



Social life cycle assessment of the olive oil industry: a case study in Guilan Province, Iran

Behzad Safeie-Noghlbari¹ · Zahra Amiri¹ · Mohammad Sadegh Allahyari^{2,3} · Amin Nikkhah⁴ · Tarek Ben Hassen⁵ · Jacopo Bacenetti⁶

Received: 17 January 2023 / Accepted: 31 December 2023 / Published online: 25 March 2024
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Abstract

Olive oil production has severe environmental consequences, including resource depletion, land degradation, carbon emissions, and waste generation. As a result, for over two decades, environmental life cycle assessment (ELCA) has been applied to the olive oil industry to identify environmental issues and reduce the environmental effects. However, little is known regarding the social sustainability of this industry. Social life cycle assessment (S-LCA) has been established as one of the most effective methodologies for assessing the social implications of products throughout their life cycles. Accordingly, based on the S-LCA approach, this study aims to assess the social impacts of the olive oil extraction industry in Roudbar County in Guilan Province in Iran, the major producer of olives and olive oil. The S-LCA model adopted in this paper is built in four major phases (UNEP/SETAC in Guidelines for social life cycle assessment of products, 2009): (1) Definition of Goal and Scope: outlines the intended use and the goal pursued and specifies the scope of the research. The research will then be defined to fulfill that purpose within any constraints. (2) Life Cycle Inventory analysis: is the phase at which data are collected, systems are modeled, and LCI results are generated. (3) Life Cycle Impact Assessment: a collection of steps to obtain data categorization, aggregation, and characterization based on performance reference points. (4) Life Cycle Interpretation: considers all important aspects of the research when drawing results, offering recommendations, and reporting. The findings suggested that the social conditions governing the olive oil extraction cycle in the study area are almost adequate. However, other categories of social impacts, such as cultural heritage, community development, and working conditions, were rated unsatisfactory by olive orchard workers and need improvement. Adopting the cause-and-effect chain in this study favors identifying specific indicators based on social issues in the study location. On the other hand, a scale-based assessment may result in the subjectivity of the results, which adds to the uncertainty. An impact-based assessment may be applied to analyze social impacts such as occupational health and safety, employment, pay, and benefits to get more credible social impact data. Consequently, integrating the scale-based approach with an efficient path-based method may improve its effectiveness.

Keywords Olive oil · Social life cycle assessment · Social sustainability · Sustainable development

Extended author information available on the last page of the article

1 Introduction

Olive oil production has long been associated with the Mediterranean cultural heritage, playing a significant role in the economic, environmental, and social structures of several countries. This industry is also a vital economic driver, with thousands of jobs, from farmers and harvesters to mill workers and distributors (Niklis et al., 2014). Olive oil also has significant cultural and historical value. It represents identity and heritage and has been a staple of Mediterranean cuisine for millennia (Perito et al., 2019). However, this industry has been linked with several environmental concerns, such as resource depletion, land degradation, carbon emissions, and waste generation (Souilem et al., 2017). Indeed, the olive oil supply chain encompasses several phases, including agricultural activities such as planting and harvesting, oil extraction from olives, packaging processes, and waste. Each step might have a significant environmental impact (Proietti et al., 2017; Rapa & Ciano, 2022). For example, waste management is a major issue in olive oil production. The olive pulp and stones account for 80% of the olive bulk. As a result, the extraction process generates four times as much waste as oil, with major byproducts such as olive pomace (Espadas-Aldana et al., 2019). If not effectively handled, these byproducts cause pollution, impacting soil quality and water sources (Dutournié et al., 2019).

Life cycle-based methodologies, such as life cycle assessment (LCA) and life cycle costing (LCC), support sustainable production and consumption patterns. These methodologies are gaining popularity as a tool for transitioning to more sustainable production and consumption systems (Tragnone et al., 2022). In the last twenty years, the application of environmental life cycle assessment (ELCA) has provided insights into these matters, resulting in the implementation of strategies aimed at alleviating the adverse ecological impacts linked to the production of olive oil. This methodology has played a significant role in enhancing comprehension of the implications throughout the different phases of the product's life cycle. It has provided valuable insights for establishing strategies to mitigate these impacts (Salomone et al., 2015).

Nevertheless, a significant knowledge gap exists, particularly regarding social sustainability. While the ELCA emphasizes the environmental dimensions (Parascanu et al., 2018; Khounani et al., 2021a; Nikkhah et al., 2021), the social aspects have not been extensively explored. This assessment is especially pertinent in the context of the olive oil sector. From farming to consumer use, the production of olive oil connects with various social issues, including labor rights, community development, health and safety concerns, cultural preservation, and economic stability. For instance, in many countries, small-scale farmers face elevated transaction expenses, challenges in adhering to advanced food safety and quality norms, limitations in accessing funds, and a dearth of knowledge regarding production techniques and market trends (Lybbert & Elabed, 2013). Including these overlooked areas is crucial to obtaining a comprehensive understanding of the total impact of the olive oil industry, considering its significant role in regional economies.

Accordingly, since 2009, social life cycle assessment (S-LCA) has evolved as a reliable framework for investigating the social effects of products throughout their life cycles (Tragnone et al., 2022). The S-LCA is a systematic process that collects the most appropriate data by the best possible method. It reports social impacts (positive and negative) related to the production life cycle from extraction to the final disposal. Scope (i.e., life cycle) and methodology (i.e., a systematic process of collecting and reporting social impacts and benefits) are the vital appealing aspects of this technique (Benoît et al., 2010). The primary objective of piloting S-LCA is to enhance social conditions for every stakeholder and boost

the overall socio-economic performance of a product across its entire life cycle (UNEP/SETAC, 2009). Further, S-LCA supplements ELCA by including social aspects in the analysis, resulting in a broader understanding of the product's entire implications (Macombe et al., 2018).

In the agro-food industry, SLCA is an emergent field that aims to quantify the social impacts along the entire value chain, from production to consumption. SLCA incorporates social dimensions such as labor conditions, community impacts, and human rights concerns. The significance of integrating future-oriented methodologies in SLCA within the agro-food industry is increasingly recognized, as shown by studies that use qualitative scenarios to assess long-term sustainability (Voglhuber-Slavinsky et al., 2022). However, it is essential to note that the methodology for SLCA in this particular sector is continuously developing and encountering challenges, including the availability and standardization of data, issues gradually being addressed by ongoing research. Social dimension in agriculture is still less considered (Tragnone et al., 2022).

This paper aims to assess the social impacts of the olive oil extraction industry in Roudbar County in Guilan Province in Iran using the S-LCA methodology and to determine the current and expected social status. With its Mediterranean climate, Guilan Province, situated in Northern Iran, is one of the leading producers of olives and olive oil (Firouzi et al., 2018; Nejadrezaei et al., 2018; Nikkhah et al., 2016). It also has the largest olive oil processing plants in Iran (Mohammadi et al., 2019), making it an interesting case. Since the inception of the Expansion of Olive Cultivation Plan in 1993, Iran's olive oil production has quickly grown. It increased by 365% between 2004 and 2020, from 2500 to 11,600 t. Meanwhile, olive oil mills have grown from 49 in 2011 to 74 in 2016. The Iranian government aims to see a sixfold increase in olive planted areas, from roughly 103,000 ha in 2014 to 600,000 ha by 2025, up from 4800 ha in 1993 (Razzaghi et al., 2018). Nonetheless, Iran remains a minor producer compared to several important Mediterranean producers, such as Spain, Italy, and Tunisia (Tehran Times, 2020). Guilan Province nonetheless struggles with increased vulnerability to natural catastrophes and the impending dangers of climate change. Precipitation and temperature fluctuation may severely hinder future agricultural development (Allahyari et al., 2016). However, data about the sustainability dimensions of olive oil production in Guilan are scarce, and little is known about the social sustainability of this sector.

2 Literature review: sustainability and socio-economic aspects of olive oil production

Historically, yield and quality were the primary concerns in olive oil production. However, as the global importance of olive oil production and environmental awareness grew, several studies concentrating on the environmental impacts of olive oil production emerged. One of the first investigations that examined the environmental impact of olive oil using LCT was conducted by Avraamides and Fatta (2008) in Cyprus. Since then, LCA has gained significant recognition as a preferred approach for assessing the environmental impacts associated with the production of olive oil (Salomone et al., 2015). Most of these studies focused on the environmental aspects, such as resources consumption and emissions (Avraamides & Fatta, 2008), wastewater treatment (Chatzisympson et al., 2013), the valorization of olive waste (Parascanu et al., 2018; Khounani et al., 2021a; Nikkhah et al., 2021), and life cycle assessment of olive oil bottles (Accorsi

et al., 2015). For example, Vicario-Modroo et al. (2023) investigated the sustainability of a representative selection of olive mills in Andalusia, known as the world's leading location for olive oil production. The study's results underscore the importance of business size, commitment to quality, and management training and professionalization in assuring the sustainable advancement of olive oil mills.

However, according to the review of Espadas-Aldana et al. (2019), the phase with the highest environmental focus from the scientific community was the agriculture phase (with pesticide use and waste/byproduct production being the 'hottest' topics). The primary factors contributing to the prevalence of the agricultural stage are fertilization, irrigation, and phytosanitary treatment. This result aligns with the findings of two other reviews (Baniyas et al., 2017; Salomone et al., 2015). For example, Tsarouhas et al. (2015) employed LCA to quantify the environmental performance of Greek olive oil production. They determined that the cultivation of olive trees and the manufacture of olive oil are the subsystems responsible for the bulk of the environmental effects and that any attempt to reduce the entire life cycle impact of olive oil production should include them. Also, Guarino et al. (2019) performed an LCA of olive oil production in the southern Italian region of Calabria. According to the results, the first stage of the life cycle, which includes everything from olive plant development to the conclusion of the production stage, is the most significant component for all analyzed indicators.

Therefore, the social aspects of sustainability were neglected. As a general observation, when evaluating agricultural sustainability, the primary emphasis tends to be on food production and environmental implications, often overshadowing the socio-economic components. This limited perspective might impede a comprehensive understanding of sustainability, particularly in complex and multidimensional businesses like olive oil production. Many global assessments have generally overlooked or undervalued the relevance of socio-economic factors in their analysis (Wei et al., 2022). Consequently, De Luca et al. (2018) suggest that considering environmental, economic, and social constraints is vital for an integrative and holistic analysis of olive oil production.

Social sustainability is seen mainly as a tool for long-term development. As shown by the United Nations Sustainable Development Goals (SDGs) announced in 2015, social sustainability is a critical component of sustainability. It is clear that a considerable number, if not the majority, of the 17 goals are devoted to addressing different societal issues (Lindkvist & Ekener, 2023). Ideal employment, human rights, society, and commitment were the leading indicators for measuring social sustainability. These indicators are linked, and each has various sub-indicators, such as security, altruism, and health (Mota et al., 2015). That goal must be identified, maintained, and measured when converting social sustainability from a broad concept to a single aim. As a result, creating social sustainability indices is crucial.

In S-LCIA, two primary methods have emerged: the reference scale (RS) approach and the impact pathway (IP) approach. The RS method focuses on the behavior (i.e., performance) of producers and other actors across life cycles. At the same time, the IP approach aims to address the final social consequences on people from activities throughout life cycles (Ramos Huarachi et al., 2020). However, as Busset et al. (2014) highlighted, integrating social LCA with environmental LCA and LCC appears feasible but problematic owing to the rarity and scarcity of social data. The primary outcomes were the challenging selection of social indicators and a lack of social data (confidentiality issues and a lack of a more comprehensive social database). The research also showed that creating a single inventory using economic and environmental data was simple but not social.

Olive oil production is an important economic activity in numerous countries, notably in the Mediterranean region. As explained above, while environmental and economic life cycle studies of this sector have received much attention in recent decades, its societal implications have remained largely unexplored. The delicate interplay of labor practices, community engagement, cultural preservation, and social responsibility along the supply chain creates many obstacles and possibilities. Additionally, research on the environmental effects of olive oil production exhibits geographical bias. For example, Espadas-Aldana et al. (2019) highlighted that most LCA studies on olive oil production or olives cultivation have been undertaken in European countries, such as Italy, Spain, and Greece. While these regions unquestionably account for a significant portion of the global olive oil industry, focusing on them in academic research might obscure findings from other important regions. Outside of Europe, areas like North Africa and the Middle East have a long history and significant interest in olive oil production. They seem to be underrepresented in sustainability research. Such geographical biases limit understanding of unique challenges, practices, and opportunities in these regions. Inadvertently, this geographic concentration might lead to a restriction of contextual dynamics. The distinct socio-economic, environmental, and cultural features of olive oil production in understudied locations received little attention. This impacts the depth of knowledge and the development of tailored solutions and strategies for various circumstances.

In Iran, few studies investigated the environmental aspects of olive oil production. Some research concentrated on finding solutions to waste issues. For example, Salikandi et al. (2021) conducted a techno-economic study of bioethanol synthesis from olive waste cake in Iran. The research discovered that olive waste cake, mostly made up of organic elements, provides an adequate substrate for bioethanol production. Moreover, Seydanlou et al. (2022) proposed the implementation of closed-loop supply chains as a feasible and environmentally friendly strategy for the olive sector in Iran. The approach addressed numerous features of the supply chain networks, including economic, environmental, and social aspects.

Further, Khounani et al. (2021) compared two olive agro-biorefinery models to the conventional olive oil production method, which included olive farming as well as oil extraction. According to their findings, transitioning from a linear, economy-focused olive agri-food model to a bioeconomy-centric olive agro-biorefinery allows them to create a greater variety of value-added bioproducts while reducing environmental effects per ton of olive oil produced. However, only two studies applied LCA in this sector. Rajaeifar et al. (2014) used LCA to examine the energy and economic flows, as well as the greenhouse gas (GHG) emissions associated with olive oil production in Iran. The investigation was conducted through an LCA, considering four primary stages: agricultural olive production, olive transportation, olive oil extraction, and oil transportation to customer centers. They discovered that the agricultural stage contributed the most to GHG emissions throughout the cycle, accounting for 93.81%, with chemical fertilizers accounting for more than 55%. Furthermore, Rajaeifar et al. (2016) also performed detailed energy and economic analyses of olive pomace oil biodiesel production over its complete life cycle. They concentrated on end-point effect categories such as human health, ecological quality, climate change, and resource usage. Their results suggested that significant improvements and changes, notably in the agricultural and combustion stages, are required for biodiesel to be utterly eco-friendly across all of these damage categories.

Hence, the domain of life cycle assessment (LCA) within the olive oil industry in Iran is mostly unexplored. Notwithstanding the increasing importance of this sector, there exists a noticeable lack of research that explicitly addresses its environmental and economic

impacts. Significantly, social sustainability, which pertains to the industry's impact on local communities, employees, and broader societal structures, has received less attention in academic literature. Against this contextual background, the current study acquires increased significance. The objective of this endeavor is to address the existing gap in knowledge. Furthermore, as Iran's leading producer of olives and olive oil, the Guilan region provides an interesting example for delving into the social factors that regulate the extraction cycle. It also provides a chance to solve shortcomings in cultural heritage, community development, and working conditions. This study's findings have the potential to extend beyond its specific regional setting, adding to a more extensive discussion of social sustainability in agro-industrial sectors. Furthermore, the novel combination of the scale-based methodology and an efficient path-based technique suggested in this study has the potential to improve the efficacy of social impact assessments. The outcomes will also facilitate the formulation of approaches and policies to support the sustainable development of olive oil production.

3 Methods

The S-LCA model adopted in this paper is built in four major phases (UNEP/SETAC, 2009): (1) Definition of Goal and Scope: outlines the intended use and the goal pursued and specifies the scope of the research. The research will then be defined to fulfill that purpose within any constraints. (2) Life Cycle Inventory analysis: is the phase at which data are collected, systems are modeled, and LCI results are generated. (3) Life Cycle Impact Assessment: a collection of steps to obtain data categorization, aggregation, and characterization based on performance reference points. (4) Life Cycle Interpretation: considers all important aspects of the research when drawing results, offering recommendations, and reporting.

3.1 Definition of goal and scope

3.1.1 Goal of the study

This study aims to identify the social impact of the olive oil production industry in Roudbar County in Guilan Province in Iran. It also seeks to present recommendations and improvement measures to support the sustainable development of this industry.

3.1.2 Functional unit

The functional units are defined as the complete olive oil production stages from olive orchards to olive oil delivery from the factory, respectively, in the model.

3.1.3 System boundary

The study's system boundaries comprise the olive oil production industry, from olive orchards through olive oil distribution from a factory in Roudbar County, the leading producer of olive oil in the Iranian province of Guilan. The scope of the assessment includes related stakeholders at each step of production.

3.1.4 Choice of stakeholder categories and subcategories

Firstly, we conducted a literature review and reviewed scientific and grey literature (written materials and government reports) on olive oil production in Guilan and Iran. This procedure helped us evaluate the industry's socio-economic features, challenges, and its most important stakeholders. Secondly, based on this review, we formed an expert panel of 20 professionals (experts, academics, olive oil company decision-makers, etc.) to validate and weigh criteria and indicators. All social impact categories and subcategories were weighted from 1 (least important) to 7 (most important).

Thirdly, we created social evaluation criteria based on those provided by the United Nations Environment Programme (UNEP) (UNEP/SETAC, 2009). These criteria are: (1) human rights; (2) working conditions; (3) cultural heritage; (4) community development; and (5) socio-economic implications. Several indicators were also designed to evaluate these criteria based on the methodological sheets for subcategories in S-LCA (Table 1).

Further, we determine each indicator's weight using the total number of indicators in each impact category as the base number. For instance, the impact category 'human rights' has three indicators: A1: Free from the employment of child labor; A2: Free from the employment of forced labor; and A3: Equal opportunities, free from discrimination (Table 2). The maximum value of the adjusted weight in this technique is equal to the total of all indicators in each impact category, even though Manik et al. (2013) allow a maximum weight of one.

Furthermore, following data collection, indicator (question) responses were calculated using the percentage of respondents who supplied "ideal" and standard answers (Fig. 1). Also, the impact subcategories were weighted, as shown in Table 2. Then, the weights were adjusted (Fig. 1).

Appendix 1 presents the impact categories, subcategories, and social indicators (the questions in the questionnaire), the stakeholders who answered the questions, the type of answers provided, and the ideal answer. In addition, the questionnaire included 4 questions about the socio-demographic characteristics of the respondents, such as education level, gender, and work experience.

3.2 Life cycle inventory analysis

Stratified sampling was utilized to select 263 individuals divided into the 5 stakeholder groups. Accordingly, the research included 8 factory managers, 85 factory employees, 70 olive orchard owners, 70 olive orchard workers, and 30 local community members. We avoided selecting individuals who might overlap and be allocated to multiple stakeholder groups. As a result, we compiled a list of the names of each stakeholder group and ensured that the same name did not appear twice in our list, ensuring that the same individual was not interviewed twice. A specific questionnaire was developed for each stakeholder group. Consequently, five questionnaires were used to collect feedback. Professional opinions of experts were employed to test their validity and dependability.

3.3 Life cycle impact assessment

Table 3 is used to rate the percentages achieved for each indicator. The actual performance result (PR_{act}) for each impact subcategory was calculated as the sum of the actual results for each impact subcategory's indicators ($\sum ACT_{CR}$) to the total of the maximum possible actual results for each impact subcategory ($\sum ACT_{max}$). The outcomes of the

Table 1 The assessment system from the impact category to the measurement unit

Stakeholders	Criteria	Impact subcategories	Inventory indicators	Inventory data
Factory managers	Human rights (A)	A1: Free from the employment of child labor	Questionnaires for each group	Stakeholder answers to the questionnaire questions
		A2: Free from the employment of forced labor		
		A3: Equal opportunities, free from discrimination		
Factory workers	Working condition (B)	B1: Freedom of association and collective bargaining		
		B2: Fair salary		
		B3: Decent working hours		
		B4: Occupational health and safety		
		B5: Social benefits		
Olive growers	Cultural heritage and community development (C)	C1: Migration		
		C2: Respect for local cultural and subcultural heritage		
		C3: Respect for the customary right of indigenous people		
		C4: Participation and employment of communities		
		C5: Safe and healthy living conditions		
		C6: Transparency on social/environmental issues		
Olive workers Local community	Socio-economic repercussions (D)	D1: Contribution to local employment		
		D2: Contribution to economic development		
		D3: Transfer of technology		
		D4: Public commitments to sustainability		

Table 2 Weight assignment and adjustment of the weights of impact subcategories

Impact subcategories	Weight	Sum of the weights impact subcategories of each impact category	Adjusted weight	Sum of the Adjusted weights impact subcategories of each impact category
A1	0.32	1	0.96	3
A2	0.33		0.99	
A3	0.35		1.05	
B1	0.19	1	0.95	5
B2	0.21		1.05	
B3	0.19		0.95	
B4	0.21	1	1.05	6
B5	0.2		1	
C1	0.16		0.96	
C2	0.14	1	0.84	4
C3	0.16		0.96	
C4	0.19		1.14	
C5	0.17	1	1.02	4
C6	0.18		1.08	
D1	0.25		1	
D2	0.27	1	1.08	4
D3	0.25		1	
D4	0.23		0.92	

indicator characterization and weighting processes were compounded to get adjusted performance results (PR_{adj}). Table 4 is used to assess the PR_{adj} of the impact subcategories. The mean PS_{adj} of the impact subcategories of each social impact category was then deemed the impact performance score (IPS), as shown in Fig. 1.

The following equation calculated the characterized results of the indicators (CR):

$$CR = \frac{\text{Number of yes or no responses to each question}}{\text{Total number of responses to each question}} \times 100 \quad (1)$$

The CRs are scored in Table 4 to yield the actual score for each indicator (ACT_{CR}). The following equation calculates the actual performance results of the impact subcategories (PR_{act}):

$$PR_{act} = \frac{\sum ACT_{CR}}{\sum ACT_{max}} \quad (2)$$

$\sum ACT_{CR}$: total actual scores of the indicators in each impact subcategory; $\sum ACT_{max}$: total actual scores of the indicators under ideal performance in each impact subcategory; ACT_{max} assumes that the indicator is in ideal performance conditions and obtains its highest level, i.e., score 5.

Finally, a questionnaire was developed to validate and weigh social impact categories and subcategories. The experts were asked to assign a score of 1–7 to criteria (social impact categories) and indicators (social impact subcategories) based on their importance. Score 7 represented the highest level of importance, and score 1 represented the lowest significance level. Finally, the subcategories were weighted by the operation presented in Table 2. The

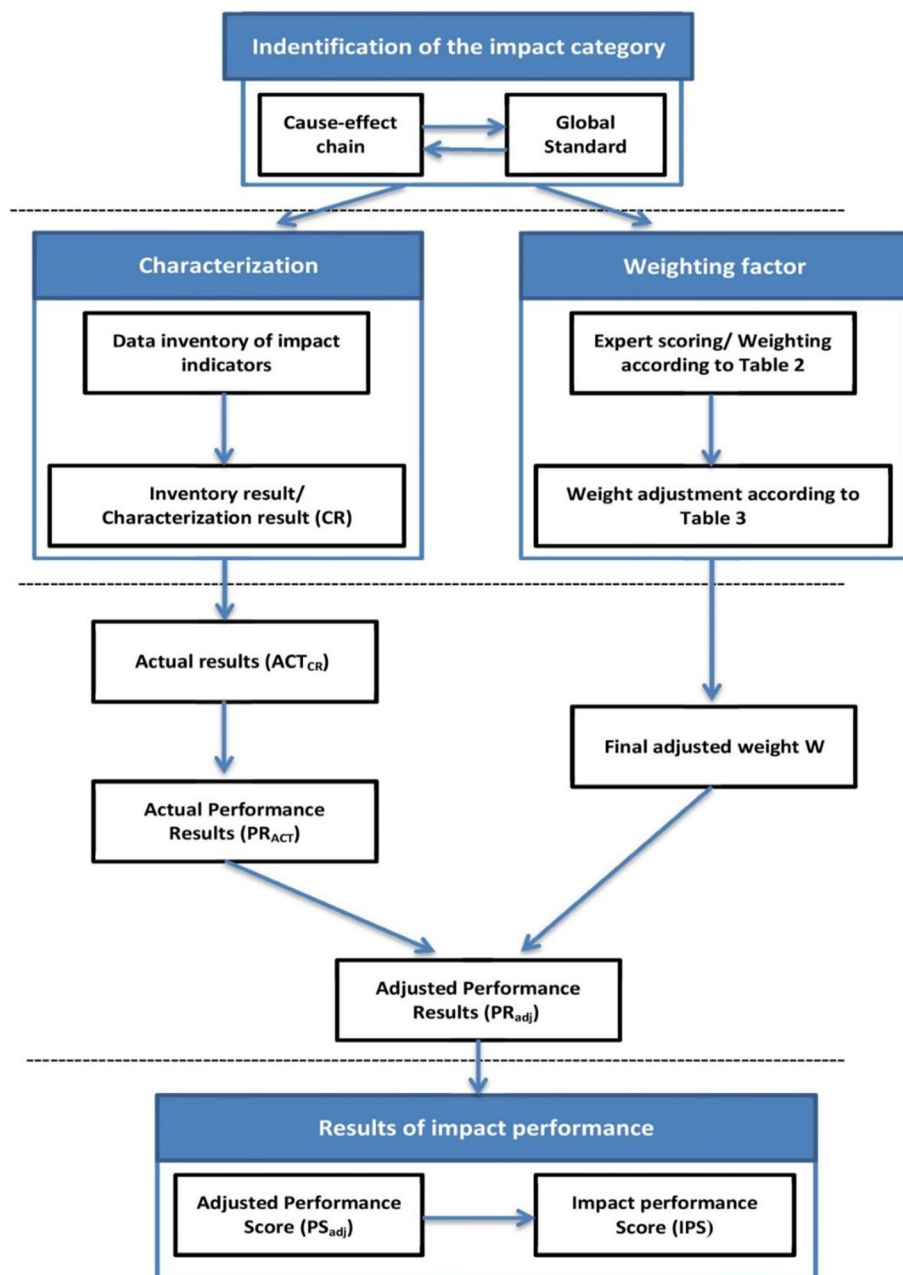


Fig. 1 Framework developed for social impact assessment (capitalize performance)

sum of the weights obtained in each impact category equaled 1. The sum of the weights of each subcategory in each impact category equaled 1. To measure the performance of each impact subcategory, they should be weighted depending on the total number of impact subcategories within each impact category. For example, there are three subcategories in

Table 3 Scoring and categorizing the results of characterization for each indicator

Characterized result (CR)	Score of ACT CR
$80\% < CR \leq 100\%$	5
$60\% < CR \leq 80\%$	4
$40\% < CR \leq 60\%$	3
$20\% < CR \leq 40\%$	2
$0\% \leq CR \leq 20\%$	1

Table 4 Determining adjusted performance score and performance rank of the social impact subcategories

Adjusted performance result (PR_{adj})	Adjusted performance Score (PS_{adj})		Rating definition
$80\% < CR \leq 100\%$	5		Best
$60\% < CR \leq 80\%$	4		Good
$40\% < CR \leq 60\%$	3		Moderate
$20\% < CR \leq 40\%$	2		Limited
$0\% \leq CR \leq 20\%$	1		Unacceptable

“human rights” (A) (see Table 1). The adjusted performance result (PR_{adj}) is calculated by Eq. (3) as PR_{act} of each indicator multiplied by its adjusted weight (W).

$$PR_{adj} = PR_{act} \times W \quad (3)$$

PR_{adj} is scored by the ranking system of Table 4, whose result is the adjusted performance score (PS_{adj}) of the impact subcategory. After PS_{adj} is calculated for each social impact subcategory, the performance score is estimated for each social impact category by calculating mean PS_{adj} . If PS_{adj} is < 0.5 , it is rounded down, but if it is > 0.5 , it is rounded up.

3.4 Life cycle interpretation

The interpretation stage examines the findings to generate conclusions about the positive and negative societal repercussions of the olive oil industry in Roudbar County, Guilan Province, Iran. Weights represent the importance of each inventory indication in terms of socio-economic evaluation.

4 Results

According to Table 5, most responders (71.7%) were males, while just 28.3% were women. Regarding education, 65% have a secondary diploma or below, while 35% have attended college. However, there are some distinctions among the stakeholders. For instance, the educational level of the expert group members was greater than that of the other groups.

After completing the questionnaires, the data were classified and entered into the MS-Excel and SPSS software programs. First, the questionnaires related to the experts'

Table 5 Socio-demographic characteristics of the participants ($n = 773$)

Stakeholder groups	Total	Gender		Education		Age	Work experience
		male	female	Secondary/lower	College education		
Factory managers	8	5	3	1	7	30–50	2–20
Factory workers	85	56	29	65	20	20–53	1–24
Olive growers	70	62	8	53	17	28–78	2–53
Olive workers	70	38	32	64	6	22–61	1–30
Local community	30	24	6	1	29	35–57	5–44
Experts	20	18	2	–	20	35–58	5–44
Total	283	203 (71.7%)	80 28.3%	184 (65%)	99 (35%)	–	–

weighting of social indicators were examined. The proportion of people who answered the questions properly (indicators) was then determined using Eq. (1) (Appendix 2). The CRs are then evaluated using Table 5, and each indication's actual score (ACT_{CR}) was approximated. Equation (2) was used to determine each indicator's actual performance result (PR_{act}) in the next phase. Each indicator's adjusted performance result (PR_{adj}) was then calculated using Eq. (3) (Table 6). The indicator's adjusted performance score (PS_{adj}) is then calculated using Table 5.

After PS_{adj} was calculated for each indicator (social impact subcategory), each indicator's performance score (IPS) was determined by calculating the mean PS_{adj} . If the value calculated was < 0.5 , it was rounded down; otherwise, it was rounded up (Table 8).

First, the data revealed a high CR among most stakeholders regarding the subcategory 'no child labor'. Consequently, they believe it is appropriate, and few individuals under 18 are engaged in olive oil production. Indeed, the ACT_{CR} for this effect subcategory varied from 4 (good) to 5 (Best), whereas the PR_{act} was assessed to be 0.9, 1, 1, and 0.8, respectively (Table 7).

Second, the subcategory 'no forced labor' had a high CR among factory managers, factory workers, olive orchard owners, and orchard workers. This suggests that it has acceptable standards in their perspective, such that compulsory labor is low in olive oil production. The ACT_{CR} of 'no forced labor' varied from 2 to 5 (from limited to best, according to the rating definition provided in Table 4) for all stakeholder groups. PR_{act} values were 0.87, 0.98, 1, and 0.93 for different stakeholder groups, respectively (Table 6).

Thirdly, the subcategory 'no compulsory labor' had a high CR, indicating some issues regarding some of its indicators. Indeed, the 'overtime of < 2 h/day' indicator had a CR of 25.9% among the factory workers. Also, for the indicator 'working hours of < 8 h, CR was 24.7% among the factory workers whose actual score was 2 (Limited). These low scores reflect the poor conditions of these indicators in the subcategory of 'no compulsory work', which needs examination and more precise planning by olive oil factory managers for improvement. However, since the total score of all indicators in an impact subcategory is utilized to generate the final social impact subcategory score, the overall state of an impact subcategory may be optimal. However, it is necessary to check the individual indicators.

Fourth, the subcategory 'equal opportunity and no discrimination' received a high CR among factory managers, factory workers, olive orchard owners, and orchard workers,

Table 6 Actual performance (PR_{act}) and adjusted performance (PR_{adj}) at the social impact subcategory

	Factory managers			Factory workers			Orchard owners			Orchard workers			Local community		
	PR_{act}	W	PR_{adj}	PR_{act}	W	PR_{adj}	PR_{act}	W	PR_{adj}	PR_{act}	W	PR_{adj}	PR_{act}	W	PR_{adj}
A: Human rights															
A1: Free from the employment of child labor	0.9	0.96	0.86	1	0.96	0.96	1	0.96	0.96	0.8	0.96	0.77			
A2: Free from the employment of forced labor	0.87	0.99	0.86	0.98	0.99	0.97	1	0.99	0.99	0.93	0.99	0.92			
A3: Equal opportunities, free from discrimination	0.77	1.05	0.81	1	1.05	1.05	0.6	1.05	0.63	0.93	1.05	0.98			
B: Working condition															
B1: Freedom of association and collective bargaining	0.8	0.95	0.76	0.47	0.95	0.45				0.6	0.95	0.57			
B2: Fair salary	0.87	1.05	0.91	0.96	1.05	1	0.64	1.05	0.67	0.7	1.05	0.74			
B3: Decent working hours	0.68	0.95	0.66	0.91	0.95	0.9	0.6	0.95	0.57	0.8	0.95	0.76			
B4: Occupational health and safety	0.8	1.05	0.84	0.9	1.05	0.95	0.58	1.05	0.61	0.69	1.05	0.73			
B5: Social benefits	0.71	1	0.71	0.63	1	0.63	0.6	1	0.6	0.4	1	0.4			
C: Cultural heritage and community development															
C1: Migration	1	0.96	0.96										1	0.96	0.96
C2: Respect for local cultural and subcultural heritage	0.9	0.84	0.76										0.8	0.84	0.67
C3: Respect for the customary right of indigenous people	0.93	0.96	0.89										0.73	0.96	0.7
C4: Participation and employment of communities	1	1.14	1.14										0.6	1.14	0.68
C5: Safe and healthy living conditions	1	1.02	1.02	1	1.02	1.02	0.72	1.02	0.73	0.53	1.02	0.54	1	1.02	1.02
C6: Transparency on social/environmental issues	1	1.08	1.08										0.6	1.08	0.65

Table 6 (continued)

	Factory managers			Factory workers			Orchard owners			Orchard workers			Local community		
	PR _{act}	W	PR _{adj}	PR _{act}	W	PR _{adj}	PR _{act}	W	PR _{adj}	PR _{act}	W	PR _{adj}	PR _{act}	W	PR _{adj}
D: Socio-economic repercussions		1	1	1		1							0.6	1	0.6
	D1: Contribution to local employment														
	D2: Contribution to economic development	1	1.08	1.08									1	1.08	1.08
	D3: Transfer of technology	1	1	1									0.6	1	0.6
	D4: Public commitments to sustainability	0.98	0.92	0.9									0.8	0.92	0.74

Table 7 The adjusted performance score (PS_{adj})* at the level of social impact subcategories for different stakeholders

Social impact subcategory		Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
A: Human rights	A1: Free from the employment of child labor	5	5	5	4	
	A2: Free from the employment of forced labor	5	5	5	5	
	A3: Equal opportunities, free from discrimination	5	5	4	5	
B: Working condition	B1: Freedom of association and collective bargaining	4	3		3	
	B2: Fair salary	5	5	4	4	
	B3: Decent working hours	4	5	3	4	
	B4: Occupational health and safety	5	5	4	4	
	B5: Social benefits	4	4	4	2	
C: Cultural heritage and community development	C1: Migration	5				5
	C2: Respect for local cultural and subcultural heritage	4				4
	C3: Respect for the customary right of indigenous people	5				4
	C4: Participation and employment of communities	5				4
	C5: Safe and healthy living conditions	5	5	4	3	5
D: Socio-economic repercussions	C6: Transparency on social/environmental issues	5				4
	D1: Contribution to local employment	5				3
	D2: Contribution to economic development	5				5
	D3: Transfer of technology	5				3
	D4: Public commitments to sustainability	5				4

*1: unacceptable; 2: limited; 3: moderate; 4: good; 5: best

Table 8 Impact performance score (IPS)* at the social impact category level and the overall result for different social impact categories

Social impact subcategories	Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community	Total
A: Human rights	5	5	5	5		5
B: Working condition	4	4	4	3		4
C: Cultural heritage and community development	5	5	4	3	4	4
D: Socio-economic repercussions	5				4	4

*1: unacceptable; 2: limited; 3: moderate; 4: good; 5: best

showing acceptable working conditions (Table 6). These high values indicate that olive oil production in Guilan province has a good status regarding equal chances and no discrimination. The factory managers group's CR for the indicator of 'discrimination in the pay of male and female employees' was 37.5%, and its actual score was determined to be 2 (Limited).

Furthermore, among factor managers, the indicator of 'discrimination among farmers in the supply of raw material (olive)' had a CR of 50%, and its actual score was 3 (Moderate). These low ratings indicate that the indicators in the 'fair opportunities and no discrimination' category are moderate, requiring more careful planning by the management to attain a higher level. However, since the sum score of all indicators in an impact subcategory is used to calculate its overall score, its overall status may be good.

Three stakeholders have been involved in this impact subcategory 'discrimination among farmers in the supply of raw material (olive),' including the factory managers, factory workers, and olive orchard workers. The CRs of this impact subcategory indicator varied from 1.4 to 87.5% (Appendix 2). This social impact subcategory is in a non-optimal condition in the olive oil production cycle considering the low CR of several indicators, such as 'employee's permission for membership in associations and collective negotiation with the employer' in the group of the factory managers (50%), and the low CR of the indicator of 'employees' membership in worker unions' in the group of the factory workers (3.5%) and olive oil orchard workers (1.4%). Also, the CR of the indicator of 'providing conditions for workers to get acquainted with unions' for factory workers was low. The CRs of this impact subcategory were also scored 1, 3, or 5 so that out of the seven studied indicators, three indicators were scored 5 (Good), one indicator was scored 3 (Moderate), and three indicators were scored 1 (Unacceptable). PR_{act} was found to be 0.8 for the factory managers, 0.47 for the factory workers, and 0.6 for the olive oil orchard workers (Table 7). PR_{adj} was found to be 0.76 for the factory managers, 0.45 for the factory workers, and 0.57 for the olive oil orchard workers (Table 7). Finally, PS_{adj} was found to be 4 (Good) for the factory managers and 3 (Moderate), for factory workers and olive oil workers (Table 8). These scores mean that we are at the edge of moving toward non-optimal conditions in this impact subcategory, which should be checked and improved by olive oil production cycle officials and policymakers.

The CRs for the indicators in this impact subcategory ranged from 21.4 to 100% (Appendix 2). Based on the findings, stakeholders believe that all indicators in this subcategory are optimal, except for three: "difference between men and women's salaries"

(37.5%); “paying for the participation of the orchard owners themselves in the work of the orchard” (21.4%); and “paying for the participation of family members in the work of the orchard” (28.6%). The ACT_{CR} for the indicators in this impact subcategory ranged from 2 to 5. For this effect subcategory, PR_{act} was 0.87 for factory managers, 0.96 for factory employees, 0.64 for olive orchard owners, and 0.7 for olive orchard workers (Table 6). These ratings represent the optimal position of this social impact subcategory in the olive oil manufacturing cycle. However, the five indicators mentioned above that have an actual score of 3 (Moderate) or below need modification and development to enhance the conditions of this effect subcategory.

The proportion of people who provided the anticipated and standard response to this impact subcategory (CR) indication was between 17.1 and 100% (Appendix 2). The results showed that the indicators ‘44 working hours per week’ (25%) and ‘overtime of less than 50% of the workers’ (25%) in the group of factory managers were not in good standing. Also, ‘8 working hours per day’ (24.2%) in the group of factory workers and ‘orchard owners who have a written contract with their workers’ (17.1%) in the group of orchard owners were not in good status.

This is supported by ACT_{CR} , which ranged from 1 to 5 for these indicators. PR_{act} for factory managers, factory workers, olive orchard owners, and orchard workers was determined to be 0.68, 0.91, 0.6, and 0.8, respectively (Table 7). PR_{adj} was determined to be 0.66, 0.9, 0.57, and 0.76 for factory managers, factory workers, olive orchard owners, and olive orchard workers, in that order (Table 7). It was discovered that the impact subcategory of suitable working hours is at the limit of optimality in the group of olive orchard owners, necessitating more investigation, adjustment, and improvement. In this impact subcategory, other stakeholder groups had optimum conditions. Accordingly, it is critical to improve the four abovementioned indicators out of the 15 indicators analyzed under this subcategory.

Appendix 2 revealed the indicator of ‘classifying workers activity within high-risk jobs’ for the factory managers (12.5%) and orchard owners (6.8%), showing the non-optimal status of this indicator among these two groups. The indicator ‘access to safety equipment in the workplace’ was also non-optimal for olive orchard owners (40%). The indicator ‘lack of noise pollution’ for factory managers (25%) and factory workers (44.7%) revealed that the olive oil production cycle was polluted by factory noise. Only 40% of the orchard workers believed that they did an activity that was harmful to their health, so this indicator is non-optimal, too. Also, 30% of the workers thought there were plans to inform them about health and safety. This indicator is, thus, non-optimal, too. The indicator ‘supplying safe and clean drinking water for workers’ was non-optimal in the group of orchard owners, so only 30% believed it was satisfied.

The indicator of ‘using machinery’ was non-optimal in the group of orchard workers, and only 7.1% believed it was satisfactory. It was found that 25.7% of the orchard owners and 4.3% of the orchard workers have participated in health and safety training courses, implying the non-optimal conditions of this indicator in the social impact subcategory of occupational health and safety. Another non-optimal indicator in this impact subcategory is ‘preventive actions for chemicals used’ in the group of orchard owners, for which only 25.7% have taken action. ACT_{CR} was in the range of 1–5 for these indicators, as lower scores for some indicators show their non-optimal conditions. Although the scores indicate that the social conditions in this impact subcategory are ideal, modifying specific indicators, particularly those with an ACT_{CR} of 3 or below, is required to enhance all stakeholders’ conditions in this social impact subcategory.

The CRs for the indicators of this impact subcategory (Appendix 2) showed that only 38.6% of the olive orchard workers had written contracts, which is non-optimal. Regarding

the indicator of ‘paying grand-in-aid for families’, the CR was 37.6% for the factory workers, showing its non-optimal conditions. The indicator of “paying allowance for childbirth and fatherhood” had CRs of 37.5 and 30.6% in the factory managers and factory workers groups, respectively, which reflect its non-optimal conditions in this impact subcategory. The CR calculated for ‘the existence of a policy for employees’ higher education’ was 37.5% for the factory managers group and 30.6% for factory workers. So, there is no policy for the olive oil production cycle employees.

Further, based on the results, 38.8% of the factory workers believed there were no specific holidays, which is non-optimal. Unfortunately, only 25.7% of the orchard workers were covered with social security insurance, which calls for proper planning by policymakers. Finally, only 20% of the orchard workers stated that they were insured, which is a meager value and needs reforms in the structure and attitude of orchard owners toward workers. The actual scores for the indicators were in the range of 1–5. Overall, it is found that this social impact subcategory is not in an optimal status and needs some new approaches to moving toward an optimal status.

Only two groups of stakeholders (factory managers and the local community) were involved in this social impact subcategory. After the CRs were calculated for the indicators of this impact subcategory (Appendix 2), it was found that this subcategory is in ideal condition from the stakeholders’ perspective. Finally, the adjusted performance score of this impact subcategory was 5 (Table 8), reflecting its optimal social conditions. These results mean that the olive oil production cycle significantly reduces migration in Guilan province.

Two groups of stakeholders, i.e., factory managers and the local community, were involved in studying this impact subcategory. Based on the CRs for the indicators of this impact subcategory (Appendix 2), it is in optimal condition from the stakeholders’ perspective. Only the indicator of ‘factories supporting cultural events’ was at the border of optimality from the perspective of the local community group. ACT_{CR} was estimated to be in the range of 3–5 for this indicator. This score shows the optimal conditions of this social impact subcategory in the olive oil production cycle.

Three indicators were considered to study this impact subcategory. The CR of 30% in the indicator of ‘holding meetings between factory managers and residents in the local community group shows the poor condition from the perspective of this group of stakeholders. The CRs of other indicators reflect the optimal conditions of this impact subcategory from the perspective of two groups of stakeholders (Appendix 2). ACT_{CR} ranged from 2 to 5 for the indicators of this impact subcategory. These scores imply the optimality of this social impact subcategory in the cycle of olive oil production.

CR for the indicators of this impact subcategory showed that the indicators were at the border of optimal conditions from the perspective of the local community. Still, the factory managers perceived it as optimal (Appendix 2). ACT_{CR} was found to be 5 for the group of factory managers and 3 for the local community group. Based on the scores, this social impact subcategory is generally optimal in the olive oil production cycle.

All five groups of stakeholders were involved in studying this impact subcategory. The CRs for the indicators revealed that the indicator of “opportunity of increasing knowledge, skills, and career progress” was in very non-optimal conditions with a CR of 17.1% in the view of the olive orchard workers. Other indicators in this impact subcategory had optimal conditions from stakeholders’ perspectives (Appendix 2). ACT_{CR} was calculated to be 1–5 for the indicators. The actual performance was 1, 1, 0.72, 0.53, and 1 for the factory managers, factory workers, olive orchard owners, olive orchard workers, and local community, respectively (Table 7). The adjusted performance was 1.02, 1.02, 0.73, 0.54, and 1.02 for these groups, respectively (Table 7). These scores mean that this impact subcategory is at

the border of optimal conditions for the indicators related to olive orchard workers. Still, it is optimal to ideal in other studied indicators.

The CR was calculated as the only indicator in this impact subcategory from the perspective of two stakeholder groups, the factory managers and the local community, which was found to be optimal from the perspective of factory managers but non-optimal from the perspective of the local community (Appendix 2). This is confirmed by this indicator's actual score, which was 5 for the factory managers and 3 for the local community. Generally, these scores show that this social impact subcategory is seemingly optimal, but the local community does not agree.

The CR was calculated as the only indicator studied in this impact subcategory from the perspective of the factory managers and the local community. The factor managers assessed it as optimal, but the local community set it at the border of optimality (Appendix 2). The actual score for this indicator was 5 for the factory managers and 3 for the local community, which supports the above conclusion. Based on the scores, the factory managers expressed that this social impact subcategory is optimal, but the local community did not agree.

This impact subcategory had only one indicator. The CR was calculated to be 100% for the factory managers and 46.7% for the local community (Appendix 2). It was observed that the perspectives of both stakeholder groups on the social impact subcategory of technology transfer were very different. The factory managers argued that technology had been transferred entirely and this indicator is optimal and ideal, whereas the local community expressed its status as non-optimal. ACT_{CR} was calculated to be 5 for the factory managers and 3 for the local community. These scores reveal a gap between the perspectives of the factory managers and the local community on the optimality of this subcategory in the olive oil production cycle.

Eight indicators examined this social impact subcategory. Based on the CRs calculated for these indicators (Appendix 2), "factories' support of local creativities, suggestions, and innovations", "holding meetings between factory managers and residents", and "being the factory harmless to the environment and air pollution" were non-optimal from the perspective of the local community and needed changes. These indicators had actual scores of 2–5. These scores mean that this social subcategory is in optimal conditions in the olive oil production cycle, but some indicators in this subcategory are not optimal and need changes.

5 Discussion

The research aimed to evaluate the social impacts of the olive oil extraction industry in Roudbar County, Iran, using the social life cycle assessment approach. The study sought to determine both the present and projected social conditions associated with this industry. A weighting technique was implemented to enhance the applicability of these criteria for multicriteria decision analysis, which relied on systematic assessment by experts.

The results indicate that the overall performance score for the social impact domains, including human rights, working conditions, cultural heritage, community development, and socio-economic implications, was assessed as 5, 4, 4, and 4, respectively, indicating positive and exemplary performance. The results of this study suggest that the social conditions surrounding the olive oil extraction process in the research region are mostly suitable. Nevertheless, it is worth noting that many elements, such as cultural heritage, community

development, and working conditions, were deemed unsuitable by orchard workers and hence needed improvement.

The aggregation of scores from many subcategories allows for a comprehensive assessment of social performance within each overarching social impact area. Nevertheless, it is crucial to consider the uncertainty associated with the aggregated indicators derived from these subcategories when evaluating the social life cycle of a product. The significance of this lies in the fact that the aggregation process naturally reduces specific and accurate information. Furthermore, discerning the influence of particular indicators on the broader social impact category might provide a significant challenge. Consider, for example, the domain of social effects on working conditions, which garnered an excellent rating of 4. The observed high score may obscure underlying concerns, namely, the perceived inadequacy of social benefits within the context of olive orchard laborers. Hence, it is essential to thoroughly examine the individual indicators and their impact on subcategories throughout completing a social life cycle evaluation. Relying merely on aggregated data may lead to misleading results.

The use of a cause-and-effect chain in this research facilitates the identification of distinct indicators associated with social difficulties in the studied region. On the other hand, using a scaling strategy may potentially incorporate subjectivity into the outcomes, amplifying uncertainty (do Carmo et al., 2017). To enhance the dependability of social impact data, it is advisable to apply an assessment centered on measuring an intervention's effects. This evaluation should thoroughly examine critical domains such as occupational health and safety, employment, as well as pay and benefits (Kruse et al., 2009; Weldegiorgis & Franks, 2014). Consequently, integrating a scale-based approach with a more focused path-based strategy can potentially augment the evaluation's overall effectiveness.

One of the study's primary limitations is that it relies on subjective data gathered from stakeholders to determine social effects. Stakeholder views and expectations might fluctuate significantly over time and geography, making personal data possibly less credible for developing a holistic understanding. While the research aims to provide insights into the social implications of the olive oil production cycle from field to factory delivery, the shifting nature of these judgments raises concerns regarding the study's generalizability and long-term validity. One further limitation is the research's focus, which is restricted to the production aspect of the olive oil cycle. Consequently, the study lacks the inclusion of customer and consumer perspectives about the social drivers of consumption. The exclusion mentioned above is important since customer opinions and tastes are pivotal in defining the sector. Including ethical buying choices and consumer activism, viewpoints offer a supplementary comprehension level about the societal implications associated with olive oil production. Furthermore, omitting consumer viewpoints creates a gap in the comprehensive understanding of social ramifications across the whole life cycle of olive oil, spanning from its production to its consumption. This phenomenon has special significance in domains such as fair trade, ethical labor practices, and sustainability, which are progressively gaining prominence among consumers.

Future studies may consider adopting a more diverse methodological framework incorporating objective and subjective data to overcome these constraints. Moreover, broadening the scope to include customer viewpoints might provide a more comprehensive comprehension of the societal ramifications linked to the olive oil sector. Including these factors can enhance the research and bolster its overall strength by including a broader range of social issues. Finally, as highlighted by Tragnone et al. (2022), a larger effort would be

necessary in defending core methodology choices as well as emphasizing the unique qualities of the products, social topics, and stakeholders involved. How.

6 Conclusion

The social life cycle assessment (S-LCA) of the olive oil extraction sector in Roudbar County, Guilan Province, Iran, has shed light on the social implications of this important agricultural activity. The results indicate that the social conditions regulating olive oil extraction in the examined region are generally adequate. However, specific social impact aspects, including cultural heritage, community development, and working conditions, require improvement. Upon analyzing the broader global context surrounding olive production and its social ramifications, this study presents findings that transcend Roudbar County, providing significant contributions to the understanding of the social sustainability of the olive oil sector.

The S-LCA study's results provide valuable information for policymakers and industry stakeholders looking to enhance the social sustainability of olive oil production. The following recommendations are proposed to address the identified social issues:

- **Strengthening labor protections:** Policymakers should prioritize implementing and enforcing labor legislation and standards to guarantee that olive orchard employees get fair salaries, better working conditions, and increased social protections. By putting workers' well-being first, the sector can create a more sustainable and socially responsible workforce.
- **Investing in community development:** To encourage inclusive growth, stakeholders should focus on supporting community development projects in areas where olive production is a substantial economic activity. Supporting local business, education, and infrastructure development may help strengthen these communities' social fabric.
- **Protect cultural heritage:** The extraction of olive oil is often linked to local traditions and cultures. Policymakers and industry stakeholders should work together to preserve this cultural legacy by supporting sustainable and efficient olive oil extraction processes consistent with traditional practices.

Further, the study's findings emphasize the significance of including social elements research in assessments of olive production and other agricultural businesses. A thorough examination of social implications across the whole supply chain should supplement the traditional emphasis on environmental life cycle assessments. This integrated approach enables a more holistic knowledge of sustainability and provides the basis for appropriate policy and practice decisions. By integrating social sustainability within the broader context of olive oil production, it is possible to foster a more socially conscientious and equitable sector that aligns with the global objectives of sustainable development. Our results also confirm that the complexity of supply chains and the need to evaluate social factors make applying S-LCA particularly challenging (Huertas-Valdivia et al., 2020), especially in the agri-food industry (Tragnone et al., 2022). This complexity stems from the unique characteristics of these systems and the social and socio-economic challenges they face, such as working conditions (Sureau et al., 2019), poverty, disparities, hunger, and

malnutrition (FAO, 2014), and the multifunctionality of the agri-food products (D'Eusanio et al., 2018).

Moreover, the study's results emphasize the need for further advances in social assessment models and theories. Researchers should try to build more rigorous and standardized approaches that capture various social impacts in varied situations as the field of S-LCA expands. This research demonstrates that combining impact-based assessments with path-based methodologies may improve the credibility and efficacy of social impact evaluations in olive production and beyond. Furthermore, the outcomes of this study highlight the importance of stakeholder participation and participatory methodologies in social assessments. Including the perspectives of olive orchard workers, local communities, and other relevant stakeholders ensures that the evaluations represent the real-life experiences and concerns of people directly impacted by olive oil production.

Appendix 1

Impact categories/social impact subcategories/questions/stakeholders answering each question/responses/standard responses.

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
A	A1	Do child workers (under 18 years) work in factories?	Yes/no	No	*	*			
		Has the factory taken actions to prevent or reduce child labor?	Yes/no	Yes	*				
		Do workers younger than 18 years (both family and non-family) work in your orchard?	Yes/no	No			*		
		Do workers younger than 18 years do hard work in the orchard that is harmful to their health? Or do they do things that prevent them from studying?	Yes/no	No			*	*	
	A2	Do workers work for the factory under a formal contract?	Yes/no	Yes	*				

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Is the amount of salary specified in the contract?	Yes/no	Yes	*				
		Are social security benefits specified in the contract?	Yes/no	Yes	*				
		Do factory officials provide full explanations to workers when signing a contract to make all parts of the contract transparent?	Yes/no	Yes	*				
		Do factory officials confirm that workers do not work more than the working hours specified in the labor law?	Yes/no	Yes	*				
		Do factory officials allow workers to resign at any time and under any circumstances specified by law?	Yes/no	Yes	*	*			
		Does the factory keep workers' personal documents (e.g., identification documents, promissory notes, educational documents, etc.)?	Yes/no	Yes	*				
		Is there a compulsion to do extra work in the factory?	Yes/no	No	*				
		Is there a penalty for workers in the factory if they do not do compulsory labor?	Yes/no	No	*				
		How many days a week do you work?	Day	≤ 6		*			
		How many hours a day do you work on average?	Hour	≤ 8		*			
		How many hours a week do you work?	Hour	≤ 42		*			
		How many days a week do you rest?	Day	≥ 1		*			

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
A3		How many over-time hours do you have per day on average?	Hour	≤ 2		*			
		Do you have break time during working hours?	Yes/no	Yes		*			
		Do you work longer than the working hours specified in the labor law?	Yes/no	No		*			
		Does your employment contract include wages, salaries, and other benefits?	Yes/no	Yes		*			
		Was the employment contract you signed transparent to you?	Yes/no	Yes		*			
		Do you impose travel bans on your workers during certain hours?	Yes/no	No			*	*	
		Do you force your workers to work overtime?	Yes/no	No			*	*	
		Do you force your workers to do hard work?	Yes/no	No			*	*	
		Is there a difference between the salary of a female worker and a male worker?	Yes/no	No	*				
		Is there a difference between the salary of a native worker compared to a non-native worker?	Yes/no	No	*				
		Is there a policy of an equal opportunity for men and women in the factory?	Yes/no	Yes	*	*			
		Is there a policy of an equal opportunity between native and non-native people in the factory?	Yes/no	Yes	*				

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Have there been cases of discrimination (between men and women or between native and non-native people) in the factory over the last 5 years?	Yes/no	No	*	*			
		Do women work in this factory?	Yes/no		*	*			
		Does the factory procure the raw materials (olives) it needs from specific farmers?	Yes/no	No	*				
		Have you experienced any discrimination in the company?	Yes/no	No		*			
		Are there female workers in your olive orchards?	Yes/no	Yes			*	*	
		Does the orchard owner determine the amount of salary regardless of gender? (Are the benefits of a female worker and a male worker different?)	Yes/no	Yes			*	*	
		Does the orchard owner care about gender in hiring workers, paying benefits and bonuses, or firing?	Yes/no	No			*	*	
B	B1	Are workers allowed to freely report any problems to the employer?	Yes/no	Yes	*	*			
		Can workers hired by the employer start negotiations with the employer individually or in groups or through unions or their representatives to determine their terms of employment?	Yes/no	Yes	*			*	

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Are you a member of a trade union or trade union?	Yes/no	Yes		*		*	
		Does the factory provide the conditions for you to become familiar with trade unions?	Yes/no	Yes		*			
	B2	Can workers meet their basic needs with their wages?	Yes/no	Yes	*				
		Is there a difference between the salary of a female worker and a male worker?	Yes/no	No	*				
		Is there a difference between the salary of a native worker compared to a non-native worker?	Yes/no	No	*				
		Is there evidence to prove workers' wages (pay slips)?	Yes/no	Yes	*				
		Has the factory work on providing fair wages to its workers?	Yes/no	Yes	*				
		Does the factory comply with the minimum wage and benefits regulations approved by the Ministry of Cooperative, Labor, and Social Welfare?	Yes/no	Yes	*				
		Do you receive your monthly salary and benefits on time?	Yes/no	Yes		*			
		Is it possible for you to use assistance in the middle of each month?	Yes/no	Yes		*			
		Is the amount you earn consistent with the amount of work you do?	Yes/no	Yes		*			

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Does the amount you receive correspond to the minimum salary approved by the Ministry of Cooperative, Labor, and Social Welfare?	Yes/no	Yes		*			
		Do the salaries you receive allow you to meet basic needs?	Yes/no	Yes		*			
		Do you have enough time to spend with your family and relax?	Yes/no	Yes			*	*	
		With the income you have, are you able to estimate the needs of yourself and your family, such as the food you need, etc.?	Yes/no	Yes			*	*	
		Do you get paid for what you yourself do in the orchard?	Yes/no	Yes			*		
		Do you think you pay your workers a fair wage?	Yes/no	Yes			*		
		Do you pay your family members if they work in the orchard?	Yes/no	Yes			*		
	B3	How many hours a week do your workers work on average?	Hour		*				
		Is there a specific overtime for the employees of this production unit?	Yes/no	Yes	*				
		What percentage of employees receive overtime payment?	%		*				
		How many hours a week do your workers work overtime on average?	Hour		*				

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Does the factory comply with the working hours of its employees in accordance with the labor law?	Yes/no	Yes	*	*			
		How many days a week do you work?	Day			*			
		How many hours a day do you work on average?	Hour			*			
		How many hours a week do you work?	Hour			*			
		How many days a week do you rest?	Day			*			
		How many over-time hours do you have per day on average?	Hour			*			
		Do you have break time during working hours?	Yes/no	Yes		*			
		Do you have enough time to spend with family and relax?	Yes/no	Yes			*	*	
		Do you work in the olive orchard with your family?	Yes/no	Yes			*		
		Do you hire a worker to do the work for your olive orchard?	Yes/no	Yes			*		
		Do you sign written contracts with your workers?	Yes/no	Yes			*		
	B4	Can orchard works be considered risky?	Yes/no	No	*	*	*	*	
		Do workers use dangerous tools?	Yes/no	No	*	*	*	*	
		Does the factory use the right equipment to protect potential health hazards for workers?	Yes/no	Yes	*	*	*	*	
		Are chemicals used in the work?	Yes/no	No	*		*	*	
		Is there noise pollution in the factory?	Yes/no	No	*	*			

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Are there any activities in the factory that could be harmful to your health?	Yes/no	No	*	*	*	*	
		Are there any precautionary measures and emergency equipment in the factory in case of accidents or injuries (e.g., first aid kits or communication devices)?	Yes/no	Yes	*				
		Does the factory provide healthcare and supplementary insurance coverage for workers?	Yes/no	Yes	*	*			
		Are there any health and safety training and improvement programs?	Yes/no	Yes	*	*	*		
		Are there any safety measures in place at the factory?	Yes/no	Yes	*	*			
		Has there been an accident at the factory in the last 5 years?	Yes/no	No	*				
		Does the company respect the health and safety rights of its workers as required by law?	Yes/no	Yes	*				
		Is clean drinking water provided to workers, especially in high temperature conditions and in the absence of sources of pollution near the source of drinking water?	Yes/no	Yes	*		*	*	
		Do you use machines to do your job?	Yes/no	Yes		*	*	*	
		Have you ever attended a health/safety training/ updating course?	Yes/no	Yes		*	*	*	

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Are there any precautionary measures against the chemicals used?	Yes/no	Yes		*	*	*	
	B5	Does the factory provide services such as dining hall, transportation service, nursery, etc. to its employees?	Yes/no	Yes	*	*			
		Do you have an employment contract?	Yes/no	Yes		*		*	
		Does the company provide suitable retirement conditions for you?	Yes/no	Yes	*	*			
		Has the company adopted a policy on disability/illness/accident?	Yes/no	Yes	*	*			
		Does the company pay the household allowance?	Yes/no	Yes	*	*			
		Does the company pay for childbirth (for female workers) or fatherhood allowance (for male workers)?	Yes/no	Yes	*	*			
		Does the company have a policy for staff education and training?	Yes/no	Yes	*	*			
		Does the company offer special holidays for employees?	Yes/no	Yes	*	*			
		Are you and your family covered by the social security insurance?	Yes/no	Yes			*	*	
		Do you insure your workers?	Yes/no	Yes			*		
C	C1	Has the factory been effective in preventing the migration of local people?	Yes/no	Yes	*				*
	C2	Does the factory support local cultural and artistic events?	Yes/no	Yes	*				*

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Has the factory been effective in introducing the local area to other parts of the country?	Yes/no	Yes	*				*
	C3	Are there meetings between factory managers and local residents?	Yes/no	Yes	*				*
		Do the factory and its managers pay attention to citizenship rights?	Yes/no	Yes	*				*
		Are local values and traditions taken into account in factory products?	Yes/no	Yes	*				*
	C4	Does the factory support the local community's initiatives, suggestions, and innovations?	Yes/no	Yes	*				*
		Does the factory give priority to local people in employment and recruitment?	Yes/no	Yes	*				*
	C5	Does the factory help develop the local economy?	Yes/no	Yes	*				*
		Is the policy or activity of the factory in the interest of the local community in economic, social, and cultural sense?	Yes/no	Yes	*				*
		Do the salaries you receive allow you to meet your basic needs?	Yes/no	Yes		*			
		Does the worker have enough time to spend with family and rest?	Yes/no	Yes		*	*	*	
		Is the worker able to estimate the needs of himself and his family, such as maintaining the required diet, etc.?	Yes/no	Yes		*	*	*	

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
D	C6	Do the workers have the opportunity to increase their skills and knowledge, to progress in the factory, or to build their future career?	Yes/no	Yes		*	*	*	
		Do agricultural service centers teach you about healthy farming methods and natural pest control?	Yes/no	Yes			*		
		Do you pay for these services?	Yes/no	No			*		
	D1	Is the factory and its activities harmful to the environment and air pollution?	Yes/no	No	*				*
		Does the factory give priority to local people in employment and recruitment?	Yes/no	Yes	*				*
		Does the factory help develop the local economy?	Yes/no	Yes	*				*
		Does the factory support local community initiatives, suggestions, and innovations?	Yes/no	Yes	*				*
		Does the factory support local community initiatives, suggestions, and innovations?	Yes/no	Yes	*				*
		Does the factory help develop the local economy?	Yes/no	Yes	*				*
		Are there meetings between factory managers and local residents?	Yes/no	Yes	*				*
		Do the factory and its managers pay attention to citizenship rights?	Yes/no	Yes	*				*
		Are the factory and its activities harmful to the environment and air pollution?	Yes/no	No	*				*

Social impact category	Social impact subcategory	Questions	Responses	Ideal response	Stakeholders				
					Factory managers	Factory workers	Olive orchard owners	Olive orchard workers	Local community
		Are local values and traditions taken into account in factory products?	Yes/no	Yes	*				*
		Has the factory been effective in introducing the local area to other parts of the country?	Yes/no	Yes	*				*
		Is the policy or activity of the factory in the interest of the local community in the economic, social, and cultural sense?	Yes/no	Yes	*				*

Appendix 2

The obtained/characterized results (CR) for each social impact subcategory related to the stakeholders.

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
A	A1	Percentage of managers and workers who answered negative to the question regarding labor younger than 18 years	87.5	100			
		Percentage of managers who answered positive to the question regarding preventive actions for child labor	75				

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
A2		Percentage of orchard owners who answered negative to the question regarding labor younger than 18			84.3		
		Percentage of orchard owners and workers who answered negative to the question regarding hard child labor and their lack of education			100	74.3	
		Percentage of managers who answered positive to the question whether workers worked with a formal contract	87.5				
		Percentage of managers who answered positive to the question as to whether salaries were specified in the contract	87.5				
		Percentage of managers who answered positive to the question as to whether social security benefits were specified in the contract	62.5				
		Percentage of managers who provide clear explanations for workers when signing the contract	75				
		Percentage of managers who answered positive to the question regarding no work beyond legal working hours as supported by factory officials	78.5				
		Percentage of managers and workers who answered positive to the question regarding the worker's freedom of resignation	100	98.8			
		Percentage of managers who answered positive to the question regarding the confidentiality of workers' personal documents	62.5				
		Percentage of managers who answered negative to the question regarding compulsory overtime	25				

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of managers who answered negative to the question regarding penalty for rejecting compulsory work	87.5				
		Percentage of workers who work 6 days a week or less		97.6			
		Percentage of workers who work 8 days a week or less		24.7			
		Percentage of workers who work 42 h a week or less		98.8			
		Percentage of workers who rest 1 day/week or more		100			
		Percentage of workers who have overtime of 2 h/day or less		25.9			
		Percentage of workers who have rest time during work		92.9			
		Percentage of workers who do not work beyond legal working hours		94.1			
		Percentage of workers who have contracts including wage and other benefits		85.9			
		Percentage of workers to whom the contract is clear		88.2			
		Percentage of orchard owners and workers who answered negative to the question regarding the prohibition of commute			98.6	97.1	
		Percentage of orchard owners and workers who answered negative to the question regarding compulsory overtime			85.7	70	
		Percentage of orchard owners and workers who answered negative to the question regarding compulsory of hard work			94.3	82.9	
	A3	Percentage of managers who do not differentiate between male and female workers' wages	37.5				
		Percentage of managers who do not differentiate between indigenous and non-indigenous worker wages	100				

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of managers and workers who believe that there is an equal opportunity between men and women	62.5	92.9			
		Percentage of managers who believe that there is an equal opportunity between native and non-native workers	62.5				
		Percentage of managers and workers who have not seen discrimination between men and women and between indigenous and non-indigenous people in the past 5 years	87.5	95.3			
		Percentage of managers and workers who answered positive to the question regarding women's working in factories	75	81.2			
		Percentage of managers who do not differentiate between farmers in the supply of raw materials	50				
		Percentage of workers who have not experienced discrimination against themselves		97.6			
		Percentage of orchard owners and workers who answered positive to the question of women' working in the orchard			61.4	98.6	
		Percentage of orchard owners and workers who believe that orchard owners determine wages regardless of gender			37.1	78.6	
		Percentage of orchard owners and workers who believe that orchard owners do not pay attention to gender for hiring, rewarding, and firing			60	92.9	
B	B1	Percentage of managers and workers who believe that workers are allowed to freely discuss problems with the employer	87.5	94.1			

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of managers and workers who believe that workers can negotiate with the employer as a group or through unions and determine their working conditions	50			81.4	
		Percentage of workers who are members of trade unions		3.5		1.4	
		Percentage of workers who believe that the factory provides the conditions for them to become acquainted with the trade unions		9.4			
	B2	Percentage of managers who believe that workers can meet their basic needs with their earnings	87.5				
		Percentage of managers who believe that there is no difference between the wages of a male and a female worker	37.5				
		Percentage of managers who believe that there is no difference between the salary of an indigenous and non-indigenous worker	100				
		Percentage of managers who issue payslips to workers	62.5				
		Percentage of managers who have taken steps to ensure fair payment for employees	87.5				
		Percentage of managers who believe that they comply with the regulations and guidelines of minimum wages and benefits of workers	87.5				
		Percentage of workers who receive their monthly wages and benefits on time		100			
		Percentage of workers who can use the assistance in the middle of the month		97.6			
		Percentage of workers who believe that their earnings are commensurate with their tasks		96.5			

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of workers who believe that their wages correspond to the minimum wage approved by the Ministry of Cooperative, Labor, and Social Welfare		96.5			
		Percentage of workers who believe that with their wages they can meet their basic needs		75.3			
		Percentage of orchard owners and workers who have enough time to rest and spend with family			78.6	68.6	
		Percentage of orchard owners and workers who can meet the needs of themselves and their families with their income			51.4	51.4	
		Percentage of orchard owners who are paid for their work in the orchard			21.4		
		Percentage of orchard owners who believe they pay fair wages to their workers			82.9		
		Percentage of orchard owners who are paid for their family work in the orchard			28.6		
	B3	Percentage of managers who believe that their employees work 44 h/week or less	25				
		Percentage of managers who have scheduled specific overtime hours for workers	50				
		Percentage of managers who believe that 50% of employees or less work overtime	25				
		Percentage of managers who believe that their employees work 30 h/week overtime or less	87.5				
		Percentage of managers and workers who believe that legal working hours are complied with	87.5	85			
		Percentage of workers who work 6 days/week or less		83			
		Percentage of workers who work 8 h/day or less		24.2			

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of workers who work 44 h/week or less		98.8			
		Percentage of workers who have 1 day off per week or more		100			
		Percentage of workers who work 2 h/day or less		100			
		Percentage of workers who take breaks during working hours		92.9			
		Percentage of orchard owners and workers who have enough time to rest and spend with family			78.6	68	
		Percentage of orchard owners who work in the orchard with their family			60		
		Percentage of orchard owners who hire workers to do the orchard work			67.1		
		Percentage of orchard owners who have written contracts with their workers			17.1		
	B4	Percentage of people who believe that what they do is not considered risky	12.5	82.4	8.6	41.4	
		Percentage of people who believe that workers do not use dangerous tools	87.5	100	94.3	97.1	
		Percentage of people who believe that there is adequate protective equipment in the workplace	100	94.1	40	92.9	
		Percentage of people who believe that they do not use chemicals in their work	37.5		57.1	87.1	
		Percentage of managers and workers who believe that there is no noise pollution in the factory	25	44.7			
		Percentage of people who believe that work activities are not harmful to health	75	80	72.9	40	
		Percentage of managers who believe that there is first aid and safety equipment available in the factory	100				

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of managers and workers who believe that the factory provides healthcare services	75	96.5			
		Percentage of people who believe there are plans for health and safety updates	87.5	69.4	30		
		Percentage of people who believe that there are public safety measures in the factory	100	100			
		Percentage of managers who believe that no accident has occurred in the factory in the last 5 years	75				
		Percentage of managers who believe that employees' health and safety rights are respected	100				
		Percentage of people who believe that clean drinking water is available to workers	87.5		30	82.9	
		Percentage of people who use machinery to do their job		67.1	91.4	7.1	
		Percentage of people who have already attended a health and safety training course		69.4	25.7	4.3	
		Percentage of people who believe that there are preventive measures against chemicals		95.3	25.7	68.6	
	B5	Percentage of people who believe that the factory provides services such as dining halls, nurseries, etc	75	80			
		Percentage of workers who have an employment contract		85.9		37.6	
		Percentage of people who believe that the company provides good retirement conditions	87.5	76.5			
		Percentage of people who believe that the company offers a good disability policy	62.5	61.2			
		Percentage of people who believe that the company pays a family allowance	62.5	37.6			

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
C	C1	Percentage of people who believe the company pays for childbirth or fatherhood	37.5	30.6			
		Percentage of people who believe that the company has a policy to employees' higher education	37.5	30.6			
		Percentage of people who believe that the company has special holidays for employees	62.5	38.8			
		Percentage of people who are covered by social security themselves or their family			81.4	25.7	
		Percentage of orchard owners who insure their workers			20		
		Percentage of people who believe that the existence of the factory has been effective in preventing the migration of local people	78.5				90
	C2	Percentage of people who believe that the factory sponsors local cultural and artistic events	75				50
		Percentage of people who believe that the factory has been effective in introducing the local area to other parts of the country	50				96.7
		Percentage of people who believe that meetings are held between factory managers and local residents	62.5				30
	C3	Percentage of people who believe that the factory pays attention to citizenship rights	100				86.7
		Percentage of people who believe that local values and traditions are taken into account in factory products	87.5				70
	C4	Percentage of people who believe that the factory supports local community's initiatives, suggestions, and innovations	100				46.7

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
C5		Percentage of people who believe that the factory prioritizes indigenous people in employment and recruitment	87.5				56.7
		Percentage of people who believe that the factory helps to develop the local economy	100				96.7
		Percentage of people who believe that the policy or activity of the factory is in the (economic, social, cultural, etc.) interest of the local community	100				100
		Percentage of people who believe that wages paid to workers allow them to meet their basic needs		75.3			
		Percentage of people who believe that the worker has enough time to spend with family and rest		94.1	78.6	68.6	
		Percentage of people who believe that the worker has the ability to meet the needs of himself/herself and his/her family, such as maintaining the required diet, etc		81.2	51.4	51.4	
		Percentage of people who believe that workers have the opportunity to improve their skills and knowledge, advance in the factory, or build their future careers		100	60	17.1	
		Percentage of people who believe that agricultural service centers provide training on healthy farming methods and natural pest control			60		
		Percentage of people who believe that these services are paid for			100		
C6		Percentage of people who believe that the factory and its activities are not harmful to the environment and air pollution	87.5				43.3

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
D	D1	Percentage of people who believe that the factory prioritizes indigenous people in employment and recruitment	87.5				56.7
	D2	Percentage of people who believe that the factory helps to develop the local economy	100				96.7
	D3	Percentage of people who believe the factory supports local community's initiatives, suggestions, and innovations	100				46.7
	D4	Percentage of people who believe the factory supports local community's initiatives, suggestions, and innovations	100				46.7
		Percentage of people who believe that the factory helps to develop the local economy	100				96.7
		Percentage of people who believe that meetings are held between factory managers and local residents	62.5				30
		Percentage of people who believe that the factory and its managers pay attention to citizenship rights	100				86.7
		Percentage of people who believe that the factory and its activities are not harmful to the environment and air pollution	87.5				43.3
		Percentage of people who believe that local values and traditions are taken into account in factory products	87.5				70
		Percentage of people who believe that the factory has been effective in introducing the local area to other parts of the country	87.5				96.7

Social impact category	Social impact subcategory	Questions in the questionnaire	CR(%)				
			Factory managers	Factory workers	Orchard owners	Orchard workers	Local community
		Percentage of people who believe that the policy or activity of the factory is in the (economic, social, cultural, etc.) interest of the local community	100				100

Acknowledgements The authors would like to acknowledge the support provided by the University of Guilan, Rasht, Iran.

Author contributions BS developed the initial concept of the research and contributed to the analysis and writing of the first draft of the manuscript. ZA contributed to the concept and supervision. MSA developed the initial concept of the research and contributed to the concept and supervision. AN contributed to the validation and editing of the manuscript. TBH contributed to editing the manuscript and validation of the results.

Funding Open access funding provided by the Qatar National Library.

Data availability The data that support the findings of this study are available from the corresponding author, Tarek Ben Hassen, upon reasonable request. Please note that the data are in Persian.

Declarations

Conflicts of interest The authors declare no conflicts of interest.

Informed consent Not applicable.

Institutional review board statement Not applicable.

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Authors and Affiliations

Behzad Safeie-Noghlbari¹ · Zahra Amiri¹ · Mohammad Sadegh Allahyari^{2,3}  · Amin Nikkhah⁴ · Tarek Ben Hassen⁵  · Jacopo Bacenetti⁶

✉ Tarek Ben Hassen
thassen@qu.edu.qa

Mohammad Sadegh Allahyari
allahyari@iaurasht.ac.ir

Amin Nikkhah
amin.nikkhah@tufts.edu

Jacopo Bacenetti
Jacopo.bacenetti@unimi.it

¹ Faculty of Agriculture, Department of Agricultural Economy, University of Guilan, Rasht, Iran

² Department of Agricultural Management, Rasht Branch, Islamic Azad University, Rasht, Iran

³ Faculty of Economic and Management Sciences, North-West University, Mmabatho 2735, South Africa

⁴ Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA

⁵ Program of Policy, Planning, and Development, Department of International Affairs, College of Arts and Sciences, Qatar University, Doha 2713, Qatar

⁶ Department of Environmental Science and Policy, Università degli Studi di Milano, Via G. Celaria 2, 20133 Milan, Italy

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