protection of the status quo and growth driven by demand and technology push.

The inclusion of the social dimension in sustainable marketing strategies has allowed the 3A SD over time to accumulate distinctive competencies that have allowed it to compete and grow in a fickle and unpredictable market and be ready to respond to new consumer needs and trends, also concerning their expect of sustainable marketing strategies from companies.

The 3A SD understood that not only did it have to act to satisfy its mutual purpose of the cooperative best, but also provide value to all its stakeholders through strategies aimed at creating a recognized value that translated into benefits for consumers (quality products) for members (fair payment for milk and funds for investments in innovation) for the territory that supports the entire supply chain.

This single case study demonstrates how the sustainable marketing strategy carried out by a company focuses on generating value for all stakeholders and the territory in general, and embodied in the corporate identity and become a corporate brand has found confirmation in the corporate image, which ultimately manifests itself in the corporate reputation, proven by the evident growth in turnover and repurchase rate of products outside the Sardinian region. Respect for the company's "social pact" with the territory is the basis

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of its ability to expand, from which, in turn, further benefits derive for the different stakeholders.

This study offers several contributions to policy, academics, and practitioners.

From the theoretical perspective, this paper confirms previous studies (e.g., Jung *et al.*, 2020; Rastogi *et al.*, 2024; Vafaei *et al.*, 2019) that found connection between sustainable marketing strategies and customer satisfaction and loyalty and see sustainability marketing as a strategic tool that allows companies to achieve sustainability in their production and commercial processes, well as exerts crucial influence on their reputation (Puma-Flores & Rosa-Díaz, 2024).

This research also provides some practical implications. First, it suggests that the success of the Company derives from the fact that sustainable marketing paid off only because it is part of the strategy that guides all the Company's actions (and not just for sales or product development, for example) and of its mission (Park *et al.*, 2022). This study also leads to the belief that sustainable marketing strategies allow high employee retention, the satisfaction of cooperative members, and compliance with external rules and new customer requirements. Moreover, it is evident that all four strategies were essential in achieving company goals: collaboration with third parties (i.e., trade associations, research bodies, etc.) to exploit external opportunities, communication towards all its audiences to disclosure and consolidate its values and image, generating a high social capital, and finally, the 360-degree innovations that have allowed it to increase efficiency and compete successfully in increasingly larger markets. In other words, this study highlights how sustainable marketing adoption can be crucial not only to meet societal expectations but also to achieve long-term success (Rastogi *et al.*, 2024).

The effects of including the social dimension in the sustainable marketing strategies of an agri-food company detected in this single case study do not claim to be generalized because of the subjectivity and context-dependence of the social dimension (Toussaint *et al.*, 2022). Moreover, limits arise from using a single case study that restricts the transferability of findings to every kind of business case. However, this is not a proper limitation; it is the expected consequence of the first understanding of a complex phenomenon from multiple perspectives and a structured starting point for further investigations.

Conflict of interest

The authors declare that there are no conflicts of interest in this study.

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