

Article

Prioritization of Water Footprint Management Practices and Their Effect on Agri-Food Firms' Reputation and Legitimacy: A Best–Worst Method Approach

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Abstract: Agricultural production is responsible for most of the withdrawal of water volume. There has been increasing the pressure on stakeholders to adapt water usage behavior and manage water resources. In this context, water footprint management (WFM) practices have been implemented. Despite the positive benefits of the adoption of WF practices, the selection and prioritization of WFM practices remains a challenge. In addition, the effects that each of these individual practices have on reputation and legitimacy have not been investigated. To fill these research gaps, this study determined the relative priority of seven different WFM practices and the relative importance of each of these practices to increase agri-food firms' reputation and legitimacy. This study applied the best–worst method (BWM) with a set of expert Chilean professionals in the field. The practice related to the promotion of the measurement of the water footprint throughout the supply chain was considered the most vital and the one with the greatest effects on firms' reputation and legitimacy. The practice related to the establishment of water auditing and control systems was considered the least important and the one that generates lower effects on firms' reputation and legitimacy. Our study also found that lack of financial resources is the main barrier to WFM implementation. These findings are useful for companies that are not capable of developing a complete program of WFM adoption due to lack of resources to implement all these practices. By knowing the importance of each practice, farmers can select the practices that will bring the greatest benefits.

Keywords: water footprint management; reputation; legitimacy; best–worst method; agri-food supply chains



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1. Introduction

The promotion of sustainable agriculture requires considering environmental problems related to the usage of environmental resources in operations in the agri-food industry [1]. One of these resources is water, a fundamental element for this sector's activities [2]. The preservation of water resources in this industry is of paramount importance. It is directly or indirectly related to the achievement of some of the United Nations' Sustainable Development Goals (SDGs), like SDG 2 (zero hunger), SDG 6 (clean water and sanitation), SDG 12 (responsible production and consumption), and SDG 17 (partnerships for the goals) [3].

Water preservation is a key aspect of sustainable development [4]. The increasing world demand for food sheds light on the effects of agricultural production on water usage, pollution, and scarcity [5] since the agriculture industry intensively consumes,

degrades, and pollutes water [6,7]. In fact, the scarcity of water has been increasing and now causes significant adverse effects on users, ecosystems, and agricultural economies [8]. In addition, agricultural production is responsible for most of the withdrawal of water volume, significantly contributing to freshwater scarcity [9], which is a relevant threat to sustainable agriculture that requires farmers to adapt their behavior regarding water usage [8]. This adaptation can be made by implementing practices related to the adoption of water-saving technologies in production processes, promoting collaboration and consumer awareness of water scarcity-related issues [10]. Due to the high impact of the agri-food industry on water resources, it is necessary to foster an agroecological transition, and water resources management practices can contribute to this paradigm shift.

Especially in water-scarce regions, it is essential to assess agri-food water usage and the effectiveness of water resources management strategies to improve water use efficiency and reduce the impact of production and industrial activities [11]. The assessment of water usage is commonly determined by water footprint (WF), which is defined as the total volume of freshwater resources used, directly or indirectly, to produce goods and services, including water directly used in production processes as well as water indirectly consumed and polluted in production [12]. This indicator takes into account (1) a blue WF that considers surface and ground-water consumption, (2) a green WF that refers to rainwater consumption, and (3) a grey WF, related to the volume of freshwater required to assimilate pollutants [13]. In this context, the concept of WF management (WFM) arises. It is defined as “the use of policies and actions at the strategic, tactical, and operational levels that support mitigating the WF of a product across its entire supply chain” [14–16]. It is essential for promoting environmental sustainability in the agri-food industry [17], mitigating the WF of a product across its entire supply chain, and achieving environmental and economic sustainability [17,18].

Previous research assessed the antecedents and effects of WFM. Aivazidou et al. [14] proposed a framework to support agri-food firms to establish WFM policies and programs. Aivazidou et al. [19] also reported that the impact of WFM on supply chain financial performance is higher when consumers’ environmental sensitivity is higher. Barbosa [20] assessed the effects of internationalization orientation on five dimensions of environmental performance, including WFM, identifying a positive and significant impact of internationalization orientation on all its dimensions with a higher effect observed in WFM. Barbosa and Cansino [21] assessed the effects of environmental collaboration on the dimensions of environmental performance, including WFM in agri-food supply chains (AFSCs). The authors observed that environmental collaboration positively influences environmental performance, with WFM being the dimension most affected by environmental collaboration. Barbosa and Pumpín [22] assessed the effects Corporate Social Responsibility (CSR) practices, government support, and coercive pressures have on the implementation of WFM practices. This study also evaluated the effects the adoption of WFM practices has on companies’ reputations and legitimacy. The authors reported that CSR has a greater influence on WFM and that WFM, in general, has a positive and significant effect on firms’ reputation and legitimacy.

Despite the positive benefits of the implementation of WF practices, the selection of which practices should be implemented remains a challenge. Another existing challenge is to compare and rank these practices, given their interconnected nature. Hence, prioritizing the adoption of these practices remains an urgent issue. To the best of our knowledge, the effects of these practices on firms’ reputation and legitimacy using multi-criteria decision-making (MCDM) methods have not been mentioned in the literature.

Thus, to fill these research gaps, the objectives of this study were to (1) determine the relative importance of WFM practices and (2) determine the relative importance of

each of these practices to increase agri-food firms' reputation and legitimacy. We also discuss the importance of identifying the relative priority of these practices to the agri-food industry. In order to achieve these objectives, this study used the best–worst method (BWM) with a set of expert Chilean professionals in the field. The BWM has been used in previous research in the sustainability field. For example, Govindan et al. [23] adopted the BWM to analyze key performance indicators for developing sustainable collaboration. Uyan et al. [24] used the BWM to determine the most suitable locations for grapevine cultivation. Madureira et al. [25] used the BWM to analyze ten attributes of organic purchasing behavior and determine the key attributes that explain their consumption. Also, Debnath et al. [26] identified and prioritized 15 barriers to implementing Circular Economy practices.

This study was carried out in Chile, which is a suitable context for some reasons. First, this country is currently facing a mega-drought that has resulted in a severe water crisis [27,28]. This crisis has put the efficient use of water resources at the forefront of the agriculture industry's concerns. The agri-food industry, which accounts for a significant part of the country's GDP and exports several agricultural products [20,22,29], is now under pressure to promote water preservation initiatives to comply with international standards and guidelines. The need for immediate action is underscored by the fact that similar studies on WFM practices have been conducted in the country [20,22,30].

In addition, the water demand in Chile and the production and exports of agri-food products that consume high volumes of water contribute to water scarcity problems [31], environmental degradation, potential conflicts, and reduced industrial productivity [32]. Hence, Chile is a country that faces severe water scarcity threats. According to the World Resources Institute, Chile faces extremely high water stress, being the 16th-highest country in the world in this water stress ranking (<https://www.wri.org/insights/highest-water-stressed-countries>, accessed on 28 March 2025).

Moreover, it has been reported that the agriculture sector is a major contributor to water scarcity problems in Chile. Due to its importance in the country's economy, solutions that reduce water use and optimize water resources are necessary. In Chile, irrigation accounts for 73% of the consumptive water use [33]. The production of irrigated surfaces contributes between 60 and 65% of the country's agricultural GDP [34]. In the country, the agricultural sector accounts for nearly 4.7% of the national GDP (<https://www.prochile.gob.cl/en/export-sectors/agriculture-food-supplies>, accessed on 28 March 2025). This mismatch between water consumption and its economic contribution has been reported in some regions, which means that in some areas, agriculture consumes a considerable fraction of local water resources but marginally contributes to the regional GDP. This mismatch highlights a low agricultural water consumption efficiency that needs to be improved [10], highlighting the relevance of this study.

This study reports some practical and theoretical contributions that will be further described in more detail. First, this work numerically prioritizes WFM practices that should be adopted by agri-food firms, supporting decision-making and resource allocation. Second, this study quantifies the influence of these WFM practices on firms' reputation and legitimacy, identifying the practices with the most significant influence. Third, this study extends the legitimacy theory, which states that there is a social contract between society and firms. When firms are committed to this contract, they will be considered legitimate by society [35]. Our study extends this theory by showing that certain WFM practices can significantly improve firms' legitimacy.

2. Theoretical Background

2.1. Water Footprint Management in the Agri-Food Industry

In order to prevent the negative consequences of these events, agri-food firms must adopt different water resource management strategies [11]. In this context, firms assess their WF to indicate the water use and pollution of their operations in order to support water conservation within the agriculture industry [4]. WF measurement comprises direct (operational) WF and indirect (supply-chain) WF. Direct WF refers to the consumption of freshwater and pollution caused by a firm's operations, being easily quantified. Indirect WF refers to the consumption and pollution of freshwater used to produce all the products and services of a company. Indirect WF is difficult to measure due to the challenge of obtaining and tracing data from the suppliers [13,36].

Several studies have aimed to evaluate the water footprint of various processes in different contexts. This assessment is usually done using methods that can directly measure the water footprint, such as the top-down and bottom-up approaches. The bottom-up approach estimates a product's WF by summing volumes of water footprint during all production phases, while the top-down approach traces the entire supply chains [37]. A commonly used top-down technique is the input–output method, which calculates the direct water coefficient and total water coefficient of different regions [38]. This model can analyze the interdependencies between economic sectors [39], allowing for the quantification and tracking of water consumption throughout the entire supply chain [40].

Some challenges exist in directly calculating a WF, such as data unavailability, inaccurate data, and complex measurement techniques. Barbosa [30] states that when direct WF measures are not available or required, a set of practices that assess the degree of implementation of water footprint management can be used to appraise if initiatives for the reduction and control of water resources are being employed. Thus, the analysis of the adoption of WFM practices is not focused on directly measuring WF but on analyzing and guiding the usage of relevant practices to manage water resources.

WFM includes policies and actions at different hierarchical levels aimed at managing and reducing the WF of their operations across their whole supply chain. In order to fully achieve the benefits of WFM, firms not only have to implement certain practices but also need to make their actions public in order to make consumers aware of their behavior and develop competitive advantages. In general, stakeholders value the disclosure of water information. In addition, it supports making more effective decisions related to the promotion of water management [41]. Since the agri-food industry is a major consumer of water resources and its excessive use could reduce access to fresh water for communities, water transparency has become a relevant aspect of firms' corporate responsibility strategy [41]. Thus, agri-food firms have been publicly addressing water stewardship as part of their corporate sustainability strategies [2]. Even when firms are not obliged to comply with specific regulations, they have been integrating their WFM programs into their CSR strategy [14,41]. In conclusion, information concerning WFM programs should be well disseminated to increase awareness of the importance and impacts of sustainable water resources management [42].

Some companies have implemented improvements in their water resources management programs which can be related to an increase in their reputation. For example, Orbia has been ranked among the top companies with best reputations in Mexico, an award received based on its innovative solutions for food and water security across Mexico and Latin America (<https://www.businesswire.com/news/home/20250109525976/en/Orbia-Ranked-as-One-of-the-Top-200-Companies-with-Best-Reputations-in-Mexico>, accessed on 28 March 2025). Colgate-Palmolive partnered with a water technology company to reduce water withdrawals from a water-scarce basin in Mexico used to ensure adequate sanitation

for its products [43]. In 2022, BBVA and Iberdrola launched the world's first syndicated line of credit linked to the WF in order to reduce their WF and prices as well as stand out from competitors by increasing their reputation. This project includes a WF loan that offers customization of sustainability in areas where the WF has a real impact. Iberdrola considers two indicators: water consumption and the disclosure and management of water risks (<https://www.bbva.com/en/sustainability/bbva-creates-the-water-footprint-loan-and-launches-it-worldwide-together-with-iberdrola/>, accessed on 1 April 2025). These examples corroborate the idea that by implementing WFM practices, firms can increase their reputation and legitimacy [22]. These topics are described in the next section.

2.2. Reputation and Legitimacy

Reputation can be defined as “the collective representation of actions and outcomes of the past and present of the organization that describes its capability to obtain valuable outcomes for different stakeholders” [44]. It is formed by the perception of internal and external stakeholders [45], and it allows firms to differentiate themselves and attract new customers [46]. Currently, a firm's reputation is linked to its actions to promote environmental initiatives and avoid damage caused by its operations to the environment.

It has been found that environmental management significantly impacts companies' reputation since people are increasingly aware of the businesses' impacts on the environment [45]. Thus, initiatives like decreasing pollution, waste, emissions, conserving energy and water, and decreasing nonrenewable material, chemicals, and components enhance firms' reputations and environmental performance [47]. Firms promote social responsibility initiatives not only to fulfill laws and regulations but also to enhance their reputation and image [48]. Firm reputation is the image of a firm. It influences firms' interaction with their customers and the promotion of marketing initiatives [49].

Previous research found that honest and transparent communication of green initiatives is crucial for companies to maintain their reputation [50]. Thus, increasing transparency in water reporting contributes to improving reputation and strengthening stakeholder relationships [51]. If a firm manages to comply with all regulations governing water use, it can make clear contributions to society and establish a better reputation [52]. On the other hand, greenwashing, when firms make false or misleading statements about their environmental performance, can negatively impact an organization's reputation and credibility. Reputation scandals and issues can cause adverse impacts on companies such as the reduction of the prices of agricultural products [53].

Previous studies reported that CSR practices enhance corporate reputation by promoting characteristics like honesty and credibility [54]. It has been observed that CSR positively impacts firm reputation, which has a significant and positive association with sustainable business performance [49]. CSR practices not only improve a firm's reputation [49], but also promote sustainable competitive advantages [54], and positively impact firms' market share.

Reputation and legitimacy have a mutual relationship. Reputation affects legitimacy when competitive behavior is performing according to standards, values, and beliefs [55]. Tyler [56] defines legitimacy as “the belief that authorities, institutions, and social arrangements are appropriate, proper, and just”. To Suchman [57], legitimacy is “a generalized perception that the actions of an entity are desirable or appropriate within a given system of norms, values, and beliefs”. It is related to the fulfillment of norms and the belief that a company's actions are desirable according to society's values and beliefs [58]. Legitimacy is an organizational resource that demonstrates that the values of a firm are in line with those of society. In this context, firms imitate successful practices implemented by firms that are recognized as legitimate. Hence, gaining legitimacy is a reason for other firms to

engage in environmental activities. Legitimacy will be achieved when a given practice is seen as acceptable by the most relevant stakeholders. A legitimate company adjusts itself to political, social, and cultural standards and promotes the community's well-being and values [59].

The legitimacy theory (LT) defines how a firm will react to society's expectations [60]. A legitimate firm meets the expectations of a social system's norms, values, rules, and meanings [61]. LT considers that firms disclose their social and environmental information to create an impression that they operate according to customers' and society's social and environmental expectations [62]. This theory assumes that firms and society establish a social contract to define the social values that will guide the approval of the firms' operations. Researchers consider that, under this theory, competitive advantages are obtained when companies behave more ethically and strengthen the environment [63].

The LT posits that, through legitimation, companies adopt strategies aligned with societal expectations. In this context, it has been used to explain why firms disclose their sustainable practices and programs [64]. Firms adopt legitimation strategies to establish a desired public image aligned with societal expectations [65]. Hence, legitimate firms adopt a high-quality sustainability discourse that reflects their social and environmental performance [66]. Grounded on the LT, firms respond to external pressures by making disclosures, such as the ones related to water resources management, to gain legitimacy from different stakeholders [67,68]. Especially in water-intensive industries that face great stakeholder scrutiny, companies have been increasingly concerned about their water resource management practices, extending environmental improvements beyond water conservation [69].

New requirements established by several stakeholders have challenged the legitimacy of farming. The farm context has an informal institutional environment and social norms that need to be followed to gain legitimacy [70]. Legitimacy is not directly observable [62], so companies need to disclose information about their actions in order to achieve legitimacy. Thus, sustainability reporting is fundamental [71]. In this context, disclosing environmental information is a practice that can promote firms' legitimacy. More specifically, it has been reported that disclosing water information can help firms gain legitimacy [72]. Firms that present poor environmental performance prefer low-quality and ambiguous information to hide their performance and keep legitimacy through a false or unclear sustainability image [73].

Based on the theoretical framework discussed above, the following section outlines the methodology employed in this study.

3. Materials and Methods

This study prioritizes WFM practices in terms of their influence on firms' reputations and legitimacy. In order to achieve this objective, it is necessary to identify and then prioritize these practices. Hence, the first phase of this study comprised the identification of these practices and the second phase involved the application of the BWM to prioritize these practices according to the opinion of a panel of experts and assess their effects on companies' reputations and legitimacy.

3.1. Survey Questionnaire and Identification of the WFM Practices

The first challenge was to identify, among the existing WFM practices, those that should be evaluated. Practice identification has been performed based on the work of Barbosa [30], who performed a systematic literature review to identify potential WFM practices. In that study, a total sample of 21 papers on the subject were analyzed after applying adequate exclusion and inclusion criteria. A panel of experts evaluated the content validation of several candidate-selected practices according to three perspectives:

relevance, clarity, and essentiality. Relevance refers to how important the item is, clarity is related to how clear the items' wording is, and essentiality refers to how necessary the item is to describe the referred construct (WFM). Different indices to assess the proposed items' content validity like Aiken' V coefficient, content validity index (I-CVI), Kappa's coefficient, and content validity ratio were used. Out of the candidate practices, seven presented values that exceeded the recommended cutoff values, so these seven practices were selected. This rigorous assessment corroborated the high content validity for the selected practices to evaluate WFM initiatives in the agri-food industry. These seven practices are considered in this study and shown in Table 1.

Table 1. Final WF measurement items.

ID	Measurement Item Description
WF1	The promotion and adoption of national and global standards for WF accounting, traceability, and assessment.
WF2	The promotion of the measurement of the WF throughout the supply chain, and the cooperation with partners to generate records of the volume of water used in manufactured products.
WF3	The implementation of processes that mitigate the risk of contamination, avoiding or minimizing the use of substances (metals, pesticides, fertilizers) in products that may be polluting water.
WF4	The establishment of water auditing and control systems.
WF5	The investment in water-efficient technologies.
WF6	The reuse and recycling of wastewater.
WF7	The identification of local risks of their impact on the water supply.

Despite the existence of several methods for directly measuring the water footprint of production activities, the use of a construct that defines a set of WFM practices was considered suitable for this study because the prioritization of WFM practices does not require direct WF measurements. According to Barbosa [30], these practices are helpful for research that requires some assessment of WF management when raw data are not available or are not necessary.

After identifying the WFM practices that need to be prioritized, we proceeded to rank them with the aid of the best–worst method, which is described in the next section.

3.2. Best–Worst Method

Multi-criteria decision-making supports decision-makers in resolving problems involving multiple criteria [74]. Some of the commonly used MCDM methods are Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), and Decision-Making Trial and Evaluation Laboratory (DEMATEL) [75–78]. Some of these are comparison-based weighting methods, in which comparisons are made between different pairs of criteria. One of the most commonly used pairwise comparison methods is the AHP method. In this method, as the number of alternatives or criteria increases, the number of comparisons increases substantially, increasing the time needed to apply it and the probability of inconsistent judgments [74]. In addition, MCDM techniques often include assigning weights of importance to the decision criteria, which is considered a challenging step of this process [79].

To overcome this challenge, Rezaei [80] proposed a method that has been increasingly used—the best–worst method. This method is based on two vectors of comparison: the

comparison of the best (most important) criterion over all the other criteria and the comparison between all the criteria and the worst (least important) criterion. It reduces the bias of the decisionmaker by using two pairwise comparison vectors based on two opposite reference points in a single optimization [24]. BWM enables the selection of the best and worst criteria of and the comparison of the best criteria to all other remaining criteria and the other remaining criteria to the worst criteria [81].

Compared to other prioritization and pairwise comparison methods, BWM presents some advantages. It requires fewer pairwise comparisons, simplifying the comparison process and producing more consistent information [24,82]. Therefore, the BWM promotes higher consistency and results reliability and a reduced time for experts to assess the decision criteria [80,83].

According to Rezaei [80], the BWM comprises the following steps: (1) A decision-maker defines a set of criteria, (2) the best criterion (the most preferred) and the worst criterion (the least preferred) are defined, (3) all criteria are pair-wisely compared with the best criterion using a scale from one to nine, with one representing the lowest preference and nine the highest for an alternative. The results from the comparison process are represented as the best-compared-to-others vector, (4) the same approach is followed for the worst criterion, (5) the weightings of the criteria are calculated, and (6) the coherence is checked. The lower the inconsistency value, the better. However, no threshold value for the inconsistency index is defined [80,84].

A panel usually defines the priorities and weights of experts. The process of selecting experts to prioritize WFM practices is presented in the next section.

3.3. Selection of Experts

The BWM method requires a relatively small panel of experts to perform prioritization [80]. Kheybari et al. [85] recommended the participation of four to ten experts to ensure the validity and reliability of data and processes in BWM analysis. Past studies have followed this recommendation by forming panels of four to ten experts: three experts [86], four experts [87,88], five experts [89,90], six experts [91], seven experts [92–95], eight experts [96–98], nine experts [99], ten experts [81,100,101]. In this study, a total of nine experts analyzed the importance (priority) of the presented practices on agri-food firms' reputation and legitimacy. Hence, the number of participating experts is within the recommended range according to several published studies.

When using the BWM, a reduced sample is considered sufficient because MCDM methods are not based on statistical inferences, which makes a large number of respondents unnecessary. In addition, the quality of information is guaranteed by selecting experienced experts. Finally, data saturation is usually achieved with few participants [95,102].

Considering the crucial role of the experts in the quality and reliability of this type of study, researchers have been concerned about the definition of specific criteria for expert selection. The most common criteria established are extensive experience [88], familiarity with the industry/sector, a minimum educational level degree, proficiency in specific topics [95], knowledge of certain themes [98], and involvement degree with specific activities [86].

Based on the previously mentioned criteria, in this study, we defined the following inclusion criteria: (1) experts need to possess a Bachelor's degree, (2) experts must be knowledgeable professionals responsible for different activities and processes in the agri-food sector, (3) experts must be knowledgeable professionals in the field of sustainability with more than five years of experience, and (4) their professional activities must be somehow concerned with the management of water resources.

Investigating the opinions of a panel of experts is valuable for gathering insights into a theme in an efficient manner. Expert invitations have been made by contacting experts via email using researchers' professional and personal networks due to the great amount of effort required to reach out to suitable experts and ensure their participation as recommended by previous studies [103–106]. In addition, this approach can facilitate achieving a demographically balanced sample [106]. As suggested by a previous study [101], the expert selection began with an email to potential participants from our professional networks asking them whether they would be willing to be part of the study and whether they fulfilled the inclusion criteria.

In this study, most of the participating experts have been working in their current company for more than five years. The experts were concerned with different agri-food activities like wine production, seed production, calves, fruits, and technology. Most of the experts are CEOs, business owners, or company general managers. Three experts work in small companies, three in medium firms, and three in large companies. The experts' opinions were collected through online interviews, which are described in the next section.

3.4. Prioritization of WFM Practices

The BWM prioritization questions were structured in an Excel file with different tabs. The first tab ("Introduction") presented the study's objectives, the informed consent, and the definition of the required concepts for answering the questions, such as reputation and legitimacy. The concepts of reputation and legitimacy were clearly defined in this first tab so that the participating experts could have a unique and common understanding of them. Based on previous studies [44,57], reputation was presented as "the set of collective judgments regarding a firm's past actions and future prospects and its ability to create value relative to competitors" and legitimacy was defined as the "congruence between the social values associated with or implied by activities and the norms of acceptable conduct in the broader social system, a widespread perception or assumption that an entity's actions are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions".

The second tab ("Questions") presented the survey questions, divided into five sets. In the first set, the respondents indicated their opinion of which of the seven WFM practices is of top priority among all. Then, they had to assess with a score between one (of equal importance) and nine (extremely more important) how much more important the top priority practice is compared to each of the others. In the second set, the respondents indicated which of the seven WFM practices is the least vital of all. Then, they rated with a score between one and nine how much more important each of the other practices is compared to the one of lower priority. In the third set, the respondents evaluated the intensity of the effect that each of the seven WFM practices has on the legitimacy of companies. In the fourth set, the respondent evaluated the intensity of the effect that each of the seven WFM practices has on firms' reputations. Finally, respondents were asked to identify some of the barriers to adopting WFM. The last set presented the questions related to the respondents' profiles.

The experts' responses were collected through online interviews. The importance of these practices was assessed through a survey that was filled out in approximately 15 min per expert. In case of time incompatibility, an Excel file with all the questions was sent by email to the respondent, along with instructions on how to fill it out. Whenever the interviewer identified that the respondent provided an inconsistent choice, the interviewer alerted the interviewee of such inconsistency and asked them to review their rating. Inconsistencies were calculated for the scores provided by every participant.

Figure 1 shows a summary of the research methodology used in this study.

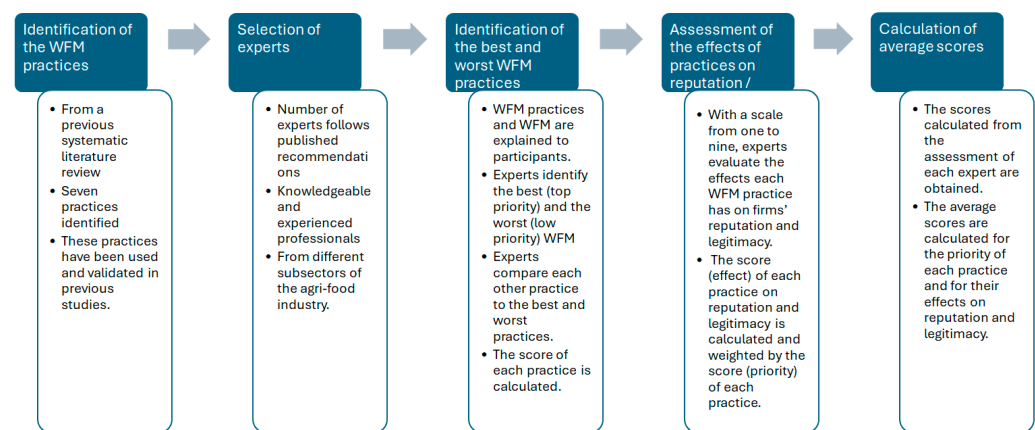


Figure 1. Summary of research methodology.

4. Results

This section presents the results of the application of the BWM to prioritize the seven WFM practices and assess their individual effects on agri-food firms' reputation and legitimacy.

Table 2 displays the best (top-priority) and worst (bottom-priority) WFM practice according to each of the nine experts (represented by the ID En). Practices WF2 (promotion of the WF measurement in the supply chain) and WF5 (use of water-efficient technologies) were often mentioned as the ones with the highest priorities. In contrast, practices WF1 and WF7 (mitigation of contamination risks) were reported as the ones with the lowest priorities. Practice WF1 has also been considered of top priority by two experts.

Table 2. Best and worst practices.

ID	Best	Worst
E1	2	3
E2	2	6
E3	2	7
E4	1	7
E5	5	1
E6	5	1
E7	1	2
E8	3	1
E9	5	1

In order to reach the final weights for the prioritization criteria, average weights (arithmetic mean) were calculated considering the assessment of the nine individual experts. The average weights are presented in Table 3 (as a result of the application of the BWM). The results of the analysis revealed that the following scores determine the priority of the WFM practices: WF2 (0.191), WF5 (0.171), WF7 (0.143), WF6 (0.140), WF3 (0.128), WF1 (0.114), and WF4 (0.114).

Table 3. Major criteria weights.

ID	WF1	WF2	WF3	WF4	WF5	WF6	WF7
E1	0.061	0.356	0.037	0.163	0.163	0.098	0.122
E2	0.073	0.548	0.082	0.082	0.082	0.049	0.082
E3	0.142	0.284	0.114	0.142	0.142	0.114	0.063
E4	0.357	0.150	0.112	0.112	0.150	0.090	0.029
E5	0.020	0.118	0.196	0.118	0.216	0.118	0.216

Table 3. *Cont.*

ID	WF1	WF2	WF3	WF4	WF5	WF6	WF7
E6	0.036	0.080	0.160	0.080	0.386	0.160	0.096
E7	0.286	0.038	0.054	0.127	0.095	0.190	0.209
E8	0.025	0.058	0.233	0.096	0.096	0.233	0.258
E9	0.023	0.092	0.161	0.103	0.207	0.207	0.207
Final score	0.114	0.191	0.128	0.114	0.171	0.140	0.143

Table 4 displays the average effects the WFM practices have on legitimacy. The practice that has the highest effect on firms' legitimacy, according to the panel of experts, is WF5 (use of water-efficient technologies). In contrast, the one with the lowest effect on legitimacy is practice WF4 (auditing and control systems). The final score has been calculated as the average (arithmetic mean), considering the scores provided by each expert.

Table 4. Major criteria weights—effects of WFM practices on legitimacy.

ID	WF1	WF2	WF3	WF4	WF5	WF6	WF7
E1	8	7	9	6	7	8	9
E2	9	2	9	9	9	9	9
E3	8	9	7	7	7	6	6
E4	9	7	8	6	7	7	6
E5	5	7	9	9	9	6	9
E6	5	5	2	3	3	3	4
E7	3	3	7	3	2	2	7
E8	7	8	9	8	7	6	7
E9	5	5	9	5	9	9	9
Final score	0.112	0.138	0.122	0.103	0.157	0.131	0.141

Table 5 displays the average effects WFM practices have on reputation. The practice that has the highest effect on firms' reputation, according to the panel of experts, is WF2 (promotion of WF measurement). In contrast, the one with the lowest effects is WF1 (adoption of national and international standards). The final score has been calculated as the average (arithmetic mean), considering the scores provided by each expert.

Table 5. Major criteria weights—effects of WFM practices on reputation.

ID	WF1	WF2	WF3	WF4	WF5	WF6	WF7
E1	7	8	9	7	7	8	9
E2	9	9	9	9	9	9	9
E3	8	9	7	6	7	6	7
E4	8	7	8	7	6	7	7
E5	7	7	9	8	9	5	9
E6	7	6	3	5	4	6	3
E7	3	3	7	3	3	2	7
E8	8	5	9	8	7	6	7
E9	3	3	9	7	9	9	9
Final score	0.107	0.185	0.128	0.110	0.168	0.138	0.140

Our study also identified the main barriers to WFM implementation, according to the opinion of the panel of experts. They were asked about these barriers in an open question; that is, they did not select the barriers from a list of alternatives. This type of question was preferred so that respondents could freely identify the main barriers according to their

opinions. These barriers are depicted in Table 6, along with the number of respondents that mentioned them as a barrier to WFM implementation.

Table 6. Barriers to implementation of WFM practices.

Barrier Description	Number of Respondents That Mentioned the Barrier
Lack of financial resources/high costs/investments	5
Lack of regulations/standards	2
Lack of coordination with stakeholders	1
Lack of controls	1
Technical knowledge	1
Investments in technology	1
Culture	1
Political influences	1
Natural risks	1

As displayed in Table 6, most respondents (five out of nine) considered that the lack of financial resources is the main barrier to WFM adoption. Two respondents considered that a lack of regulations and standards also hampers WFM implementation. This finding highlights the urgent need for government intervention to foster WFM implementation, either by providing financial assistance to WFM or defining regulations to establish guidelines, requirements, and restrictions related to WFM. Other barriers like lack of control, need for technical knowledge, and need to invest in technology were mentioned only by one respondent each.

5. Discussions and Contributions

This study determined the priority (importance) of seven different WFM according to nine experts from the agri-food industry. Our study determined a numerical priority for these practices. This finding is helpful for companies that are not capable of developing a complete program of WFM adoption since they do not have enough resources to implement all the required practices. By knowing the importance of each practice, managers and farmers can select the practices that will likely bring the greatest benefits to their businesses.

This study also determined the effects of each of these seven practices on firms' reputation and legitimacy. Our study showed that the practices that have the highest effects on reputation and legitimacy are WF2 (measurement of the WF throughout the supply chain) and WF5 (adoption of water-efficient technologies). The practices with the lowest effects on reputation and legitimacy are WF1 (adoption of national and international standards) and WF4 (establishment of water auditing and control systems). These findings complement the general prioritization of WFM practices by showing which practices have the greatest effects on reputation and legitimacy, which can guide farmers to make more informed decisions.

Practice WF2 (promotion of WF measurement) was identified as the most vital by the panel of experts, with a score of 19.1%. The adoption of this practice includes measuring WF not only in the context of firms' operations but also in the supply chain, making the adoption of this practice more challenging. The importance of this practice might be interpreted by the fact that supply chain partners have been increasingly held accountable for the environmental and social impacts of the production chain [107]. Thus, collaboration relationships are necessary to achieve better environmental and societal outcomes [108]. The promotion of WF measurement has also been reported as the practice that mainly impacts firms' reputation, which highlights the importance of measurement as a way of controlling the WF through supply chains.

The practice of adopting water-efficient technologies (WF5) has been prioritized as the second most important by the panel of experts, with a score of 17.1%. Water governance strongly depends on the technical capability to quantify water resources [109]. In the agri-food industry, digital technologies like sensors, remote data collection, and artificial intelligence contribute to the reduction of production costs [110] and water usage [111], the estimation and prediction of water quality [112], modeling the WFs [113], and the improvement of water efficiency [114]. Technology also plays a relevant role in water reuse and recycling. Agricultural water use is heavily impacted by irrigation efficiency, which can be enhanced through technological advancements [11]. This finding shows that digital technologies such as sensors, data analysis techniques, and artificial intelligence highly contribute to the effective management of water resource usage.

Practice WF7 (mitigation) of risks has been considered the third most essential (14.3%) by the experts, and practice WF3 (identification of contamination risks) has been considered the fifth most crucial (12.8%) by the experts. These practices are related since both correspond to risk management. Firms' operations can have impacts on local water resources. In fact, agricultural activities and pesticide usage are considered the main risk factors for European surface water bodies. Hence, mitigation measures include the reduction of pesticide use and the prevention of their transport to non-target aquatic environments [115]. Using wastewater for irrigation also may cause adverse environmental impacts by the contamination of crops, soil, and water [116]. Pollution by insecticides poses high risks to aquatic ecosystems [117]. Risk analysis studies assess contamination pathways in water reuse practices [118]. Our study's results corroborate previous research findings that highlight the need to implement measures to stop pesticide contamination [119]. Including pollution risks in WF management is relevant because it has a high impact on biodiversity and reduces water availability in sectors with high water quality requirements [120]. This outcome highlights that risk management activities are necessary to identify threats and plan responses to reduce the negative consequences of adverse events on water resources.

Water reuse and recycling (WF6) has been considered the fourth highest priority, with a score of 14.0%. Water reuse reduces the dependence on natural water resources [121]. Sources of reused water include treated municipal wastewater, onsite collected water, industry process water, and stormwater [122]. Water reuse occurs when wastewater is directly used in other activities [123] and when it presents the lowest concentration of polluting materials from agricultural activities [124]. It requires specific treatment technology to reduce potable water use [125]. Water reuse has been increasingly utilized in the world, especially in Europe, America, China, and Australia [126].

Water recycling technologies include the processes and equipment necessary to treat, store, and distribute used water [123]. Some of the benefits of recycling wastewater in agricultural environments include the protection of freshwater resources, the management of harmful components to the environment, and the economic gains due to the reduction of new water resources [126]. Previous research considers that further studies are required to investigate the impact of water recycling on crop yield across different climatic and site conditions [127]. There is a shortage of skilled human resources in developing countries to meet the challenges of water recycling and reuse [126]. Droughts and growing populations are reasons for fostering water reuse policy adoption [122].

The practice of adopting global and national WF standards (WF1) obtained a final score of 11.4%. A typical WF standard comprises activities like data collection, validation, relating, and aggregation for water-related inputs and outputs of the unit process. These standards include the calculation of both the direct and the indirect WF [36]. Currently, some WF standards are well-known, like the "Environmental management—WF—principles, requirements, and guidelines"—ISO 14046 [128], which assesses the use of water and its

environmental impacts [129], and the global WF standard published by the Water Footprint Network that can calculate the WF at company and product levels [36]. National standards should also be followed as they might be required to comply with local norms or specific industries. Researchers suggest that, in developing countries, it is necessary to support the implementation of policies and detailed standards [36]. The lower priority given to WF standards shows that experts consider strict compliance with their guidelines not to be a top priority and would not be highly recommended for effective water resources management.

The practice of performing auditing and control (WF4) has been assigned a score of 11.4%, considered the least important WF practice by the expert panel, together with WF1. Water audits can determine the amount of water lost in a process, unauthorized or illegal withdrawals from water systems, and the cost of such losses. They can support the correct diagnosis of water-related problems, assess the performance level and efficiency of a system, and suggest remedial measures for the reduction of water loss [130]. Aivazidou et al. [14] stated that auditing and control systems allow us to identify processes that generate water losses. In this sense, companies that adopt these quality systems will be sure that their initiatives have been implemented correctly and that they comply with internal or external standards. According to the experts, this is the practice with the lowest impact on firms' reputation and legitimacy. Interestingly, the practice of water auditing and control systems (WF4) was found to have the least impact on both reputation and legitimacy, which may suggest that while such systems are essential for internal management, they may not be as visible or impactful to external stakeholders.

The final ranking of WFM practices represents the importance given by the panel of experts to these different WFM practices. Prioritization of alternatives is usually done in situations in which resources are limited. In the context of this study, firms with limited resources could be restricted to adopting just some of the WFM practices. Thus, the ranking of practices reported in this study could also be interpreted as the order in which it would be advisable to implement these practices in companies. This rationale does not imply that there are dependencies among these practices, but the implementation of lower-priority practices could benefit from the early adoption of high-priority initiatives. Taking this into account, the highest priority practices of promoting the measurement of WF into the whole supply chain and using water-efficient technologies could be the cornerstone for the implementation of other practices. The lower priority practices of following national and international standards and implementing auditing and control systems should be implemented after the implementation of other practices due to the nature of these activities and the required maturity to execute them.

A very similar prioritization presented for WFM practices was obtained for the effects of these practices on firms' reputation and legitimacy. Gaining legitimacy is of particular relevance in the context of WFM since drought effects have been only recently perceived by most companies and consumers. In addition, firms' ability to manage water resources will have positive effects on their reputation. This study extends previous research that has reported that the set of WFM practices has a positive and significant impact on firms' reputation and legitimacy [22]. This study presents a novel contribution to the literature by identifying and quantifying the most priority WFM practices to achieve this goal.

5.1. Managerial Contributions

This study answers calls for further evaluation of legitimacy and reputation in different industries [55]. Our results corroborate previous research that reported that green management practices like WFM initiatives improve firms' reputations, competitiveness, and market positioning [131]. In addition, Richter [132] states that water management bolsters businesses' reputations in relation to sustainability and attracts new customers.

Our study is also aligned with previous studies that consider that water conservation leads to cost savings and enhanced reputation [4].

The findings of our study are aligned with a previous study that found that companies engaging in managing and evaluating water resources enhance their legitimacy [133]. Previous research considered that legitimacy is associated with corporations that tackle water issues, manage corporate engagement on water; follow guidelines for corporate water stewardship, and openly communicate their water management initiatives [134]. Finally, our study is aligned with previous research that has stated that if a business wastes water or adversely impacts the local water quality, its legitimacy will be challenged [52].

Our study presents valuable contributions to managers and farmers since it presents a path for the adoption of WFM practices according to the priorities defined by experts. Companies with limited resources for the development of water management programs should first invest in the promotion of WF measurements across their supply chains, as well as in technologies for the efficient use of water resources. These two practices establish the necessary structure to adopt other practices. Auditing and control systems and alignment with national and international standards are practices that should be implemented only when firms achieve a certain level of maturity on the adoption of WFM practices.

5.2. Theoretical Contributions

Our study's findings can also be analyzed under the lens of legitimacy theory [35], which states that a firm reacts to society's expectations. It has been used in research in the field of sustainability to justify why firms are concerned about their social and environmental performance [64]. This reactive theory also postulates that firms are successful when there is a congruence between the firms' activities and society's expectations. When firms report their sustainable performance, they create an impression that they fulfill social needs [62]. Our study showed that when firms are capable of reporting the adoption of WFM practices, especially those related to the adoption of WF measurement and the use of water-efficient technologies, they are more likely to increase their legitimacy and reputation.

According to the LT, legitimacy is comprised of different dimensions, some of which are relevant for the analysis of this study's findings, like moral legitimacy and associational legitimacy. Moral legitimacy refers to the judgments about whether an activity is correct based on common normative assessments. Associational legitimacy is related to establishing connections with other firms whose legitimacy or reputation has already been confirmed in a way that firms might be acknowledged by their relationships with reputable organizations [135].

First, this study extends LT by identifying specific WFM practices that are positively related to firms' reputation and legitimacy. Existing works have reported a general effect of WFM practices on firms' reputation and legitimacy [22]. However, to the best of our knowledge, researchers have failed to analyze the individual effects these practices have on these aspects of firms' performance. Second, this study reported positive effects of some WFM practices on moral legitimacy, which is closely associated with the general definition of legitimacy informed to the experts who participated in this study. Third, by showing that the promotion of WF measurement through the supply chain is one of the WFM practices with the highest effects on firms' legitimacy, this study reinforces the importance of associational legitimacy in a way that partners can benefit from the positive outcomes of WFM practice in the focal firm.

This study also offers a novel theoretical application of the BWM, an MCDM that has been applied in several other different contexts. Our study demonstrates that the method has a suitable application for the selection and prioritization of WFM practices in the agri-food industry.

5.3. Contributions to Policymaking

This study also offers some contributions to policymakers. Our study highlighted the importance of the WFM practices associated with the promotion of WF measurement and the adoption of water-efficient technologies. These findings can support and guide the development of specific water-related policies focused on the agri-food industry. Based on the concept of WFM used in this study, the promotion of WF measurement should be carried out in the whole supply chain, which implies the participation of stakeholders that may lack the required capabilities and resources (e.g., technical knowledge, technology, human resources). Hence, public policies should support the adoption of innovative technologies and training for the implementation of WFM practices. Policymakers should also consider that experts reported that the lack of resources is the main barrier to the implementation of WFM practices.

Our study identified that the main barriers to WFM implementation are a lack of financial resources and a lack of regulations. In fact, the lack of financial resources was mentioned as one of the main barriers to WFM by half of the experts in the panel, which shows that there may be a certain consensus in the agri-food industry that more government support to foster WFM practices is necessary. In fact, this finding is aligned with previous research that has shown that government support has a positive but low effect on WFM [22].

6. Conclusions

This study determined the numerical priority (importance) of seven different WFM according to nine experts from the agri-food industry. This finding is useful for companies that are not capable of developing a complete program of WFM adoption since they do not have enough resources to implement all the required practices. By knowing the importance of each practice, farmers can select the practices they think will bring the greatest benefits to their businesses. Our study identified that the main barriers to WFM implementation are a lack of financial resources and a lack of regulations. This study contributes to the agroecological transition, which is a suitable path toward achieving sustainable food systems and socio-ecological systems.

This study also determined the effects of each of these seven practices on firms' reputation and legitimacy. Our study showed that the practices that have the highest effects on reputation are the ones related to the promotion of WF measurements across the supply chain and the adoption of water-efficient technologies. These findings are useful for companies that are not capable of developing a complete program of WFM adoption since they do not have enough resources to implement all the required practices. Our study showed that top-priority practices also have the potential to have the most significant effects on legitimacy and reputation. These findings complement the general prioritization of WFM practices by showing which practices have the greatest effects on reputation and legitimacy, which can guide farmers to make more informed decisions.

Although this study followed a strict methodology, it is not free of limitations. Some of these limitations are associated with the use of the BWM and have been reported in previous research. The criteria for selecting the best and worst alternatives are not necessarily explicit or objective. In addition, each one of the participating experts will likely use diverse criteria to make decisions. Moreover, in several real-world problems, there are no unique best and/or worst criterion/criteria [136]. Another limitation of the expert selection process is taking into account existing cultural nuances. Also, the BWM method assumes that experts have uniform knowledge and experience, which may not always be the case. Despite its robustness and reliability, the sole use of BWM may not be sufficient to gain a deep understanding of complex issues, such as the adoption of WFM practices or their effects on firms' reputation and legitimacy. Therefore, studies using BWM support the

identification of future research agendas involving qualitative investigations to carry out a deeper analysis of the findings, provide a more thorough comprehension of the context, and support more effective decision-making [83]. Then, research using BWM usually does not delve into analyzing the interconnections among the analyzed factors. Thus, it is expected that future studies will conduct expert interviews and surveys to explore the priority and influence of these factors further. Finally, research on BWM opens avenues for future research on (1) comparative analysis with other MCDMs, (2) extending analyses to different sectors and industries, and (3) the development of quantitative models [137].

Apart from the common limitations of the BWM presented in related studies, we may highlight specific limitations to this study. The first one is the number of experts interviewed. Despite the fact that expert selection was based on recommendations of previous studies and the fact that a varied panel of experts was assembled, the results are influenced by the participating experts. Second, this study was performed in Chile, a Latin American agricultural commodities exporting emerging economy, so the country's business environment influences our findings. Future studies should investigate the prioritization of WFM practices in developed countries. Third, this study analyzed a certain subset of WFM practices identified in a previous study [30]. Although these practices have been previously validated, other WFM practices could be explored by future research.

This study opens some opportunities that can be explored by future research. Based on the prioritization of WFM practices reported in this study, researchers could propose and assess WFM maturity models to guide the implementation of WFM practices and to allow for the adoption level among firms. Second, due to the increasing awareness and importance of environmental issues, we suggest that the influence of customer pressure on the adoption of WF practices be further investigated. Third, a more thorough understanding of the experts' reasoning for prioritizing the WFM practices could be explored. Fourth, future studies could compare the prioritization of firms in different scenarios, such as companies of different sizes (small x large companies) or segments (agri-food production, industrial activities, among others). Finally, researchers could execute longitudinal case studies to follow and monitor the implementation of WF programs in agri-food firms to assess the benefits of these practices over time.

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Abbreviations

The following abbreviations are used in this manuscript:

AFSCs	Agri-food supply chains
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
BWM	Best–worst method
CEO	Chief Executive Officer
CSR	Corporate Social Responsibility
DEMATEL	Decision-Making Trial and Evaluation Laboratory
GDP	Gross Domestic Product
MCDM	Multi-criteria decision-making
SDG	Sustainable Development Goals
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
VIKOR	VIseKriterijumska Optimizacija I Kompromisno Resenje
WF	Water footprint
WFM	Water footprint management

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