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The Determining Factors for Adopting a Food Safety Management System in Algerian Agri-food Businesses

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Abstract

This article analyses the main factors influencing implementing a food safety management system (FSMS) in Algerian agri-food companies. Our study focuses on 218 companies operating in the agri-food sector. We used the questionnaire and face-to-face interviews to facilitate data collection. We conducted a statistical analysis of linear correlation and a linear logistic model to assess the factors influencing the adoption of systems in these companies. The results of our study indicate that several key factors significantly influence the adoption of FSMS practices in food companies. This includes the age of the company, the age and education level of its leaders, the industry sector of the agri-food businesses, their target market, and the company's size. The results of our study indicate that companies established for 5 to 15 years have a probability of 43.5% and p-value = 0.043 of adopting the FSMS system, while those established for 15 to 25 years have a probability of 37.0% and p-value =0.012. Managers with a university education are very likely (91.3%) to implement an FSMS, with a p-value of 0.043. The analysis also shows that limited liability companies (LLCs) have the highest likelihood of adoption (50.0%, p=0.019) and that businesses targeting both local and international markets have a significant probability of adoption (10.6%, p=0.020). These results highlight the importance of experience, training, and market reach in promoting a Food Safety Management System (FSMS) in the agri-food sector.

***Keywords**: FSMS; Determinant; Adoption, agri-food companies; Algeria.*

Introduction

Since the mid-1980s, agricultural markets in many developing and transitioning countries have shifted from state-controlled to privately governed systems. This transition has led to a significant rise in high-value exports to global retail markets, driving a notable transformation in agricultural value chains characterized by increased coordination and consolidation (Reardon and Timmer, 2007; Reardon et al., 2009). Consequently, the importance of food safety and quality standards has grown, with their scope, diversity, and complexity expanding significantly. Agricultural producers worldwide now face more stringent requirements in key export markets and high-value domestic markets (Faour-Klingbeil and Todd, 2018; Asfaw et al., 2010). The impact of these evolving standards on small-scale farmers in developing countries remains a debated issue in the literature. Recent food safety incidents, such as the melamine-contaminated milk scandal in China and the presence of dicyandiamide (DCD) in New Zealand dairy products, have renewed concerns about dairy product safety (Pei et al., 2011; Montgomery et al., 2020). These incidents highlight the broader risks associated with food safety, which affect public health, the stability of national food markets, and the livelihoods of small-scale producers (Henson and Caswell, 1999; Maestre et al., 2017; King et al., 2017). Animal-derived products, due to their nature, are particularly vulnerable to microbial contamination, posing significant public health risks ranging from mild gastrointestinal discomfort to severe illness (Prache et al., 2022; Ribeiro et al., 2024). The assessment of the implementation of food safety practices in agri-food businesses, specifically in the dairy production sector, relies on a scoring system derived from the extent to which essential practices are adopted. This scoring system measures the effectiveness of these practices in ensuring food safety, taking into account the factors that influence their adoption (Simmons et al., 2007; Soderlund et al., 2008; Pappa et al., 2018). The significance of an FSMS and financial aid in upholding adherence to food safety procedures is occasionally overlooked. Assessing the understanding and implementation of food safety protocols is vital, particularly for perishable items such as milk and milk products, which are susceptible to contamination. Cost-effective behavioral changes, improved infrastructure, and targeted financial support can address many of these issues effectively. By adopting hygienic practices such as using clean utensils, ensuring animal health, maintaining sanitary conditions, and following proper storage and transportation protocols, contamination risks throughout the supply chain can be significantly reduced (Ebert, 2018; Weber and Meemken, 2018). However, structural challenges remain that hinder the ability to ensure food safety at various stages of the supply chain (Marucheck et al., 2011; Astill et al., 2019). Food security is closely tied to producers' understanding and awareness

of food safety requirements. This system security emphasizes the critical role of producers in implementing safety practices and argues that despite existing laws and regulations, food security cannot be guaranteed without increased awareness among value chain participants, particularly producers. Research conducted in various countries indicates that farmers are generally hesitant to implement food safety practices, primarily due to the lack of financial incentives and consumer unwillingness to pay premiums for safer products. (Kumar et al., 2016; Mwambi et al., 2020). The cost of compliance with food safety standards is often inversely proportional to the size of the agri-food business, meaning smaller businesses bear a higher per-unit cost of compliance (Bourlakis et al., 2014; Rabada´n et al., 2019). In addition to business size, the availability of resources, including human capital such as education, expertise, and experience in dairy farming, significantly influences the adoption of food safety practices (Rezaei et al., 2018; Lawton et al., 2024). Other factors, such as marketing channels, demographic characteristics, access to information, and the perceived likelihood of inspections, also play crucial roles in determining the level of adoption (Tonsor et al., 2009; Schoneveld et al., 2019). Furthermore, while farmer training is instrumental in increasing awareness and improving attitudes towards safe dairy production, these changes do not always translate into long-term behavioral shifts. The connection between training, awareness, and attitude is more robust than the link between training and actual food safety practices (Vyas et al., 2020; Feyisa et al., 2024). This study aims to identify the factors that affect the adoption of a food safety system within Algerian agri-food companies. To achieve this, we developed a logistic model to analyse the relationship between different factors and the implementation and adoption of a food safety system in the agri-food companies under study.

Methodology

In our study on the factors affecting the implementation of a Food Safety Management System (FSMS) in Algerian agri-food companies, we gathered information from various government institutions, including the Ministry of Industry, the National Chamber of Industry and Commerce, and the trade departments of the wilayas of Algiers and Blida in northern Algeria. Based on this data, we identified 218 agri-food companies in the study area. To gauge the willingness of these companies to participate in our study, we contacted them by phone. Out of the contacted companies, only 46 agri-food companies have adopted the FSMS system, making up 21% of the surveyed companies. Following this, we distributed questionnaires to the managers to address our expectations.
The questionnaire was carefully designed in collaboration with experts in the agri-food industry and colleagues from ENSA. Before creating this questionnaire, a preliminary survey was conducted to gather the perspectives of the managers of these agri-food companies regarding their behavior, the questions posed to them, and the production methods employed by these companies. Additionally, the survey aimed to evaluate the practicality of our questionnaire in implementing a food safety system. The questionnaire was created and sent to the management of food companies for reading and data collection. This step was followed by a series of face-to-face conversations conducted in several sessions to ensure consistent responses from these managers. This type of discussion allowed managers to openly discuss the adoption of their organizations' food safety systems.

Results and Discussion

Implementing a food safety system in Algerian agri-food enterprises is imperative to enhance a nation's progress and yield advantages for customers. This safety system enables the mitigation of potential hazards and threats that may lead to significant disruptions in the production process of agri-food and processing firms and in the manufacturing of food products.

Characteristics of the Surveyed Agri-food Businesses and their Managers

Table 1 displays the primary attributes of the agri-food enterprises surveyed by the managers in charge of the food safety system. It is important to acknowledge that most of these agri-business (80.5\%) have been operating for over 15 years. The majority of employers surveyed in these companies were university graduates, accounting for 91.3\% of the total. Additionally, 96.6\% of the managers in these companies were aged 31 or older. Most managers (91.3\%) in agri-food enterprises have more than 15 years of experience. The legal status of the companies includes three types: joint-stock company (JSC) with 23.9\% ownership, Limited Liability Company (LLC) with 50\% ownership, and Multinational with 26.1\% ownership. Approximately 97.8\% of enterprises operate within the private sector.
The concept of adopting an FSMS encompasses multiple aspects, including monitoring, traceability, food quality, safety assurance, information collection on food products, storage, sharing, logistics, and marketing. These factors contribute to the value of food products. Each aspect can be considered separately by company employees depending on their position, level of education, and gender. Individuals involved in management and administration (owners, managers, and administrators) perceive the adoption of an FSMS for products as an element that adds value; individuals with substantial knowledge, including high school and university degrees and doctorates, view food safety as a factor that enhances product value (Saurabh and Dey 2021; Corallo et al., 2020). Consumer perceptions of food safety vary based on demographic and socio-economic variables, such as gender, age, educational attainment, and economic status (Waaswa et al., 2021; Rizzo et al., 2024).

Table 1 : Characteristics of the surveyed agri-food businesses and their managers (n=46).

Charachteristics	Frequencies (%)
Year of setting up the company	
less than 5 years	4,3 (2)
Between 5 and 15 years	43,5 (20)
Over 25 years	15.2 (7)
Manager's level of education	
Secondary	8.7 (4)
University	91.3 (42)
Age of manager	
30 years or less	4.3 (2)
between 31 and 50 years old	63 (29)
Over 50 years old	32.6 (15)
Nnumber of years' experience of the manager in the food industry	
less than 5 years	8,7 (4)
Between 5 and 15 years	32,6 (15)
Between 15 and 25 years old	43,5 (20)
Over 25 years	15,2 (7)
Company legal status	
JSC	23,9 (11)
LLC	50,0 (23)
Multinatioanl	26,1 (12)
Business sector	
Public sector	2.2 (1)
Private sector	97.8 (45)

Support provided by cooperation programs

The table 3 presents key insights into the sectoral distribution, professional affiliations, and support from cooperation programs among surveyed companies. It reveals that the majority of companies operate in the private sector (97.8%), with a smaller portion in the public sector (2.2%). A significant 61.4% of the companies are affiliated with professional associations or clusters, indicating active engagement in industry networks, while 38.6% are not affiliated. Membership in professional associations is diverse, with notable participation in Association of Algerian Beverage Producers (APAB) (32.1%) and Club of Entrepreneurs and Industrialists of Mitidja (CEIMI) (35.7%). Additionally, the table highlights that over half of the companies (51.1%) have not received support from cooperation programs, with Support program for SMEs (PMEII) being the most accessed program (22.2%), United Nations Industrial Development Organization (UNIDO) with 11.1% and other cooperation programs such as Support program for SMEs (PMEI), Economic Diversification Program (DIVECO) and United Nations Development Programme (UNDP) with a low rate. These findings underscore the dominance of the private sector, the importance of professional networks, and the mixed levels of engagement with external support programs within the industry.

Increasing investments in agricultural research and development is essential for boosting farm productivity worldwide, particularly in developing countries, and is widely recognized as a cornerstone for ensuring long-term global food security (Alston et al., 2009; Lobell et al., 2013). Tradi ²tionally, the public sector has spearheaded investments in agricultural research and development, largely due to market failures and the relatively small scale of agricultural enterprises. However, in recent years, the private agro-industry has begun to take on a more prominent role, complementing and sometimes even surpassing public sector efforts (Fuglie and Toole, 2014). Recent estimates indicate that global research and development expenditures in the food and agriculture sector have seen more rapid growth in the private sector compared to the public sector. In developed countries, private research and development investments now exceed those of the public sector, reflecting a shift in the dynamics of innovation and development within the industry (Fuglie et al., 2018; Anderson, 2018). Companies are associated with professional associations or clusters, which indicates their active involvement in industry networks. Inclusion involves integrating small-scale producers into existing local knowledge exchange networks, which are designed to meet the demands of agribusiness markets. The configuration of social networks offers valuable insights into the relationships between individuals, their social capital, the breadth of knowledge accessible to them, and the resources they can acquire (Carpenter et al., 2012; Anderson, 2018). Network governance elucidates the process by which new technologies and practices are introduced, as well as the role played by various actors (Mansuri and Rao, 2013; Mansuri and Rao, 2012).

The competitiveness of agri-food firms is intricately tied to their capacity to engage in collaboration with other companies and associations. The growing need for collaboration highlights the importance of forming closer, enduring working relationships and even alliances with suppliers at various stages of the supply chain. This is done

to create supply chains that are increasingly efficient and responsive, ultimately providing exceptional value to customers (Lamming et al., 1996; Willem Ziggers and Trienekens, 1999; Benos et al., 2016).

Services from the quality institutions

The table 4 reveals distinct patterns in how companies engage with various quality institutions. Algerian Accreditation Organization (ALGERAC) shows low engagement, with only 15.2% of companies requesting its services, while 80.4% have not, suggesting a need for greater outreach or demonstration of value. In contrast, Algerian Institute of Standardization (IANOR) and National Office of Legal Metrology (ONML) have very high engagement rates, with 89.1% of companies utilizing their services, reflecting strong industry trust and reliance on these institutions for maintaining standards. National Algerian Institute of Industrial Property (INAPI) is also widely used, with 87.0% engagement, though a slightly higher 13.0% of companies do not use its services. The data indicates that while some institutions are well-integrated into business practices, others like ALGERAC may benefit from strategies to increase awareness and perceived value among companies, highlighting opportunities for improving the overall effectiveness of quality assurance efforts across the sector. The trade of agricultural and food products, both within Algeria and globally, is increasingly dominated by supply chains controlled by agribusinesses. These supply chains impose a growing number of standards on suppliers to secure market access (Tallontire, 2007; Tallontire et al., 2011; Havinga, 2018). Often, these standards take the form of voluntary norms established and monitored by new alliances between private and non-governmental sector actors, collaborating through private standards initiatives. These public-private sustainability initiatives, represent a new mode of governance in the agri-food sector, raising important questions about sustainability and the democratic legitimacy of these initiatives (Garbutt and Coetzer, 2005). The adoption of private forms of regulation, such as standards, by Algerian agri-food companies has become a prominent subject in the literature on agri-food, trade, and value chains.

Table 3. Distribution of company sector, professional affiliations, and support from cooperation programs.

Responses	**Valid Percentage**
Sector activity of the company	
Public sector	2.2
Private sector	97.8
Are you affiliated with a professional, employers' association, or a cluster?	
Yes	61.4
No	38.6
Professional Association	
APAB	32.1
FCE	25.0
CEIMI	35.7
CCI	3.6
Has your company ever been supported by cooperation programs such as PMEI and PMEII?	
PMEI	6.7
PMEII	22.2
UNDP	4.4
UNIDO	11.1
None	51.1
DIVECO	4.4

Table 4. Algerian agri-food businesses seek help from reliable institutes to guarantee the authenticity of their products.

Responses	Frequencies (%)
Has your company ever requested services from the quality institutions? AILGERAC	
Yes	15.2
No	80.4
Not familiar with these institutions	2.2
New company	2.2
Has your company ever requested services from the quality institutions? IANOR	
Yes	89.1
No	10.9
Has your company ever requested services from the quality institutions? ONML	
Yes	89.1
No	10.9
Has your company ever requested services from the quality institutions? INAPI	
Yes	87.0
NO	13.0

Perceptions of quality concept

The table 5 provides a comprehensive overview of how respondents perceive quality in various aspects of their agri-business operations. The majority view quality as essential for maintaining a good company image, with 65.2% strongly agreeing and 34.8% somewhat agreeing, indicating a near-universal recognition of its role in shaping public perception. Quality is also overwhelmingly associated with meeting customer needs, as 71.7% strongly agree and 26.1% somewhat agree, emphasizing its critical importance in customer satisfaction. Similarly, conformity to standard norms is widely regarded as a key component of quality, with 91.3% strongly agreeing, reflecting a strong consensus on the importance of compliance with established standards. However, opinions are more divided when it comes to linking quality with profit improvement and luxury products. While a majority still sees a connection between quality and profit, with 26.1% strongly agreeing and 28.3% somewhat agreeing, a significant portion of respondents are skeptical, with 30.4% strongly disagreeing. The perception of quality as synonymous with luxury is even more varied, with a nearly even split between those who agree and those who do not, highlighting diverse views on whether high quality necessarily implies luxury. Overall, the results underscores the multifaceted nature of quality and its varied implications depending on the business context. The managers interviewed in this customer study perceive quality as an essential element of a food company's reputation. The widespread agreement, with a majority of individuals expressing either strong or moderate agreement, demonstrates the nearly universal acknowledgment that quality plays a crucial role in shaping a company's reputation in the market. This image is especially evident in the agri-food industry, where quality encompasses not just the product itself, but also the company's dedication to sustainability and ethical standards (Borsellino et al., 2020).

Consumers' opinion of quality has a direct impact on a company's image. In the era of digitalization, where information spreads rapidly, it is crucial to uphold a reputation for superior products in order to preserve a favorable public perception. Companies that are viewed as consistently delivering high-quality products tend to benefit from increased consumer trust and loyalty, which is important for sustaining a positive reputation (Fernández et al., 2024). The findings offer useful insights on the perception of quality in the context of luxury products and adherence to established standards. De Barnier et al (2012) explore the multifaceted perspectives of luxury, highlighting the strong connection between the excellence of luxury goods and their rarity, skilled craftsmanship, and brand legacy. This is consistent with the conventional perspective that luxury is determined by exceptional levels of excellence and scarcity (De Barnier et al., 2012).

Relationship Between Enterprise Longevity and Quality System Adoption

Table 6 presents the crosstabulation analysis, revealing significant trends in the adoption of quality systems HACCP, ISO 22000, and FSSC 22000 across various agribusiness characteristics. Among newly established agri-business (less than 5 years), HACCP and FSSC 22 000 are equally preferred, while those in operation for 5 to 15 years favor HACCP (75%), with minimal adoption of ISO 22 000. Interestingly, older enterprises (15-25 years) show a higher inclination towards ISO 22 000 (41.2%), with no adoption of FSSC 22 000.

Table 5. Perceptions of quality and its impact on agri-business

Responses	Frequencies (%)
What does quality mean to you: A good company image	
Strongly agree	65.2
Somewhat agree	34.8
What does quality mean to you: Profit improvement	
Strongly agree	26.1
Somewhat agree	28.3
Somewhat disagree	15.2
Strongly disagree	30.4
What does quality mean to you: Meeting customer needs	
Strongly agree	71.7
Somewhat agree	26.1
No opinion	2.2
What does quality mean to you: Luxury products	
Strongly agree	30.4
Somewhat agree	32.6
No opinion	8.7
Somewhat disagree	13.0
What does quality mean to you: Conformity to standard norms	
Strongly agree	91.3
Somewhat agree	6.5
No opinion	2.2

The adoption of quality systems across agri-business of different ages reflects strategic choices tied to their development stage. Newly established companies (under 5 years) often prefer HACCP and FSSC 22 000 due to their flexibility and focus on food safety, which are crucial for building market trust. Enterprises that have been operating for 5 to 15 years show a strong preference for HACCP, as maintaining stringent safety standards becomes key to expanding their market share. The minimal adoption of ISO 22 000 in this group might be due to the complexities and costs associated with ISO certification, which are typically more accessible to older, more established companies. Companies with 15 to 25 years of operation increasingly favor ISO 22 000 (41.2%), likely due to its comprehensive integration with broader quality management systems, enhancing their competitiveness and credibility in international markets (Karaman et al., 2012; Soon and Baines, 2013; Herath and Henson, 2010). Overall, HACCP remains the most widely adopted system (69.6%), particularly among older enterprises and those with legal statuses like JSC and LLC agri-food compagnies. The preference for HACCP is based on its demonstrated efficacy in mitigating food safety hazards and assuring adherence to regulatory requirements, which are essential for upholding market reputation and stability. HACCP is highly advantageous for organizations in the agri-food industry that prioritize long-term performance because the haccp system is less costly than ISO 22000 and FSSC 22000 standards (Mayett-Moreno and López Oglesby, 2018; Beesterm¨oller et al., 2018). However, multinational agri-business demonstrate a more diverse adoption pattern, including a higher adoption rate of FSSC 22 000 (33.3%). The analysis also indicates that managers with higher education levels and those over 50 years are more likely to adopt a broader range of quality systems, including ISO 22 000 and FSSC 22 000, compared to younger managers and those with secondary education, who predominantly opt for HACCP. These findings underscore the varying preferences for quality systems based on enterprise age, legal status, and manager characteristics, with a clear preference for HACCP across most categories. The adoption of quality systems by multinational agri-business often reflects their need to meet diverse regulatory requirements and market demands across different regions. The higher adoption rate of FSSC 22 000 (33.3%) among multinationals can be attributed to its comprehensive approach, which integrates ISO standards with additional requirements, making it suitable for global operations where stringent food safety protocols are necessary (Mensah & Julien, 2011). FSSC 22 000 is particularly favored in agri-business where supply chains span multiple countries, and where certification can enhance credibility and competitiveness (Overbosch and Blanchard, 2023; Mensah and Julien, 2011).

The table 6 also highlights key findings regarding the adoption of quality systems across various agri-business characteristics. Agri-business targeting local markets predominantly adopt HACCP (81.3%), while those with broader scopes, such as international markets, favor ISO 22 000 (75%). Agri-business in the African market show an equal split between ISO 22 000 and FSSC 22 000, with no adoption of HACCP. Additionally, older agri-business and those with a legal status of JSC or LLC are more likely to adopt HACCP and ISO 22 000, whereas multinationals demonstrate a more diverse pattern, including FSSC 22 000 standards. Managers with higher education levels and older managers tend to adopt a broader range of systems, with a strong preference for HACCP across all age groups. Overall, HACCP remains the most commonly adopted system (69.6%), reflecting its widespread acceptance across different market scopes and enterprise characteristics, while ISO 22 000 is preferred by those with international aspirations.

The Pearson's chi-squared test value of 0.025 indicates a significant relationship between a business's age and its choice of quality management system, suggesting that these choices are influenced by the maturity and experience of the agri-business. Older businesses are more likely to adopt established systems like HACCP, while newer companies tend to favor more standards such as FSSC 22 000. This significant association underscores the importance of aligning quality system adoption with the specific operational and strategic needs of businesses at different stages of their development. Understanding this relationship can guide better decision-making in quality management practices (Ghobadian and Gallear, 1996; Davila et al., 2009).

The chi-square test value of 0.0125 indicates a significant correlation between a manager's education level and the choice of FSMS in agri-food businesses. Managers with secondary education predominantly adopt HACCP, while those with a university education are more likely to implement advanced systems like ISO 22 000 and FSSC 22 000. This suggests that higher education levels provide managers with the knowledge and confidence to adopt more complex quality systems, emphasizing the role of education in strategic decision-making in FSMS (Mensah and Julien, 2011; Hu et al., 2023). The chi-square value of 0.0250 suggests a significant relationship between manager age and the adoption of FSMS. Managers aged 30 years or less exclusively adopt HACCP, while those aged 31-50 and over 50 show more diversity, including ISO 22000 and FSSC 22000. This indicates that younger managers prefer simpler systems, while more experienced managers opt for more comprehensive systems that align with advanced operational needs (Keen, 1993; Davila, 2005).

The chi-square coefficient of 0.038 indicates a statistically significant association between the legal status of a corporation and its selection of quality management systems (Kafetzopoulos and Gotzamani, 2014; Ferrón Vílchez and Darnall, 2016). The majority of JSC firms (81.8%) implement the HACCP system without adopting the FSSC 22000 certification. On the other hand, LLC agri-business also favor HACCP (73.9%), but they also demonstrate some utilization of the ISO 22000 and FSSC 22000 certifications. Multinational corporations exhibit a higher level of diversity, as seen by 50% of them adopting the HACCP system and 33.3% implementing the Food Safety System Certification (FSSC) 22000. This trend highlights their requirement for strong worldwide standards. It may be inferred that the legislative framework has a substantial impact on the decisions about the deployment of an FSMS.

Table 6. Test of association between factors affecting the adoption of a system in agri-food businesses.

What is the nature of this system?				Pearson Khi-deux coefficient
	HACCP	ISO 22 000	FSSC 22 000	
Year of setting up the business				
less than 5 years	50,0%(1)	0%(0)	50,0%(1)	0.025
Between 5 and 15 years	75,0%(15)	5,0%(1)	20,0%(4)	
Between 15 and 25 years old	58,8%(10)	41,2%(7)	0.0%(0)	
Over 25 years	85,7%(7)	14,3%(1)	0.0%(0)	
Manager's education level				
Secondary	100,0%(4	0,0%(0)	0,0%(0)	0.0125
University	66,7%(28)	21,4%(9)	11,9%(5)	
Manager age				
30 years or less	100,0%(2)	0,0%(0)	0,0%(0)	0.0250
between 31 and 50 years old	69,0%(20)	20,7%(6)	10,3%(3)	
over 50 years	66,7%(10)	20,0%(3)	13,3%(2)	
Legal status of the business				
JSC	81.8%(9)	18.2%(2)	0%(0)	0.038
LLC	73.9%(17)	21.7%(5)	4.3%(1)	
Multinational	50.0%(6)	16.7%(2)	33.3%(4)	
Your company's target market				
Local	81.3%(26)	9.4%(3)	9.4%(3)	0.015
North African	66.7%(2)	0%(0)	33.3%(1)	
African	0%(0)	50%(1)	50%(1)	
International	25,0% (1)	75,0% (3)	0%(0)	
Local and international	60.0%(3)	40.0%(2)	0%(0)	

The chi-square coefficient of 0.015 indicates a significant relationship between a company's target market and the adoption of quality management systems (Talib et al., 2013; Willar et al., 2016). Local market-focused companies predominantly adopt HACCP (81.3%), while those targeting North African and broader African markets show a preference for ISO 22000 and FSSC 22000, with 50% of African market-oriented companies adopting each. This suggests that companies targeting wider markets adopt more comprehensive and globally recognized standards to meet diverse regulatory and consumer expectations. The chi-square coefficient of 0.015 reveals a significant relationship between a company's market scope (international versus local and international) and its adoption of quality management systems (Spadoni et al., 2014; Carrillo-Labella et al., 2020). Companies targeting international markets primarily adopt ISO 22000 (75%), while those operating both locally and internationally show more diversity, with 60% adopting HACCP and 40% ISO 22000. This indicates that companies engaged in international markets prioritize globally recognized standards like ISO 22000 to meet international regulations and market demands.

Logistic Regression in Assessing HACCP System Adoption Determinants

This study uses a logistic regression model to determine the characteristics influencing the adoption of an FSMS in agri-food compagnies. The study employs a linear model aligned with our research aims and the dependent variables influenced by the deciding factors. This model aims to analyze the anticipated goals, which are often continuous, assuming a linear connection between these goals and the independent components being studied. Simple linear regression examines the impact of a solitary independent variable on a continuous outcome, whereas multivariate linear regression assesses the influence of many factors concurrently. By accounting for the impacts of other variables, researchers can see the distinct contributions of each variable, therefore gaining a comprehensive picture of how various factors influence the outcome. The fundamental equation for multiple linear regression has several independent variables and is described as follows (Kafetzopoulos and Gotzamani, 2014; Herath& Henson 2010):

$$\hat{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i \quad (1)$$

The constituents of this equation are as follows: $\hat{Y}$ represents the predicted continuous outcome,
while $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i$ represents the linear regression equation for the independent variables in the model.
The term β_0 refers to the intercept of the regression line, which represents the point where the line intersects the vertical Y-axis. This is regarded as an immutable value. The expression $\beta_1 X_1 + \beta_2 X_2 + \ldots$ represents a linear

combination of variables. The value of each independent variable (X_i) is multiplied by its appropriate beta coefficient (β_i) to obtain the weighted value ($\beta_i X_i$). Beta coefficients represent the rate of change of the dependent variable for every one- unit increase in the independent variable, as indicated by the slope of the regression line. A higher beta coefficient indicates a stronger contribution of the related independent variable to the result.

Table 8 provides a thorough analysis of the factors that affect the adoption of efficient agri-food systems within Algerian agri-businesses. This analysis covers variables such as the year the business was established, the manager's level of education, the manager's age, years of experience in the agri-food sector, the business sector (public or private), the legal status of the business, and the target market. The results of the logistic regression study indicate that the agro-industry in the middle age range, specifically those that were created between 5 and 25 years ago, have a notable likelihood of adopting efficient FSMS. The probability is 43.5% with a p-value of 0.431 for 5 and 15 years ago and 37.0% with a p-value of 0.012 for 15 and 25 years ago. This is likely attributed to the collected experience of these organisations. The data suggests that managers with a university degree are highly likely (91.3%) with a p-value of 0.043 to embrace systems, emphasizing the importance of higher education in effectively managing complex systems. Moreover, managers older than 31 are the most likely to adopt the system, with an adoption rate of 63.0% and a statistically significant p-value of 0.039. This outcome could be attributed to their ability to integrate their experience and willingness to adopt an FSMS.

The table 8 hilighted also the highest level of flexibility and adaptability when it comes to adopting advanced systems for the LLC Companies, with a coefficient of 0.090 and a 50.0% likelihood. Companies that operate in both local and international markets also show a significant probability of adopting an FSMS, with a likelihood of 10.6% and a p-value of 0.020. This emphasizes the importance of market scope in driving efficiency and adherence to global standards.market scope in driving efficiency and adherence to global standards (Hashemi and Hedjazi, 2011; Ai et al., 2023).

The table 9 shows the outcomes of a logistic regression analysis exploring the factors that impact agribusinesses' implementation of an FSMS. The analysis showed that companies established 5 to 15 years ago have a 43.5% adoption rate for these practices, with a p-value of 0.043, indicating a moderate correlation. Managers aged 15 to 25 are most likely to implement FSMS commitments, with a probability of 52.2% and a p-value of 0.022.

Table 8. Logistic regression for the adoption of agrifood systems by agribusinesses.

Does the system work effectively?						
Variables	Probability	Frequency	Yes	No	Overall Sig	Coefficient
			88.3	0.002	11.7	
Year of Business Establishment						
Less than 5 years	4.3	2				0.751
Between 5 and 15 years	43.5	20				0.431
Between 15 and 25 years	37.0	17				0.012
More than 25 years	15.2	7				0.043
Manager's Education Level						
Secondary	8.7	4				0.214
University	91.3	42				0.043
Manager's Age						
30 years or less	4.3	2				0.690
Between 31 and 50 years old	63.0	29				0.039
More than 50 years old	32.6	15				0.029
Business Sector						
Public Sector	2.2	1				0.548
Private Sector	97.8	45				0.032
Legal Status of the Business						
JSC	23.9	11				0.090
LLC	50.0	23				0.494
Multinational	26.1	12				0.017
Market						
Local	69.6	32				0.093
North African	6.5	3				0.015
African	4.3	2				0.768
International	8.7	4				0.0431
Local and International	10.6	5				0.020

Note: The logistic model is constructed with a 95% confidence level.

University-educated managers show a strong likelihood (91.3%) of defining such policies, emphasizing the role of education in effective management (p-value = 0.050). Additionally, JSCs have the highest probability (50.0%) of adoption, with a significant p-value of 0.019, highlighting the influence of legal status. Companies that focus on local and international markets have a significant adoption probability of 69.6% with a p-value of 0.028 and 8.7% with a p-value of 0.032. These results suggest that a broader market presence increases the demand for comprehensive health of an FSMS. The agribusiness sector demonstrates a high commitment to an FSMS for the private sector, with a probability of 97.8% and a p-value of 0.011. The years of manager's experience in the agri-food sector over 5 years have the highest reliability to the commitment to an FSMS and target market. These results underscore the importance of company age, managerial education, legal status, and market scope in determining the likelihood of adopting robust health safety practices in agribusinesses.

Table 9. Logistic Regressions for the Adoption of Agrifood Systems by Agribusinesses: Policy, Objectives, and Commitment in Health Safety Management and Target Market.

Have you defined a policy, objectives, and commitment in health safety management?						
Variables	Probability	Frequency	Yes	No	Overall Sig	Coefficient
Year of Business Establishment						
Less than 5 years	4.3	2				0.951
Between 5 and 15 years	43.5	20				0.043
Between 15 and 25 years	37.0	17				0.022
More than 25 years	15.2	7				0.694
Manager's Education Level						
Secondary	8.7	4				0.755
University	91.3	42				0.050
Manager's Age						
30 years or less	4.3	2				0.741
Between 31 and 50 years old	63.0	29				0.033
More than 50 years old	32.6	15				0.043
Business Sector						
Public Sector	2.2	1				0.724
Private Sector	97.8	45				0.011
Legal Status of the Business						
JSC	23.9	11				0.019
LLC	50.0	23				0.041
Multinational	26.1	12				0.312
Years of Manager's Experiencein the Agri-food Sector						
Less than 5 years	8.7	4				0.722
Between 5 and 15 years	32.6	15				0.023
Between 15 and 25 years	43.5	20				0.048
More than 25 years	15.2	7				0.249
		Business Sector				
Public Sector	2.2	1				0.724
Private Sector	97.8	45				0.011
Your Target Market						
Local	69.6	32				0.028
North African	6.5	3				0.504
African	4.3	2				0.789
International	8.7	4				0.032
Local and International	10.6	5				0.755

Conclusion

The implementation of systems in agri-food businesses is a very detailed and complex process that is significantly influenced by numerous internal and external factors. These include the age, experience, and education level of the managers working in the business, the types of national and international markets targeted, the nature and status of the business, market trends, consumer needs, and other relevant considerations. Furthermore, the process of making decisions is consistently influenced by factors such as deeply ingrained business principles, the

unwavering drive for effectiveness and competitiveness, the necessity of upgrading facilities, the critical aspect of business succession, and the invaluable impact of social connections. To adopt such a food safety system, agri-food company managers, in collaboration with specialised consultancies, carefully analyse these complex elements while at the same time assessing in-depth and making precise use of even intelligent technologies. This enables them to change their deeply rooted attitudes, firmly held opinions, and unshakeable perceptions. This study aims to identify the factors that affect the adoption of a food safety system in Algerian agrifood companies. To achieve this, we developed a logistic model to to determinize various factors and the implementation and acceptance of a food safety system in the agrifood firms being studied. The logistic regression analysis reveals that mid-aged agribusinesses, particularly those established between 5 and 25 years ago, have a significant probability of adopting an efficient FSMS, with adoption probabilities of 43.5% with p-value=0.043 and 37.0% with p-value =0.012 respectively. University-educated managers are shown to have a strong likelihood 91.3% with p-value=0.045 of implementing such system. Managers aged 31 to 50 years have the highest adoption probability (63%, p=0.033). LLCs compagnies exhibit the highest likelihood (50.0%, p=0.019) of adopting an FSMS. Additionally, companies operating in both local and international markets have a significant likelihood adoption of an FSMS (10.6%, p=0.020). These findings emphasize the crucial roles of company age, managerial education, legal status, and market scope in determining the likelihood of adopting robust FSMS in agribusinesses.

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