TECHONEY

Development of a **blockchain-based ecosystem** that allows an **improved positioning of small producers of honey** on local and international markets

WP1: Honey innovation and learning community Lab (HILE)

D1.2. Report on the stakeholder mapping and context analysis (R) (PU) (CREDA, M12)

CHARTER

PROJECT	**Project full title**	Development of a blockchain-based ecosystem that allows an improved positioning of small producers of honey on local and international markets		
PROJECT	**Project acronym**	TECHONEY		
PROJECT	**EC programme**	Grant Agreement	National Founding Prima Sec. 2	
PROJECT	**EC programme**	Programme	Partnership on Research and Innovation in the Mediterranean Area (PRIMA)	
PROJECT	**EC programme**	Section 2	Multitopic 2021	
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DELIVERABLE	**Version**	I.)		
DELIVERABLE	**Abstract of the deliverable**	The report D1.2 (M12) *Stakeholder Mapping and Context Analysis* is structured in three main pillars. The chosen project approach of WP1 as stated in the project description divides the report in (i) a structured theoretical stakeholder mapping definition with its main categories of identification, prioritization and analysis for contemplable stakeholders. This background provides the tools for the initial mapping methodology, computing of the CREDA Stakeholder Excel file to further analyse via Super Decision Software the final results thereof from each case study country (Luxembourg, Türkiye, Tunisia and Spain). The results of the mapping section lay the ground for (ii) the deep interviews (I1) of mapped stakeholders who are actively and		

	passively involved in the Mediterranean honey supply chain or posing expertise in new distributed digital ledger technologies as the Blockchain Technology. A SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) is conducted and represents a situational assessment of all players and stakeholders of each case study countries selected interviewees. In the last section (iii) a context analysis of each country involved in D1.2 of the honey supply chain was elaborated with statistical data, current situation and important aspects for TECHONEY as traceability, fraud, trade as well as digital application usage and possible adoptions. Social, economic and environmental factors are discussed. Especially honey adulteration, fraud and health risks for bee production are reported from all countries.

VERSION TRACKER

VERSION	REVIEWER	PARTNER	DATE	STATUS
0.1	DR. ZEIN KALLAS	CREDA	25th April	Final Draft
0.2	DR. CHRISTOPH STAHL	LIST	27st April	Ready for publication

DISCLAIMER

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ABBREVIATIONS

ER Expected results

F2F Farm to fork

HCLL Honey Community Living Lab

HILE Honey Innovation and Learning Ecosystem

HS6 6-digit of the Harmonized System - trade elasticity at the product level

ICT Information and Communications Technology

IoT Internet of things

JRC Joint Research Centre

KPI Key performance indicator

LL Living Lab

OEC Observatory of Economic Complexity

OLAF Office européen de lutte Antifraude

PDN Production and Distribution Network

SO Specific objectives

TM Target metrics

PROJECT ABSTRACT

TECHONEY project's main objective is to identify strategies and establish lines of resilience to the new challenges determined by the COVID-19 pandemic for beekeepers in the Mediterranean (Med) agricultural systems through the implementation, definition, enhancement and transfer of competitive, profitable, efficient and trustful honey supply-chain alternatives that address beekeepers' capacities and attractiveness to fulfil consumer needs on unexpected food market changes.

TECHONEY project proposes the development of a traceability system to guarantee the quality and safety of honey within the supply chain for more effective communication to consumers and to strengthen access to different markets (e-commerce, direct sales, etc.). This approach will be unfolded by the joint creation of two levels of interaction: **[1]** physical: characterization of honey; **[2]** "living laboratory": creation of a *Honey Community Living Lab* (HCLL) and a *Honey Innovation and Learning Ecosystem* (HILE) that will be the arena to collect information from beekeepers, stakeholders, and consumers to transfer and apply the new optimized models.

TECHONEY is structured in 4 main technological pillars: **[1]** creation of a consortium IoT blockchain platform that involves various actors in the honey supply chain to ensure transparency and traceability, in addition to reducing costs and ensure the traceability in the honey supply chain; **[2]** creation of a transformative learning community to ensure a smart-short-resilient shared supply chain; **[3]** characterization of the quality of honey to guarantee its traceability within the blockchain directly by consumers; **[4]** develop ICT tools for honey supply chain participants and consumers.

TECHONEY will be committed not only to promote the continuation of the direct sales of honey from producers to consumers even after the COVID crisis but also develop a common methodology and clear new optimized resilience protocol to be used by small-scale beekeepers and farmers, smallholders as a new business model with a more efficient added-value chain, sustainable with fair profit, accepted by final consumers, which will be replicable to other food products and supply chains. **TECHONEY** will help beekeepers to: **[1]** generate a traceability mechanism for honey produced in the Med. Area; **[2]** diversify markets and distribution channels offers business flexibility and freedom from dependence on a single market, which will reduce risk in the event of a crisis; **[3]** cooperate and pool resources among themselves (pooling of the workforce, etc.) for logistical flexibility and solidarity in the supply chain, which will also reduce the risks in the event of a crisis.

TECHONEY proposes to design and develop a multidimensional framework to analyse 6 full honey supply chains (farm to table) that will integrate economic, social and environmental indicators and a traceability system, with a bottom-up approach considering the stakeholders´ perspectives. A consortium Blockchain, coupled with IoT (Internet of Things), system will be created to offer real-time tracking and complete traceability of honey along the supply chain from the characterization of honey in a certified laboratory, the retailer, until the end consumer.

The characterization of the quality and safety aspects of local honey through local certified laboratories jointly with the use of e-commerce and quality labelling schemes will increase the opportunity for beekeepers to be identified locally and allow them to gain access to new markets (foreign markets). The implementation of e-commerce with the mobile application will enable local honey to be better traced by consumers who attach more value to local food and local beekeepers. **TECHONEY** contributes to increasing farm profitability and increasing flexibility and risk mitigation capabilities. A shared, short and circular supply chain will allow actors in the honey supply chain to access markets and have higher incomes, share resources and skills and save money by reducing costs (economies of scale), and increase the efficiency, sustainability and flexibility of processes to strengthen resilience and flexibility to face crises and lower risks. The learning community lab and the use of the blockchain network will secure the storing of records, will strengthen intellectual property rights, as well as bring transparency throughout the supply chain; it will reduce frauds, enhance food safety, and improve the communication between retailers and beekeepers. The traceability system offered will also allow consumers to give direct feedback to beekeepers. **TECHONEY** commits not only to promote a continuation of direct sales, but also develop a common methodology and clear new optimized resilience protocol to be used by small-scale beekeepers, farmers and smallholders as a new business model with a more efficient added-value chain, sustainable with fair profit, accepted by final consumers and replicable to other food products and supply chains.

Moreover, a **TECHONEY** web ICT tool consumer/farmer-centred will be developed, by testing and evaluating several machine and deep learning algorithms, providing small-scale beekeepers with key information on new markets and opportunities, contributing to a better decision making and to ensure the traceability of their product. Consumers will have exhaustive knowledge of the different honeys of the Med. area, knowing their traceability from the initial producer, guaranteeing the quality and safety of each product.

TECHONEY *is a project coordinated by CITA (Spain) and funded through the PRIMA Section 2 Multitopic 2021 – Thematic Area 3 - Agrofood chain – Topic 2.3.1 Increasing the resilience of small-scale farms to global challenges and COVID-like crisis by using adapted technologies, smart agri-food supply chain and crisis management tools. (RIA*[5])" under the funding scheme of "Collaborative Project" and type of Action "Research and Innovation Actions (RIA)."*

1. INTRODUCTION

Deliverable 1.2 Mapping of stakeholders and context analysis is part of task 1.2 "Mapping and selection criteria of stakeholders"; where CREDA is the main responsible for this report and executing work package 1 (WP1) as task leader; with participation of all case study leaders (Algeria, Luxembourg Morocco, Spain, Tunisia and Türkiye) as well as an involvement of CITA as project leader and main coordinator of the TECHONEY project.
The report and task 1.2 include mandatory contributions, of each case study country, initial deep interviews (I1) with at least 2 stakeholders or representatives/experts of each node of the honey supply chain, the stakeholder mapping for the creation of the HILE and a context analysis of the honey and beekeeping sector.

THE CONDUCTED DEEP INTERVIEWS ALLOW TO:

(i) assess first drivers, barriers and governance framework of the current honey value chain, presenting a small sample and first impression for the honey supply chain in the respective case study country;
(ii) secondly, to understand small beekeepers' capacity of adaptation to the COVID-19 crisis and the decision taken at short and long run;
(iii) thirdly, to analyse the level of digital maturity and potential adoption of digital technologies at apiary/farm level. Blockchain technology has been introduced during the deep interviews and first impressions and understanding have been collected.

THE MAPPING PROCEDURE IS A TWO-STEP PROCESS WHERE:

(a) a list of criteria is defined to identify the relevant stakeholders;
(b) a quota assigned to each criterion to populate the Honey Innovation and Learning Ecosystem (HILE) with the organizations and individuals that will be invited to be part of the HILE. The criteria will consider, amongst others, the dual territorial and value chain perspectives in the project. On the one hand, stakeholders at the Med. and regional level will be identified, while a hive-to-jar (including civil society) perspective will simultaneously be adopted to secure the involvement of stakeholders along the value chain. Different extents of involvement are defined in the report as one of the relevant criteria to consider in the HILE articulation.
Since the platform, to be set in WP4, will address Mediterranean and global scales, the HILE will be articulated by creating 6 national and - with evolving of the project - one Mediterranean branch of the platform after the annual TECHONEY General Assembly take place at Naples in June 2023.

Case-study leaders of Algeria, Luxembourg, Morocco, Spain, Tunisia and Türkiye are responsible for the setting up and the coordination of the platform (HILE), deep interviews (I1) and carrying out their own mapping (systematic approach introduced by Creda in September 2022 including a 2h online meeting recorded and shared with all partners, ongoing support and necessary effort for a fruitful collaboration) in their respective country.

2. STAKEHOLDER MAPPING

2.1 Stakeholder Definition

The Stakeholder Analysis (SA) is a decision-support tool (Bendtsen et al., 2021) that starts with a clear definition of what stakeholders (SH) mean and which guidelines are followed to conduct the analysis. Considering aspects for identification, determination of interests, power, influence and how to document and report findings (Bendtsen et al., 2021). In the SA, individuals or groups of individuals who are directly or indirectly affected by a project or organization, have interest in, or can affect a decision, are identified and their roles, relations and/or interests within the honey supply chain are systematically analysed.

First, the SA needs to clearly define what the term "stakeholder" includes. The Stakeholder Theory (ST) stress the interconnected relationships between an organization or projects, and its customers, suppliers, employees, investors, communities, social entities and other agents who have a stake in the organization or projects (Parmar et al., 2010). Accordingly, organizations or projects deal with a multitude of constituent groups and a deep analysis of what these relationships mean is required. (Freeman, 1984) developed a comprehensive and integrated understanding of the stakeholder concept. More in detail, as for the stakeholder definition it is her or him who has specific knowledge or a direct or indirect relation about the studied idea, project or initiative, while actors are defined as those individuals who have the power to implement changes. The stakeholders have a relation and are motivated by the specific project or initiative aiming at influencing on its implementation. The stakeholder approach seeks to broaden management's vision beyond profit maximization. Particularly, ST deals with the nature of the relationships between the organization and its various stakeholders. Especially in terms of the processes and outcomes for the organization/project and the stakeholders.

2.2 Stakeholders Mapping Methodology

The stakeholders' mapping is divided into three main phases:

- **Identification**: listing of potential stakeholders
- **Analysis**: evaluating of potential stakeholders
- **Prioritization**: ranking of potential stakeholders

2.2.1 Identification

Initially, starting a stakeholders' mapping is set with the preliminary identification of potential stakeholders. For the TECHONEY project stakeholders are identified who are involved actively or passively in the honey food supply chain. An adequate description of the TECHONEY project is helpful for a successful identification and convincement of different actors. Identification contributes for effective characterization of stakeholders and clarifies which stakeholders are needed and whom are contacted. In the same step, it is of importance to realize that stakeholders must have specific roles during their engagement. Therefore, the prioritization exercise is needed to clearly identify the stakeholders' roles and analyse their level of involvement. The identification of their role is necessary because some stakeholders' roles might be more influential or significant than others.

For identifying the stakeholders, an initial stakeholder screening is used as a top-down approach, since it is more efficient in the matter of time. This initial approach is based on a literature review and previous conducted studies to collect data on potential related stakeholders to the TECHONEY project. In a second step, a bottom-up approach is used by means of a snowball-sampling, where researchers ask stakeholders (from the top-down identified list) to nominate other stakeholders as potentially interested in the TECHONEY project (Clausen et al., 2020). This approach requires more experience as well as time resources and can be based on deep interviews and participatory qualitative methods such as Focus Groups, World Café discussions, Nominal Groups Discussions, to analyse stakeholders' opinions and interests.
An initial identification of the stakeholders can be performed taking into account the following classification of the stakeholders:

(i) *Direct Stakeholder* = Stakeholders who have a direct relation with the TECHONEY project
(ii) *Indirect Stakeholder* = Stakeholders without a direct relation with the TECHONEY project
(iii) *Ally Stakeholder* = Stakeholders who support the success of the TECHONEY project
(iv) *Competitor Stakeholder* = Stakeholders, who hinder the successful implementation of the TECHONEY project.

The stakeholders will be identified from all the potential stakeholder´s types or category. Indicatively, the initial list of stakeholders may include the following groups:

- National or International organizations
- Regional or local administrators
- Agencies & authorities (national and international)
- Research & innovation agencies & authorities (national and Europeans)
- Universities
- Research centres
- Think tanks
- Institutions
- NGOs
- Consumers
- Consultancy firms
- Investors
- National Standardization Bodies

- National associations (farming, food, consumers, forester, retailers, others?)
- European association (farming, food, consumers, forester, retailers, others?)
- Media and Journalists
- Others?

The mentioned methodological approach should also allow the inclusion of a wide range of entities through the "quadruple helix innovation system", profiles related to the honey value chain (such us: local clusters of beekeepers, small manufacturers and distributors, public institutions, academia, research centres and final consumers). Therefore, stakeholder identified should also ensure a balanced representation according the 4 dimensions of the quadruple helix innovation system: Government, Academia, Industry and Citizens with the TECHONEY project centred in the middle as interface of all four dimensions.

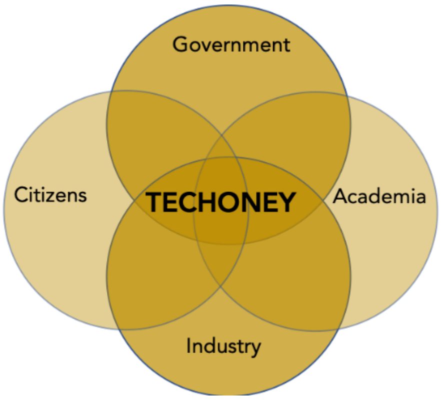

Figure 1: Quadruple Helix Innovation System, where the TECHONEY project represents the innovation in the centre including all 4 dimensions.

A crucial point is the fact that the procedure of the stakeholders' mapping is a dynamic procedure and it could lead to the continuous changes of the selected stakeholders. Some indicative questions, which will help for the successful identification of the stakeholders can be the following:

- Do the stakeholders have significant expertise in the relative field(s) of the project?
- Do the stakeholders represent diverse perspectives and/or experiences?
- Is the stakeholder able to raise crucial questions contributing to the improvement and success of the project?
- Do the stakeholders want to benefit from the project in order to reach self-goals?
- Are the stakeholders to be considered as a proponent of evaluation and supports the testing or implementation of the project?
- Could the stakeholders delay or stop the project?
- Should the official decision-making authority be included into the selected stakeholders?
- Do the stakeholders have the power to implement recommendations?
- Will the stakeholders be affected by the outcome of the project?

The elaboration of the above questions may enhance significantly the procedure for the effective identification of the participating stakeholders. Some recommendations for the identification of the stakeholders could include:

- Be open-minded and to consider potential stakeholders taking into consideration the innovation – new markets and technologies, new regulations and legislations etc.
- Trying to keep a balanced selection of representatives including societal organizations, public bodies, private sector representatives, scientific experts etc.
- Thinking strategically and politically about the selected stakeholders. It is important to keep in mind that a single group might have specific interests and expectations, while others might have different emphases.

2.2.2 Analysis

The analysis follows the previous stakeholder identification process, where characteristics and profiles should be analysed. It is important to mention that different stakeholders may have different levels of interest as well as overall influence. Nevertheless, the stakeholders should represent a mix of perspectives, experiences and roles, relative to the TECHONEY project. Profiling the potential stakeholders helps to map and assess them.

The taken approach targets the qualitative assessment of specific stakeholders' components such as their degree of expertise, their willingness for participation, their influence and necessity resulting in an overall impact, which is expected to be triggered by their involvement.
The selected criteria, which must be evaluated, are described briefly below:

I. *Capacity:* Evaluate the resource capacity of each stakeholder taking into consideration their knowledge, expertise and technical capabilities;
II. *Willingness:* Evaluate stakeholders' availability and willingness for participation;
III. *Influence:* Evaluate the number and the quality of stakeholders' connections, which can influence all the involved parties;
IV. *Necessity:* Evaluate stakeholders' necessity for inclusion;

All the above criteria will be first assessed by the researcher (in each case study country) in order to identify the weight of each criterion. These weighting supports then a better adaptation to the specificities of each Mediterranean country to be analysed.
The prioritization of the criterion will be assessed through the Analytical Hierarchical Process (AHP) technique (Saaty, 1980). The AHP is a multi-criteria decision-supporting method in discrete environments. The AHP allows eliciting weights (w) (i.e. priorities) for elements or criteria that will be used to assess stakeholders. The priorities (w), also known as relative importance are estimated for the Criterion (C_n) i n is the number of the main categories. In TECHONEY, four main categories are identified: *capacity, willingness, influence, necessity.* Following a hierarchy created with the different criterion to be assessed in Figure 2 below:

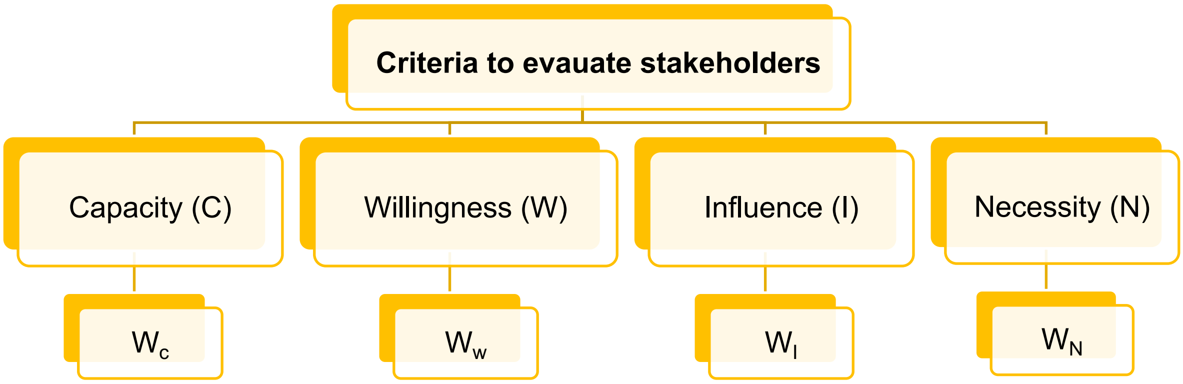

Figure 2: Hierarchical structure to prioritize the criteria to evaluate the stakeholders in TECHONEY. Own representation.

For execution and implementation of the AHP, questions needs to be designed (in our case to be answered by the researchers) where individuals are asked to evaluate the criteria in pairwise comparisons, using the following comparison as showed in Table 1:

Table 1: The pairwise comparison of criteria and questions formed. Own representation, CREDA 2023.

Capacity																**Willingness**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**
Capacity																**Influence**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**
Capacity																**Necessity**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**
Willingness																**Influence**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**
Willingness																**Necessity**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**
Influence																**Necessity**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**

Subsequently, the researcher has to indicate, which of the two elements consider as important to evaluate the stakeholders using a nine-point scale to measure the strength of importance by means of verbal judgments. (Table 2):

Table 2: The AHP comparison scale from 1-9. Own representation, CREDA 2023

Degree of importance rating	Definition of the scale
1	The two elements have **the same importance**
2	The first element has an importance between 1 and 3 against the compared element
3	The preferred element is **slightly** more important
4	The first element has an importance between 3 and 5 against the compared element
5	The preferred element is **moderately** more important
6	The first element has an importance between 5 and 7 against the compared element
7	The preferred element is **strongly** more important
8	The first element has an importance between 7 and 9 against compared element
9	The preferred element is **absolutely** more important

The practical application of analysing the criteria using the AHP for each living lab will be carried out in the Excel table file "Stakeholder Mapping". This first evaluation to prioritize the criteria corresponds to step 1 in the Excel file (Stakeholder Mapping). Every partner was introduced into the exact approach, including a recorded step-by-step video and individual support was offered to all partners.

2.2.3 Prioritization

Once the criteria are analysed (with the AHP in section 2.2.2), the final step of the stakeholders' mapping is the prioritization process. This aims to the scoring (prioritization) of between 12-16 stakeholders which should have been selected to identify the stakeholders. It will then represent the core members of the HILE living lab.

However, it is worth keeping in mind that all identified stakeholders will be contacted to join the Stakeholder platform of the project, independently if they will join the HILE or not.

The total score (priority) assigned to a stakeholder "*k*" (total number of stakeholder is K) will be estimated using the AHP, by evaluating jointly all stakeholders on the basis of the 4 criteria mentioned above (capacity, willingness, influence and necessity). The number of the pairwise comparison to be done will depend on the total number of stakeholders identified. The comparison will be carried out as follow:

Table 3: The pairwise comparison of the Stakeholders for a specific Criteria

Stakeholder 1 / Type 1																**Stakeholder 2 / Type 2**
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								**Equal importance**								→ **More important**

Stakeholder 2 / Type 2																Stakeholder 3 / Type 3
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								Equal importance								→ More important
Stakeholder 3 / Type 3																Stakeholder 4 / Type 4
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								Equal importance								→ More important
Stakeholder K Type K																Stakeholder K / Type K
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
More important ←								Equal importance								→ More important

On the basis of the results obtained the evaluation of the stakeholders can be performed according to the following classification criteria:

Table 4 : Criteria Classification of relative importance of percentile rank order:

1. **If the percentile score is higher than 75% as relative importance from the AHP, then the specific stakeholder can be characterized as "Very important stakeholder".**

2. **If the percentile score is between 50% and 75% as relative importance from the AHP, then the specific stakeholder can be characterized as "Important stakeholder".**

3. **If the percentile score is between 25% and 50% as relative importance from the AHP, then the specific stakeholder can be characterized as "slightly important stakeholder".**

4. **If the percentile score is lower than 25% as relative importance from the AHP, then the specific stakeholder can be characterized as "not important stakeholder".**

Finally, and once the previous described steps are carried out, a final list of the stakeholders' - ordered from the least to the most important stakeholder - to be included in the project is obtained.

3. RESULTS STAKEHOLDER MAPPING

3.1 Case Study Countries

In total TECHONEY consists of six case study countries. Algeria, Luxembourg Morocco, Spain, Tunisia and Türkiye.

The results of the stakeholder mapping are twofold: In a first section (i) an identification of the involved stakeholders of the honey supply chain in each case study country was carried out. Subsequently, to continue with the second section (ii) of the final mapping and selection of the stakeholders in each case study country. As a process to reach the ultimate goal to create a successful HILE within the project and obtain a basis for cross-pollination of thoughts, co-creation of ideas, interests, table of discussion, co-design and final inclusion of all stakeholders' expertise for a successful implementation of the TECHONEY project.

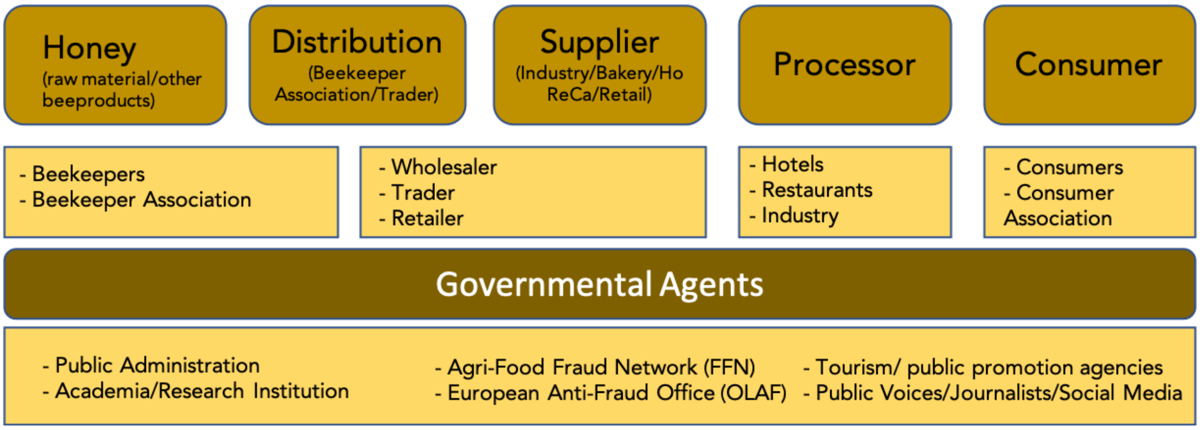

Figure 3: Involvement of possible stakeholders. own representation CREDA 2023.

The Super Decision© software was used to create a first global map that include all stakeholder groups, as shown in figure 4.

After identifying the honey supply chain stakeholders, the next step is to prioritize the selection criteria: capacity, willingness, influence, and necessity, using a pairwise comparison based on the AHP methodology (Figure 5). The significance of these criteria varies by country and available stakeholders. The same methodology was used to determine the priorities of the various stakeholder groups, which will determine their participation in TECHONEY´S Honey Innovation and Learning Community Ecosystem. Finally, a list of stakeholders involved with the product who could be considered for the HILE is compiled for each case study country. This list will be used to create a list of candidates, who will be evaluated based on their suitability and contribution to the project.

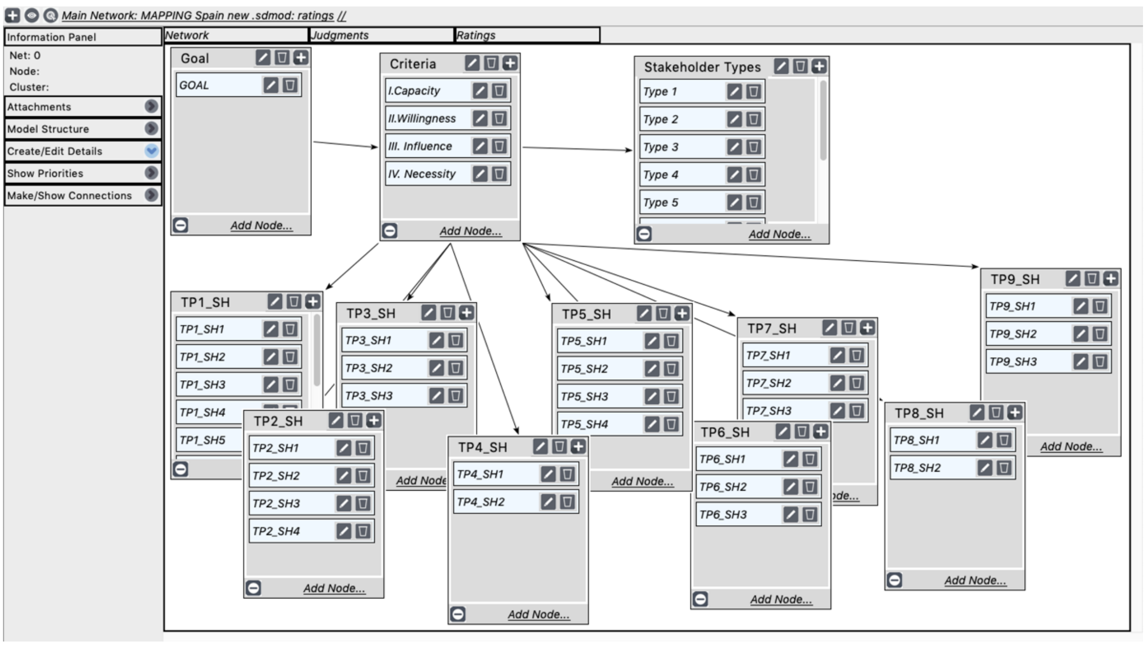

Figure 4: Screenshot form Super Decision Software on mapping of Stakeholders in case study country Spain. CREDA 2023

Comparison of different Stakeholders in Super decision software:

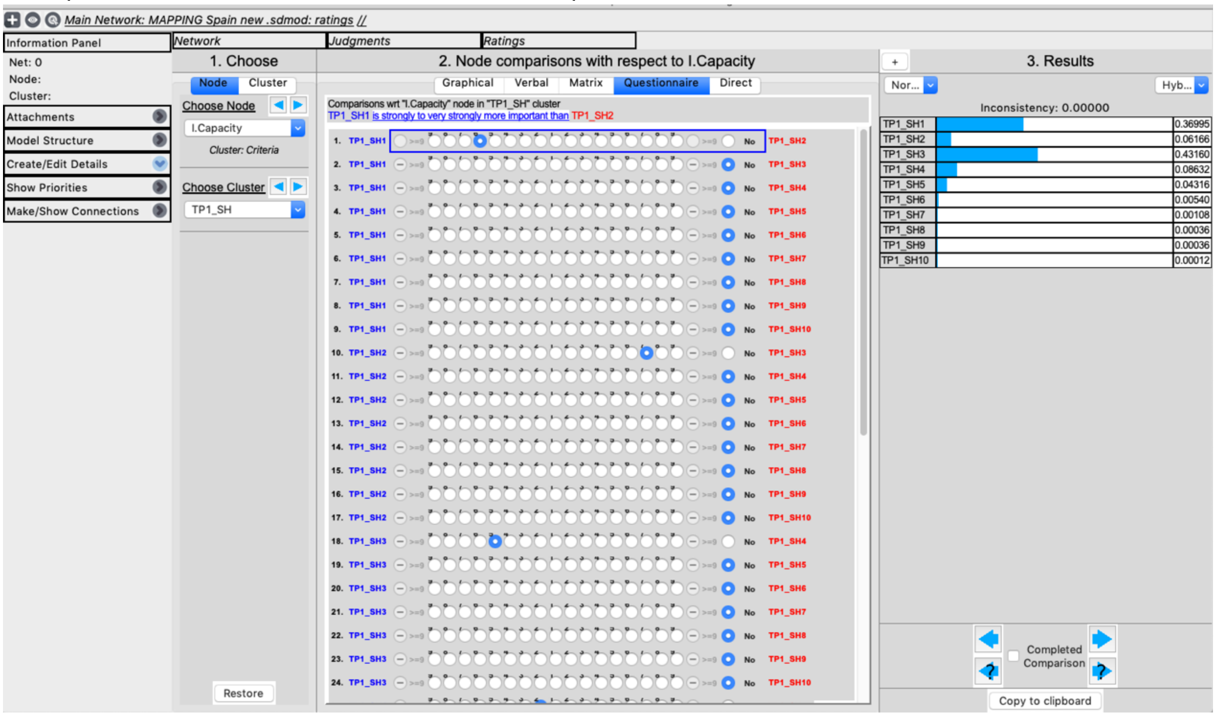

Figure 5: Screenshot from Super Decision on judgements and comparison of factor capacity between the different Stakeholders. CREDA 2023

Additionally, through an advanced calculation model, an overall criteria weight was calculated together with a shared and distributed excel coding file for all partners to provide a tool for typing the rating (Table 5) in every case study country. Of all the partners who have calculated the weight and CREDA received adequate data on time, a list of stakeholders involved in the honey supply chain could be considered for the HILE. It was calculated in the four criteria weights for each case study country. This list will be used to create a ranking of candidates, who will be evaluated based on their suitability and contribution to the TECHONEY project, completing the identification section described in the document section analysis of stakeholder mapping methodology.

Table 5: Criteria weight for each case study country based on their rating and Excel software calculation from CREDAs Excel computing file:

	CAPACITY	WILLINGNESS	INFLUENCE	NECESSITY
Algeria	*no data*	*no data*	*no data*	*no data*
Luxembourg	50,39%	29,09%	7,51%	13,01%
Morocco	*no data*	*no data*	*no data*	*no data*
Spain	20,35%	43,38%	16,07%	20,10%
Tunisia	18,16%	38,20%	15,71%	27,93%
Türkiye	25%	25%	25%	25%

3.2 Stakeholder Mapping Spain

Starting with the identification as a first step of the mapping process, in total, out of 30 potential mapped stakeholders 9 could be selected for the Honey Innovation and Learning

Ecosystem (HILE). Table 6 represents the final global percentage after computing the Excel file with the Super Decision Software.

Table 6: Final results of analysis of all stakeholders in % of case study country Spain computed with Super Decision Software. CREDA 2023

Type 1 (TP1_SH) Beekeeper									
TP1_SH1	**TP1_SH2**	**TP1_SH3**	**TP1_SH4**	**TP1_SH5**	**TP1_SH6**	**TP1_SH7**	**TP1_SH8**	**TP1_SH9**	**TP1_SH10**
26,18%	6,62%	43,34%	12,11%	7,11%	1,12%	0,26%	1,36%	1,52%	0,38%
Type 2 (TP2_SH) Beekeeper Association									
TP2_SH1	**TP2_SH2**	**TP2_SH3**	**TP2_SH4**						
42,07%	6,92%	8,00%	43,02%						
Type 3 (TP3_SH) Industry/Bakery									
TP3_SH1	**TP3_SH2**	**TP3_SH3**							
86,94%	11,34%	1,72%							
Type 4 (TP4_SH) Hotel/Restaurant									
TP4_SH1	**TP4_SH2**								
79,27%	20,73%								
Type 5 (TP5_SH) Retail									
TP5_SH1	**TP5_SH2**	**TP5_SH3**	**TP5_SH4**						
60,13%	12,04%	13,72%	14,11%						
Type 6 (TP6_SH) Consumer Association									
TP6_SH1	**TP6_SH2**	**TP6_SH3**							
84,03%	12,26%	3,71%							
Type 7 (TP7_SH) BCT Experts									
TP7_SH1	**TP7_SH2**	**TP7_SH3**							
74,50%	22,46%	3,04%							
Type 8 (TP8_SH) Academia									
TP8_SH1	**TP8_SH2**								
85,09%	14,91%								
Type 9 (TP9_SH) Government/Authority									
TP9_SH1	**TP9_SH2**	**TP9_SH2**							
86,94%	11,34%	1,72%							

3.3 Stakeholder Mapping Türkiye

The approach for identifying stakeholders of case study country Türkiye (Table 7) was following the same procedure, although instead of creating a final selection with the super decision software tool, the partners used their own calculation resulting in a total number of 68 identified stakeholders of which 13 had been seen as very important and considered for the HILE and further ongoing project.

The overall procedure has been similar as seen in the Spanish mapping section. With the outcome of a scientific selection of the important stakeholders of each sector involved and a willingness to be part of the TECHONEY project as well as the HILE.

Table 7: Comparison of different Stakeholders and output of Stakeholder Mapping (Beekeepers as example) with self-chosen Excel approach in case study country Türkiye:

PRODUCER																	
KÜBRA ATEŞ	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	1	1	2		1	1	2		1	1	1	1	28,39%	23,87%	23,87%	23,87%	9%
	1,00	1,00	2,00	1,00	1,00	1,00	2,00	1,00	1,00	1,00	1,00	1,00	28%	24%	24%	24%	9%
BARIŞ ŞEN	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	3	1	1	3	1	3	3	1	1	3	1	3	20,80%	15,80%	27,37%	36,02%	86%
	3,00	1,00	1,00	3,00	1,00	3,00	3,00	1,00	1,00	3,00	1,00	3,00	21%	16%	27%	36%	86%
HANIM ŞEN	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	1	2	2	1	1	1	1	1	1	1	1	1	27,16%	27,16%	22,84%	22,84%	19%
	1,00	2,00	2,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	27%	27%	23%	23%	19%
İMDAT YANKUNCU	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	4	1	3	1	1	4	2	1	1	3	1	1	30,82%	16,56%	21,79%	30,82%	93%
	4,00	1,00	3,00	1,00	1,00	4,00	2,00	1,00	1,00	3,00	1,00	1,00	31%	17%	22%	31%	93%
GÖKHAN ŞEN	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	1	1	2	1	1	1	1	1	1	1	1	1	28,39%	23,87%	23,87%	23,87%	9%
	1,00	1,00	2,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	28%	24%	24%	24%	9%
SERKAN DUMAN	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	2	1	1	1	1	1	1	1	1	1	1	1	28,39%	23,87%	23,87%	23,87%	9%
	2,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	28%	24%	24%	24%	9%
OSMAN TAŞ	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	3	1	1	3	4	1	2	1	3	1	1	1	31,50%	29,31%	22,27%	16,92%	93%
	3,00	1,00	1,00	3,00	4,00	1,00	2,00	1,00	3,00	1,00	1,00	1,00	31%	29%	22%	17%	93%
DANYAL KESKİN	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	2	1	1	1	1	1	1	1	1	1	1	1	28,39%	23,87%	23,87%	23,87%	9%
	2,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	28%	24%	24%	24%	9%
İLKNUR ÇAKMAK	Capacity	Willingness	Capacity	Influence	Capacity	Necessity	Willingness	Influence	Willingness	Necessity	Influence	Necessity	W_C	W_W	W_I	W_N	CR
Fill only yellow cells	3	1	1	4	3	1	1	4	3	1	1	1	29,47%	29,47%	24,06%	17,01%	98%
	3,00	1,00	1,00	4,00	3,00	1,00	1,00	4,00	3,00	1,00	1,00	1,00	29%	29%	24%	17%	98%

3.4 Stakeholder Mapping Luxembourg

Luxembourg identified a total of 32 stakeholders of six different nodes who can serve as potential stakeholders in the HILE. Table 8 represents the final global percentage after computing the Excel file with the Super Decision Software.

Table 8: Final results of analysis of all stakeholders in % of case study country Luxembourg, computed with Super Decision Software,. CREDA 2023

Type 1 Beekeeper Association (TP1_SH)													
TP1_ SH1	**TP1_ SH2**	**TP1_ SH3**	**TP1_ SH4**	**TP1_ SH5**	**TP1_ SH6**	**TP1_ SH7**	**TP1_ SH8**	**TP1_ SH9**	**TP1_S H10**	**TP1_S H11**	**TP1_S H12**	**TP1_S H13**	**TP1_S H14**
12,48%	4,78 %	17,61%	9,31 %	9,31 %	9,31 %	4,63 %	4,63 %	4,66 %	4,66 %	4,66 %	4,66 %	4,66 %	4,66 %
Type 2 Beekeepers (TP2_SH)													
TP2_ SH1	**TP2_ SH2**	**TP2_ SH3**	**TP2_ SH4**	**TP2_ SH5**	**TP2_ SH6**								
16,67 %	16,67 %	16,67 %	16,67 %	16,67 %	16,67 %								
Type 3 Authorities (TP3_SH)													
TP3_ SH1	**TP3_ SH2**	**TP3_ SH3**	**TP3_ SH4**										
13,28 %	35,83 %	15,72 %	35,17 %										
Type 4 Experts (TP4_SH)													
TP4_ SH1	**TP4_ SH2**	**TP4_ SH3**											
28,51 %	42,98 %	28,51 %											
Type 5 HoReCa (TP5_SH)													
TP5_ SH1	**TP5_ SH2**	**TP5_ SH3**	**TP5_ SH4**	**TP5_ SH5**									
36,31 %	19,46 %	13,11 %	13,11 %	18,01 %									

Type 6 Retail (TP6_SH)													
TP9_ SH1	**TP9_ SH2**												
47,40 %	52,09 %												

3.5 Stakeholder Mapping Tunisia

Tunisia identified a total of 24 stakeholders of nine different nodes who and can serve as potential stakeholders in the HILE. Table 9 represents the final global percentage after computing the Excel file with the Super Decision Software.

Table 9: Final results of analysis of all stakeholders in % in case study country Tunisia. CREDA 2023

Type 1 (TP1_SH) Beekeeper									
TP1_SH1	**TP1_SH2**	**TP1_SH3**	**TP1_SH4**	**TP1_SH5**	**TP1_SH6**				
15,05%	13,00%	52,79%	13,81%	2,98%	2,38%				
Type 2 (TP2_SH) Processor									
TP2_SH1	**TP2_SH2**								
70,18%	29,82%								
Type 3 (TP3_SH) Retail									
TP3_SH1	**TP3_SH2**								
37,30%	62,70%								
Type 4 (TP4_SH) Consumer Association									
TP4_SH1									
100%									
Type 5 (TP5_SH) Local Authority									
TP5_SH1	**TP5_SH2**	**TP5_SH3**							
67,69%	25,34%	6,97%							
Type 8 (TP8_SH) Academia/Research									
TP8_SH1	**TP8_SH2**	**TP8_SH3**							
41,74%	9,21%	49,05%							
Type 11 (TP11_SH) Food Quality Certification									
TP11_SH1	**TP11_SH2**								
88,67%	11,33%								
Type 12 (TP12_SH) Beekeeper Association									
TP12_SH1	**TP12_SH2**	**TP12_SH3**							
22,43%	32,76%	44,81%							
Type 13 (TP13_SH) Hotel/Restaurant									
TP13_SH1	**TP13_SH2**								
84,58%	15,42%								

3.6 Stakeholder Mapping Algeria

Algeria identified a total of 12 stakeholders of 12 different nodes who and can serve as potential stakeholders in the HILE. Algeria also used its own approach to calculate and map the selected stakeholders.

Table 9b: Selected stakeholders of Algeria:

Stakeholder Type	Capacity	Willingness	Influence	Willingness	Percentage
TP1_SH	**0,11**	**0,09**	**0,13**	**0,10**	**10,62565%**
TP2_SH	**0,11**	**0,09**	**0,13**	**0,14**	**11,55157%**

TP3_SH	0,12	0,13	0,13	0,14	12,73155%
TP4_SH	0,05	0,06	0,05	0,04	4,72335%
TP5_SH	0,08	0,09	0,07	0,07	7,99267%
TP6_SH	0,05	0,06	0,05	0,04	4,72335%
TP7_SH	0,05	0,06	0,05	0,04	4,72335%
TP8_SH	0,10	0,09	0,10	0,10	9,75985%
TP9_SH	0,10	0,08	0,09	0,10	9,18164%
TP10_SH	0,05	0,06	0,05	0,04	4,72335%
TP11_SH	0,11	0,09	0,10	0,11	10,36611%
TP12_SH	0,10	0,08	0,08	0,10	8,89755%
	1,00	1,00	1,00	1,00	1,00

3.7 Stakeholder Mapping Morocco

Info: CREDA did not receive any stakeholder mapping data from Moroccan partners until the last deadline of this report. (Excel file was not received by CREDA to maintain and fulfil this task.

4. DEEP INTERVIEWS (I1) AND FOCUS GROUP (FG1)

Semi-structured deep interviews are a qualitative research method that involves open-ended questions to explore complex topics in-depth. In the context of the honey supply chain, semi-structured deep interviews can be used to gain insight into the challenges and opportunities that honey producers, processors, distributors, and retailers face.

Through these interviews, researchers can uncover the diverse perspectives and experiences of various stakeholders in the honey supply chain, including their knowledge of beekeeping practices, honey processing techniques, digital adoption possibilities and marketing strategies. Additionally, the interviews can help identify the factors that affect the quality and safety of honey, as well as the sustainability of the honey supply chain.

Overall, semi-structured deep interviews can provide valuable insights for improving the efficiency and effectiveness of the honey supply chain, as well as ensuring the long-term viability of honey production and trade.

The deep interviews as well as the year one focus group are part of WP1. This first descriptive content analysis is proposed in the project as a mandatory task of every case study country involved in the TECHONEY project (Algeria, Luxembourg, Morocco, Spain, Türkiye and Tunisia).

The approach of conducting deep interviews in every case study country with at least two stakeholders representing each node in the honey food supply chain will allow the WP 1 and case study leaders of each country to gain important insights for forth coming work packages of the project. The same applies to the focus group (FG1). Additionally, it serves as a basis to build up the survey and deeper understanding of the current honey supply chain and its involved actors in each node. It is also seen as a good starting point to get to know the stakeholders and create a room for discussion. Also for a coming invitation in the focus group and HILE it is seen as an important step.

The matter of the state of research concerning the digitalization and implementation of the blockchain technology in the honey supply chain as one of the goals in the TECHONEY project is a very new approach.

In a more general aspect and nutshell of distributed ledger technologies, the blockchain technology is one of the most prominent digital tamper proof technologies already piloted in many cases in the agri-food supply chain around the world. Most of these blockchains operate as a consortium blockchain or use a hybrid form of it. For example the biggest retailer in the US and the world, Walmart, with annual sales of 503 billion in 2019, works together with IBM and the Hyperledger Fabric blockchain from the Linux Foundation (Kamath, 2018). However, with the implication of a blockchain, transactions all along the supply chain can be recorded and leave an immutable or unchangeable record of the product. Therefore, provenance of a product can be made visible from the genesis up to the end of the supply chain via the consumer. The technology offers the potential of radical transparency and traceability of food products from the source to the store (Bechtsis et al., 2019). Overall, it is a new and evolving field in the Mediterranean area adding such technology for advanced trust and traceability in the honey supply chain (Wassermann, 2020).

The implementation of such digital traceability systems on the whole food supply chain is yet under investigated but pilot projects are especially seen at big retail markets on several food categories in Europe and US, at the big 4 (ABCD) in grain and soy trading, in India and Australia.

Therefore, the deep interviews are seen as a reasonable method to shine a light on the actors of the honey food supply chain. The subjective perspective of the previously mapped stakeholders in the report is of high interest to answer first research questions and gain insides. Moreover, with the selected interviewed honey supply chain actors and their advanced knowledge in the honey industry, the generated content gives an overview of the possibilities of the technology for more transparency and traceability in Spain. The deep interviews as well as included followed-up focus group are discussed within the SWOT framework (strengths, weaknesses, opportunities and threats) and summarized in a table below.

Within the subject of deep interviews, it is important and highly advised that transcripts are recorded on the conducted interviews. According to Mayring, several types of interviews are used in social sciences, which differentiate in their way and structure of asking questions. The different forms are: narrative interview, biographical interview, deep interview, focus interview and semi-structured interviews, which are all leading to transcripts (Mayring, 2014).

For the deep interviews in TECHONEY, CREDA forejudged the type of semi-structured interviews to keep a compromise between flexibility and clearness. This interview type is based on a list of predetermined questions and topics. These list of topics was send to all case study partners via email on 16th November 2022. Additionally, WP 1 tasks webinar

(recorded and shared with all participants and case study leaders) about semi-structured interviews as well as stakeholder mapping was provided on 8th September 2022. This helps the authors and case study leaders to ask the same topics and have a structured line on the different interviews in the different countries.
Semi-structured interviews are sometimes referred to as informal, conversational or 'soft' interviews which are partially structured. A mixture of talking and asking as well as listening, paying attention, being careful and systematic with the things people tell you (Longhurst, 2003). Hence, the possibility of an explorative approach will contribute to new hypotheses and more insights into the situation in the honey supply chain in each case study country.

In detail the deep interviews:
(i) access drivers, barriers and the governance framework of the current honey supply chains in the case study countries;
(ii) get a better understanding of small beekeepers' capacity of adaptation to the covid-19 pandemic and its three years disturbing the market;
(iii) a first insight of actors' digital maturity and their understanding as well as possibilities adopting new emerging digital technologies as the distributed ledger technology to the honey supply chain.

4.1 Deep Interviews (I1) and Focus Group (FG1) Spain:

For case study country Spain, the deep interviews had been conducted by CREDA on 24th to 26th of November 2022 in the region of Aragon and the following first year Focus Group (FG1) was held in Zaragoza at CITA - Centro de Investigación y Tecnología Agroalimentaria de Aragón (CITA), on 31st of March 2023. CITA was organizing, recruiting the stakeholders for the deep interviews in Zaragoza as well as the focus group there. At the focus group the same stakeholders had been invited and 10 stakeholders attend for co-creation and cross pollination as well as discussing their thoughts. All together it was possible analysing via a SWOT analysis the strengths, weaknesses, opportunities and threats. Besides interview notes all interviews had been recorded and transcript to protect the collected information for further in depth analysis and descriptive content analysis. The same applies for the focus group.

According to the task 1.2; the interview focus on the identification of the baseline scenario in each living lab and to understand stakeholders' opinions regarding the motivations of adopting technologies, practices and solution at stakeholders' levels. Accordingly, this section will contain the main questions during the interview.

In total, fourteen experts are interviewed on the pre-defined research questionnaire and shared document (topics bloc) with all case study leaders. They were carefully selected through the previous stakeholder mapping process, their expertise of the honey sector in

Spain and previous involvement in honey supply chain, governmental regulation or blockchain operations. All interviews were conducted in Spanish and were translated automatically and corrected into English afterwards.

4.1.1 Interviewed Experts: (14)

Table 10: List of interviewed experts (14) involved in the honey supply chain in Spain

Stakeholder Group	Name	Short Description
Beekeeper	David Salo Honesto	Honey Producer
	Miguel Ángel Santisteban	Honey Producer
	Miguel Lecha	Honey Producer
	Ángel Serrano	Honey Producer
Beekeeper Association	Alfredo Sanz	President of Beekeeper Association ARNA, Zaragoza, Aragon
Administration/ Governing Authority	Carmen Urbano	General Director Innovation and Promotion in Agriculture, Regional Government DGA, Zaragoza, Aragon
	Monserrate Moliner	Agri-food Quality Inspector, Zaragoza, Aragon
Research/Academia	Maria Fernanda Enseñat	Researcher at CITA, Expert in honey analysis and certification of honey in province of Aragon
Blockchain Technology Experts	David Ciprés	Department Head Smart Labs (Research in digital technologies) ITAINNOVA (Technological Institute Aragon
	Antonio Lorente	President of Union Blockchain Zaragoza, Aragon
Consumer Association	Lucía Germani	President Consumer Association ACTORA Zaragoza, Aragon
	José Ángel Oliván	President Consumer Association UCA, Zaragoza, Aragon

Restaurant HoReCa Expert	José Manuel Romeo	Coordinator Hotel and Catering School TOPI Zaragoza, Aragon
Retail	José Miguel Capape Abós	Shop owner retail BioBio, Zaragoza, Aragon

4.1.2 Deep Interviews

The results of the conducted interviews are following the approach of a descriptive content analysis. The most important findings, topics and views for the TECHONEY project from the interviewed and mapped stakeholders are summarized in thematic blocks, for the project most important points, to successfully implement the technology as well as add value, resilience and additional food safety measures.

The following outlined blocks summarize the deep interviews as well as the focus group meeting and are presenting first insights in their current point of views in the honey food supply chain.

4.1.3 Traceability:

The aspect of the current non-transparent and in some nodes opaque honey supply chain was mentioned by all interviewed stakeholders along the supply chain. There was a common sense that it is not always completely clear what happens with the honey when sold e.g. from beekeepers in bulk to wholesalers on one side, where information flow ends for them; about their honey produced in terms of further steps and added value in the chain. On the other side it is also reported from the governmental stakeholders, although there are well documented trade flows, it seems that the overlooking of trade flows within the country and beyond is very tricky and resource intensive, as well as an open door for bad apples in terms of fraud and falsification of documents or re-labelling, mixing primary produced honey with honey or sugars from other countries.

4.1.4 Honey Fraud:

Similar to the aspect of traceability the deep interviews reveal a consensus on the matter of ongoing fraud within the honey-supply chain. All actors reported knowledge and believes that not everything is always in good sense and especially consumer association stakeholders and beekeeper´s threat that a loss of trust could happen to the whole sector, e.g. if a food scandal will pop up in terms of fraud or other incidences. Fraud is seen of all stakeholders as a major threat for the sector.

4.1.5 Covid-19 and beekeepers capacity of adaptation

Outlined in the TECHONEY project, D1.2 and part of the research goal to identify strategies and establish lines of resilience to the new challenges determined by the COVID-19 pandemic for beekeepers in the Mediterranean (Med) as well as the matter of multiplication of sales; this could not be validated at this time of the interviewed experts. At least there was

a general increase in the overall number of sales reported form retail BioBio, it was not the case with honey reported from stakeholders at the deep interviews.
Similar suggestions and answers had been received from interviewed beekeepers and beekeeper association perspective but to keep in mind that the number of affected stakeholders interviewed was small (6).

4.1.6 Digital maturity and potential adoption of digital technologies at production level:

As part of the deep interview section and important bottleneck within the TECHONEY project, a first impression of (i) the understanding of general digital maturity and (ii) potential of adoption was discussed and prompted from the beekeepers, beekeeper association and backwards form the end node of the honey supply chain at the consumers' association.
(i) First impressions of overall digital maturity, for example of communication via email, organising production or digital accounting was reported to be not used much from the interview partners. Interviewees from production level, source their accounting out - especially their documents needed for regulatory frameworks and yearly tax calculations. Novel digital innovative tools hard- and software nature together with their production itself (e.g. smart or genius hive systems, hive balances, remote control via cameras, special weather assessment tools, temperature sensors, measurement software etc.), are not in use yet. Although some beekeepers have a very professional and large-scale production with >1000 hives per apiary, and all of them know the technique available on the market. Further so far, the blockchain technology itself was not known to be also used to adopt on the food supply chain.
On one side beekeepers agree within the need of more transparency and traceability for their produced honey resulting in possible higher sale prices and added value, on the other side the willingness to change their current business and production strategy was not seen and interest seems to be limited. The beekeeper association representing 1100 apiaries and manage about approximately 110-120 thousand hives in Aragon explains difficulties in adopting new approaches.
The president reported that it is even difficult for the association to convince their members to use ARNA labelled coloured drums instead of others, for them selling in bulk.
However, the association is aware of traceability, fast changing markets, and general economic digitalization to keep their position in the Spanish and International honey market and showing interest to not lose market power and pace in the fast ongoing market.

4.1.7 Environment/Climate Change/Honey Production:

According to collected interview information on vast impacting climatic parameters and the past beekeeping season 2022, all stakeholders reported the extreme heat and hot summer 2022. These personal feelings and experience (less flowering plants, more transhumance to irrigated agricultural crops as lucerne to avoid drought stress for the bees and add up resilience, one beekeeper reported of more than 80% loss of his 3000 hives in 2022) climate change is in the forefront and as major future challenge vastly discussed. These findings are in line with the Spanish metrological agency AEMET, where spokesman Rubén del Campo explained: „average temperature in Spain reached 15.3°C, which is 1.6°C warmer than normal", something he described as unprecedented. "It is by far the warmest year in the historical series. The warmest year in at least 107 years".

Besides climatic challenges seen as a new dare for future seasons and threat for the sector, the controlment of main disease varroosis and stressor in beehives *Varroa destructor,* an external parasitic mite that attacks and feeds on the honeybee Apis mellifera, is posing an ongoing threat and increase in production difficulties.

Commonly reported by the beekeepers their conventional synthetic pesticides do not have the same effect efficiency anymore as they had few year ago. Concluding from their point of view an increase in resistance of Varroa destructor against the used parasitic insecticides is strongly recognized.

4.1.8 Blockchain Technology:

The interviewed stakeholders showed vast expertise and knowledge in their field of information technologies and the blockchain technology itself as well as its possibilities adopting in the food sector and honey supply chain. Both, the president of the union of Blockchain Zaragoza and the department head of Smart Labs (ITAINOVA) are convinced of its possible application in the agri-food system. At Smart Labs they already successfully run use cases and pilots on the logistics sector as hub between Barcelona and Madrid. They are also aware of issues dealing with digital maturity but from their point of view people adopting even faster the last years to digital technologies. Pointing out the boost due to Covid-19 pandemic times and the necessity of home-office, webinars and adoption of people and companies who have been not mature before. Another important aspect to mention was that it might be comparable with the dot.com and broad scale internet introduction in the beginning of the 2000'. And also questioned how much people e.g. consumers need to understand the system behind to still be able to use the blockchain technology and its advantages.

To conclude, all interviewed stakeholders have been interested to join the HILE Living Lab and further participate with their knowledge and expertise in the field for broader discussion and implementation of pilot cases which can be used in the honey supply chain. The focus group was also a further step to discuss the importance of the honey sector and its opportunities further.

The results examine the current situation of the blockchain technology in the Spanish beekeeping sector and honey supply chain following the strengths, weaknesses, opportunities and threats according to the deep interviews and the focus group.

4.1.9 SWOT Analysis Deep Interviews (I1) and Focus Group (FG1) Spain

Table 11: SWOT analysis deep interviews and focus group Spain:

Strengths	Weaknesses
• Traceability of the honey supply chain • Consumer demand of more traceability as chance for added value • Visibility for actors • Environmental communication • Transparency • Traceability • Immutability • Honey quality due to special climate zone • Proximity of the production area to large city (Zaragoza) • Health perception of the honey • Essential for Ecosystem Services • Beekeepers standing at consumer side	• Digital maturity- willingness to adopt new technologies • Change and open mind • Data collection • Bottleneck beekeeper • No smart hives yet • Very clustered and segmented beekeeping sector. • There is not enough cooperation within the sector; e.g. no honey cooperative in Aragon. • The sector has vague experience in marketing and communication campaigns • Consumers are not able to identify good honey nor frauded honey. • High quality honey is expensive compared to substitutes or mixed honeys from abroad honey in the supermarkets. • There is no similar legislation regarding the traceability of the honey quality from beekeepers to consumer as e.g. in meat products • Land saturation and allowance of placing new hives. • Honey products are not well positioned in supermarkets and next to jams, substitutes and others (Nutella…) • Honey is negatively perceived by young consumers • low knowledge level of regulation (sector and honey) Associating the honey with high caloric product.
Opportunities	**Threats**
• Improvements against food fraud • Trustworthy certificates • Better protection of high-risk potential products	• Infrastructure • Knowledge of the technology and digital maturity • Climate Change

• Relevance for long value chains • Food safety • Improvement of trust for consumers • Better market segmentation • Higher competitiveness in international markets • Including honey in traditional • Aragon food and sweets • Perfect white sugar substitute • To put more in value honey from crops (de la huerta) • Introduce intelligent label to ensure honey quality and put in evidence the honey history from beekeeper to consumer	• Willingness to adopt • Unification of standards • Varroa destructor and varroosis resistance • Appearance of new substitutes of honey as vegan segment increases in Spain

4.2 Deep Interviews Türkiye

Authors Content and Text: Case Study Leader Seval Mutlu Çamoğlu (Ordu University) et al.
Formatting: Thomas Wassermann, CREDA

Within the WP1 of the TECHONEY project, we have identified 14 stakeholders in Turkey as a result of mapping of stakeholders with taking into account the representation of the quadruple helix innovation approach.

14 Stakeholders consist of:

1 Industry (producer): 4 individual beekeepers, 1 beekeeper association, 1 retailer, bakery/industry, 1 Restaurant-hotel

2 Research: 2 experts. 1 in Honey and 1 in Digitization of supply chain (Blockchain).

3 Authority: 2 institutions (1 food quality certifications/ food safety authorization) 1 local authority

4 Society: 2 consumers' associations

In-depth interviews (I1) were conducted with 14 stakeholders. Summary reports of in-depth interviews are presented below.

4.2.1 Individual Beekeepers Interviews Report (Industry - Producer)

In-depth interviews were conducted with 4 beekeepers. As a result of the interviews with the beekeepers, the average age of the producer is 43. The education level of 3 beekeepers interviewed in-depth is secondary school and the other is primary school. Beekeepers have an average of 18 years of experience. Except for one beekeeper, they earn all of their income from beekeeping. Beekeepers produce with an average of 290 hives. The average strained honey production is 1498 kg, and the combed honey production is 513 kg.

Beekeepers produce both strained and combed honey. One of the beekeepers also sells pollen and propolis, which are by-products of bee. The average income of four beekeepers is 149.250 Turkish Lira (TL) per year.

Beekeepers generally make their sales either wholesalers or directly to the buyers in their environment. A beekeeper also trades through online channels and sales points.

Accommodation, pesticides used in agriculture, production costs, transportation costs, mobile beekeeping and climatic fluctuations were stated as important problems encountered during honey production. Incorrect production by beekeepers who do not have experience also poses a threat to the sector.

Beekeepers use the Caucasian bee breed in production. Diseases encountered in bees are nosema, vergo, lime and varroa disease. Beekeepers used cake and invert syrup for bee feeding during the winter months. Some producers prefer sugar in bee feeding in winter.

Mobile beekeeping is carried out in four producers. Production regions are Mersin flora, Ordu flora, Sivas flora and Tokat flora. Beekeepers stated that pesticides used in agriculture of these regions affected honey production. Common production expenses consist of transportation, bee feed, veterinary and accommodation. Production costs differ between producers. Average honey production cost for four beekeepers is 139.900 TL (383 euro) per hive in 2022.

In the last five years, climate change stands as the most important problem in honey production. It has shown a continuous increase in costs. Beekeepers reflected the burden of inflation on honey prices. Beekeepers stated that sales increased in four beekeepers after Covid-19.

Beekeepers tend to use online sales channels. Increasing costs, climate change and lack of market dominance are the most important problems.

4.2.2 Beekeepers' Union Report (Industry - Producer)

The representative of the Ordu Beekeepers' Union stated that there are approximately 600 registered beekeepers. Activities and meetings are carried out by the Union; It is classified as production training, veterinary training, good agricultural practices, packaging training. It has been stated that they are in constant communication with the producers.

According to the Beekeepers' Union input costs, climatic conditions, export situation and domestic demand are the most important factors in the formation of prices in beekeeping.

The strengths of the sector are stated as the diversity of flora in Turkey and the use of bee products in the health sector. The increase in demand was also evaluated as another strong feature. Weaknesses are variable costs, unconscious production and honey fraud events.

The representative of the union stated that the sector creates many opportunities, but the sector contains some threats. Mobile beekeeping can be done easily in the country due to the high demand for honey and Turkey's flora advantage as the opportunities of the sector. On the other hand, the threats were stated as ensuring security in production area, honey fraud, high production costs and not getting the return of seasonal investments.

According to the representative, honey production is affected by many seasonal factors. A fluctuation is observed in production. Production conditions are directly dependent on the climate and weather. If the climatic conditions are good, the production also increases.

The two most important factors affecting the quality and quantity in production are the diversity of flora and conscious production. In addition to this, bee type, bee diseases and number of colonies are also effective factors. If these factors are taken into consideration, the determined quality and quantity can be reached.

The main problems encountered in production and quality are stated as unconscious production, agricultural spraying, adverse climatic conditions, lack or excess demand, bee diseases, closeness of production areas, and low number of colonies.

The honey is usually sold by beekeepers to their social circles or brokers through bilateral relations. Some honey producers also use digital channels in the sales process. Flower honey and nectar honey are cultivated in the region.

The representative of the union stated that quality is important for them and that beekeepers are given training on this issue. Value-added production will be possible with high quality production.

It is difficult to follow the traceability in honey production, and although they set criteria as a union, the producers preferred to stay away from the issue of traceability due to the costs. In terms of organic honey potential, it has been stated that the region is advantageous in terms of production and flora, and that the producers are willing in this regard. Good agriculture and good price practices are adopted as a union.

The Union has economic activities that will create added value for the producer. A company named BALMER was established in the region. The company also provides support in the packaging and branding process. In addition, contributions are made to the producers by searching for new markets through the association.

The union also attaches importance to the traceability of the honey production process in the food sector. It has become even more important, especially after the Covid-19 pandemic. In this context, the traceability of the process has created opportunities for the consumer and facilitated the creation of value-added goods for the producers who produce well.

Regarding the question of what kind of relations, they establish with other unions, it was stated that negotiations with their superior unions are currently ongoing. Mutual meetings are held with the unions that have a common flora. Since the producers are mobilized, the union is negotiating on behalf of the beekeepers.

The representative considered fraud in honey production as a major problem for them. It has been stated that the concepts of fake honey and sugar honey have become widespread. The union favours the concept of digitalization for quality, food safety and traceability in honey production. It has been stated that digitalization will give them an advantage. In this case, it was emphasized that bad production would decrease and quality would come to the fore. Stating that digital channels take place in every aspect of people's lives, the representative also emphasized that this situation will create a purchasing advantage for consumers.

4.2.3 Industry Firm Report (Industry - Producer)

This firm has been in the sector for 14 years. The trade share in the sector is between 12 and 15% of the local market. This stakeholder firm produces its own brand. They work on an export basis. EU countries, Far East and USA are its export regions.

This firm exported 3.5 tons of honey and earned 1.2 million dollars in 2022 and it also has domestic sales. There are mostly micro-scale enterprises in honey sales in Turkey. The competitive areas of micro enterprises serve the common market. It also carries out active promotion and sales in digital channels.

The criteria that consumers pay attention to in honey products are quality, price difference and attractively packaged products.

The expense items of the firm consist of 15% marketing and advertising, 20% honey purchase, 20% transportation, 30% raw material and 15% labour. Firm size with cost items according to micro-scale enterprises be able to play and reduce costs seen as an advantage. The price differences added until the firm buys honey and honey products from the producer and becomes the subject of export creates a serious cost. In exports, the transportation part affects the trade as a serious cost expense.

The firm is trading in the world market. It is not affected by fluctuations in domestic honey sales. There are periodic changes in honey sales due to price increases and climatic changes in the market. The supply of products is provided by small producers and brokers.

According to the company, honey import is almost non-existent in our country. The reason for this is that honey is a product that is seriously exported in our country and provides foreign exchange inflow to the country.

The company sells the product that has been analysed, produced in quality standards and branded. In this case, it provides reliability in the honey market. The demand for a reliable product ensures that the company takes a long-term place in the sector. The low-quality product exchange experienced in the supply of raw materials emphasizes the weak side of the company.

By increasing the demand in the world market in post-Covid-19 sales due to export-oriented works positively affected. The use of honey in the field of health contributed to the increase in market share demand.

Problems experienced during sales are poor quality raw materials, counterfeiting and increased prices. Opportunities, on the other hand, have made positive contributions to the advertising activities as the company has been accepted in the market.

It has been stated that the honey products analysed and transferred to digital media will be demanded by consumers. Bee products, which are traceable and can forward complaints to the quality department, are a precaution against honey fraud.
Informative advertisements made through digital channels guide customers towards correct consumption.
Thanks to digital channels, the consumer has the opportunity to reach the company and express their complaints and satisfaction. Climate is a very important criterion in honey production. Each flora creates its own condition. The fact that Turkey has different climatic conditions ensures that honey production is carried out at different season intervals.
The aspects that distinguish the firm from other firms specified as to be a reliable brand, to determine export as the main target, having a diverse market audience, conducting honey analysis studies.
Honey consumption in company marketing and sales creates a sales strategy against the consumer by using its health benefits.

4.2.4 Honey Retailer-Supplier Firm Report (Industry - Producer)

This firm is a stakeholder of the TECHONEY project that supplies honey to the market. The firm has been working as a supplier for 16 years. Annually demand of this firm is 2000 kg, and 2200 kg are supplied to the market. The firm has been in this industry for 16 years. The firm trades 2200 kilograms of honey annually, only 5% of which is used for domestic consumption and the rest is exported. The firm usually buys honey from small producers. In some regions, it has contracted production with beekeepers.
While the characterization of honey for sale, they prefer honey that has been analysed in the laboratory and usually the same honey supplier. In case of a new producer entering the market, honey analysis is performed.
First of all, the most fundamental determinant for the manufacturer in ensuring the quality and price stability of the firm is the costs. Others list the quality, type and brand of honey as important price-determining factors.
The firm's perspective on organic honey production; as consumers prefer organic honey more, the value of the product increases. At the same time, there is a demand for organic production in the branding process. This becomes an important factor in the emergence of real prices.
The quality parameters of honey are organic production, information about the production, packaging, agrochemicals used, plant diversity and climate. According to the firm, the origin of the honey is usually clear and obvious, but sometimes the problem of fake honey is also encountered.
The strengths of the sector are listed as follows: nutritious food, a large number of producers and consumers, a wide market area, being the subject of export and its use in the field of health. The firm mentioned its weaknesses as honey frauds, different price and quality demands, lack of domestic demand and ignorance, insufficient production, pesticides used in agriculture and high transportation costs.

The firm's perspective on the value-added product in honey; it has been stated that it will bring positive results in terms of being preferred by consumers, correct pricing, facilitating consumption in export and domestic market, and differentiation in honey and honey sub-products. According to the firm, the more transparent and reliable, the more positive contributions will be made to the markets, consumers and the future of the firm.

4.2.5 Restaurant Interview Report (Industry - Producer)

The firm has been in the sector about 5 years and its field of work is cafe and restaurant management. The company also offers organization services in addition to breakfast, food and dessert.

The restaurant purchases the honey through digital channels and wholesaler from well-known brands. Factors that are taken into consideration in choosing the products are quality, well-known brands, taste and smell.

The restaurant manager stated that the reason for the changes in honey supply and sales price was due to the price fluctuations in the production process. A market price applied to the consumer is determined according to the changing quality and price fluctuations.

The restaurant creates a chain of trust while presenting its products to its customers with the quality and safe brands they offer.

While the restaurant reaches safety food, it carries out the purchasing process by researching through digital channels.

Since the restaurant generally appeals to conscious and young costumers, it is easier for them to access the information of the products with the QR menu, because of the developing technology.

Another factor that ensures the reliability of the restaurant is the transparent presentation of the meals to the customer.

4.2.6 Honey Expert Interview Report (Expert)

The honey specialist has 17 years of experience in the industry.

He emphasizes the importance of certification and record keeping for the process. The weak aspects of the process are that there are deficiencies in auditing. Inspection and control of certificate issuing firms will create a reliable process.

It is not possible to understand the quality of honey by looking at its taste, smell or appearance. Analyses are carried out in a laboratory environment to measure the quality of honey. The high sugar content of honey in its structure facilitates honey fraud cases. Its complexity makes it difficult to detect frauds. Analyses are made by evaluating the parameters in the Turkish Food Codex (TGK) Honey Communiqué. The results of the analysis should be consistent with each other. Corn syrup is detected from the IRMS device. By determining the C4 sugar ratio over the stable isotope carbon ratios, it is determined whether there is honey adulteration.

Both R&D and special request analyses are applied to honey. The analyses included in the TGK Honey Communiqué are applied in special request analyses. In R&D analyses, in addition to these, analyses such as antioxidant, protein, pollen, volatile component, colour are applied.

A success rate of 90% or more is targeted in the laboratory analysis. The quality department examines the identified complaints and implements the necessary improvements.

Analysis difficulties are generally experienced in honeycomb honeys and honeys whose botanical origin is mislabelled.

According to the honey expert, these will be positive in terms of standardization and control of origin and good agricultural practices in all bee products and honey. There is no import of Chinese honey in Turkey. Imported honey comes to Turkey from neighbouring countries such as Georgia, Iran or illegally. Although imported honeys are not wholesale, specially honeys such as Manuka honey are brought in retail.

It is advantageous to apply the technological innovations. There are also some disadvantages. When the technological infrastructure, the age of consumers and producers, and their educational status are taken into account, it becomes difficult for the analyses presented in the digital environment to reach large masses. As a solution, analysis results should be included in the label content of honey packages.

The unequal technological infrastructure all over Turkey creates a problem in using digital channels. According to the expert, to be solution-oriented; It is necessary to provide a mechanism that will establish digital channels, constantly update them, and ensure data security and control.

The beekeepers should be informed about the advantages of certified production. If young producers follow technology closely and are open to innovations, certified production will become more popular.

During the Covid-19 pandemic, there has been intense demand for honey and bee products. However, factors such as travel restrictions, access to raw materials, and labour price increases that came with the pandemic did not cause an increase in the amount of production. This situation is evaluated as an opportunity on the basis of the sector.

The expert discussed technology while determining the changes that honey may experience in the future. With the developing technology, devices that distinguish the quality and structure of honey more precisely and the use of artificial intelligence supported algorithms can create clear results in the analysis results.

When the honey production data of the last ten years are examined, the highest production level has been reached in the world and in Turkey in 2017. Honey production has been in a downward trend after 2017. It is seen that the increase in the number of hives affects the yield per unit by decreasing it.

4.2.7 Digitalization Expert Interview Report (Expert)

The digitalization specialist has 10 years of experience in the industry. Technology shows itself in every aspect of daily life. Especially, the use of smart devices and internet network advance our steps to the age of technology.

The use of blockchain technology in the food supply chain is preferred by consumers in terms of traceability and data security.
Blockchain technology provides reliable information in every field and protection of information with multi-user verification. Although the development of blockchain in Turkey increases with technology investments, it lags behind in the global sense.
According to the expert, due to the nature of the blockchain, it is already built on traceability and every stage is traceable.

THE STRENGTHS OF BLOCKCHAIN TECHNOLOGY

It is traceable, provides secure information sharing, ensures that data is unalterable, can be verified by many users thanks to its decentralized structure, and creates a chain structure.

THE WEAKNESSES are high electricity consumption, being innovative and not being able to verify the input source of the information.

OPPORTUNITIES CREATED BY THE SYSTEM presenting new market opportunities thanks to technology, a reliable production process, openness to the development of technology and a tendency to artificial intelligence technology that will develop in the future.

THE THREAT posed by blockchain technology is the high energy cost. The problem can be overcome by providing the high energy need of the system with renewable energy sources.
Since the blockchain is a new system, it is stated that the system will become widespread and generally accepted by the society.
The expert suggested that the system should be put into practice as a hybrid in order to facilitate its operation. He argues that the infrastructure cost of this system should be covered by the public, and supported from the private sector for the system to be functional.
The high energy consumption of the blockchain creates high energy costs. High costs are the weakness of the system.
The system has no vulnerabilities. It secures against sabotages with multi-user authentication.
In order for the system to work well, the expert stated that it is correct to use powerful and new generation processors, but the system will not work without a good network.
According to the expert, the internet already has a decentralized structure by its nature. The new generation called the technology generation has internalized the internet. After two generations, this technology will be a part of life.

4.2.8. FOOD SAFETY AUTHORIZATION INTERVIEW REPORT (INSTITUTION)

The laboratory has been serving in the region for 40 years. The fact that the Turkak (Turkish Accreditation Agency) procedure is very comprehensive and heavy makes the certification process difficult.
The food laboratory detects honey fakes by applying the analyses specified in the Turkish Food Codex Communiqué on Honey (No: 2012/58).
Corn syrup is determined by performing C4-C13 carbon analyses with the IRMS device. Since rice syrup is not used in Turkey, its analysis is not done.
There are no complaints from the analysis results throughout the year. Honey analyses are documented with an analysis report.

Authenticity and good agricultural policies should be supported in honey production. Quality production should be auditable with support.
As the use of digital channels can present a vulnerable environment due to the nature of technology, controls should be followed closely. Analyses of all bee products ready for sale must be carried out safely.
Problems in the control of digital channels can cause imitation and abuse.
It is stated by the expert that the certified work of the producers will be positive for the honey sector. It is recommended that it serves the purpose of being certified and not only in a document.

4.2.9 The Local Authority Interview Report (Institution)

The interview was held with the Project Manager at Ordu Municipality, who is a Food Engineer as a local administrator. This public official has been actively involved in food and agricultural projects for 6 years.
This public official stated that they provide support to the beekeepers by planning their production stages as well as providing raw materials, production tools, and funding support. The institution carries out studies aiming to reach more consumers by discovering new markets.
While the project manager talks about the strengths of the region in honey production and consumption, he states that climate, vegetation, agricultural products specific to the region and beekeeping activities make positive contributions. The project manager states that agricultural products such as hazelnuts, persimmons and kiwis produced in the region and in the field of beekeeping, chestnut honey and flower honey production provide employment to many people.
As a project food engineer, he communicates with beekeepers through digital channels or one-on-one meetings, and collaborates with the beekeeper's union.
The institution determines the region by conducting research on climatic conditions and plant diversity in field studies. It records the works by following the beekeepers in the determined regions from their places.
The institution provides positive support to the production process by providing beekeeping materials, production tools, and cash aid to the producers.
One of the most important points of the institution is to ensure food safety with the conditions provided for the producers to produce quality products. At this stage, the institution has signed certain protocols with the producers.
While Ordu province ranks first in the beekeeping sector, it has a special place in the region in terms of production. Although the institution is not active and sufficient in the media, but they are more effective in the social media.

4.2.10 Consumer Association Interview Report

The consumer association has been operating for 28 years. The main purposes of the foundation of the association are to defend food safety and consumer rights.

The association maintains its communication with consumers by telephone, e-mail, social networks and face-to-face.

Its mission is to ensure that consumers reach products that are of high quality, reliable and sustainable, at the right price. Its vision is to inform consumers, to enlighten manufacturers and retailers about correct production and sales, and to provide necessary legal support to consumers.

While ensuring food safety, it carries out its activities with tools such as training seminars, public service announcements and billboards. It follows the inspections in terms of traceability and carries out legal follow-up of the related complaints.

Economic-based problems experienced throughout the country lead consumers to buy cheaper products.

All investments made in the product make its price more expensive than other products. The issues that the association considers while producing quality honey are as follows: honey type, sugar content, organic production, place of production, analysis results and examination in terms of nutrition.

The issues that the consumers apply to the association are the honey produced in bad conditions, packaging fraud, fakes, the difference between the advertisement and the product purchased.

The association uses social media, website, e-mail and mobile phone applications in its activities. The problem seen in digital channels arises from the fact that consumers are not sufficient to use technology.

According to the association, the conscious behaviour of consumers towards food safety has increased after Covid-19. Many diseases that came with the pandemic have led people to healthy, organically produced products. When the conscious production meets the conscious consumer, a reliable food corridor is provided.

The strengths of the association's work in terms of food safety; conscious consumption, right price, quality, efficiency, controllability. Weaknesses; income loss, low production, low consumer income and social unconsciousness.

OPPORTUNITIES CREATED BY FOOD SAFETY; right price, quality product, quality service and more consumption. While food safety creates opportunities, it creates threats by causing counterfeiting, unconscious consumption and marketing differentiation.

Health problems with Covid-19 have caused people to consume more honey. The increasing demand for honey has led to the fake honey and the production of low-quality honey. However, conscious food consumption prevents this.

Knowing the quality of honey and the characteristics of honey in honey consumption is a reason for preference among consumers.

Since honey consumption is shaped by income, it is not always produced with high quality.

While evaluating the 10-year process, the association stated that food safety and traceability have increased with the widespread use of developing technology and digitalization.

4.3 Deep Interviews Tunisia

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Formatting: Thomas Wassermann, CREDA

About this report

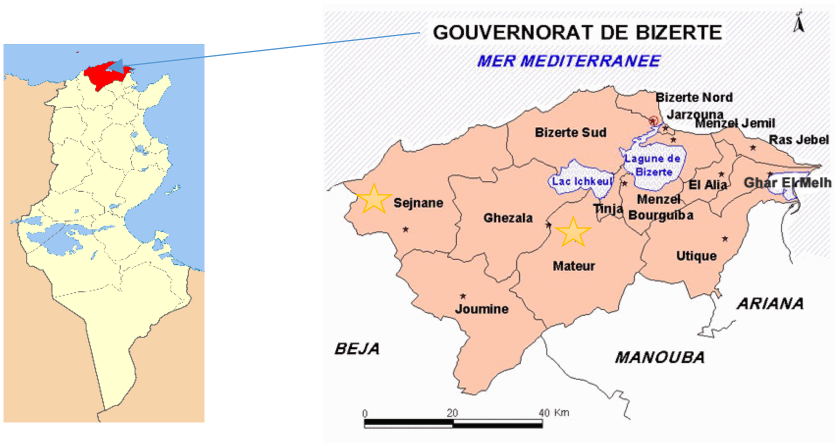
This report presents the findings from the in-depth interviews with the main stakeholders of the honey value chain implemented from December 2022 to March 2023 in Tunisia. During this period the INAT interviewed 17 stakeholders distributed as follows in the Table 12.

Table 12: Stakeholders interviewed in case study country Tunisia

INDUSTRY/PROCESSOR	RESEARCH	AUTHORITY	SOCIETY
6 Individual beekeepers **2** Beekeeper association **2** retailers **1** Bakery/industry **1** Restaurant-hotel	**2** experts →1 in Honey and →**1** in Digitization of supply chain *preferably in Blockchain Technology*	**2** institutions → 1 food quality certifications/ food safety authorization → **1** local authority	**1** consumers' association

4.3.1 Beekeepers

6 beekeepers were interviewed: 4 in the region of Sejnane (Bizerte), one in the region Mateur (Bizerte) and the last one in Tunis capital. Beekeeping significantly contributes to increasing and diversifying the incomes of many rural households in the governorate of Bizerte. Also, the region has vast potential for honey production.



Production parameters

Input prices

Wax, feed, treatments and transhumance costs are the most important expenses for beekeepers. These costs are distributed as follows:

- Wax: each hive consumes 2 kg of wax at a cost of 26 DT/kg, i.e. 52 DT/hive/season.
- Treatments against varicella: For approved products 110 DT/package (11 DT/hive) and unapproved products (imported from China) 2 DT/package: a preventive treatment must be carried out once a year.
- Cost of guarding in transhumance areas: 3 to 5 DT/hive/month.
- Packaging: 1kg jar at 1.75 DT, box of 24 jars costs 40 DT.

OUTPUTS PRICE

- Direct selling from beekeepers to final consumers: 40 to 50 DT/ kg
- Direct selling (beekeepers to intermediaries: 35 to 45 DT/kg
- Selling via specialized shops and retailers: 55 to 150DT/kg (Marube)

Figure 6: Hives in the region of Sejnane (Bizerte)

→ In general, prices are not differentiated according to honey quality.

DISTRIBUTION CHANNELS OF HONEY

Most of the beekeepers sell their production directly to final consumers and in some cases to intermediaries. Beekeepers have their loyal clients who generally make group-purchases for their family members, friends and colleagues. Confidence in beekeepers and recommendations constitute the criteria for purchase for those consumers. In general, beekeepers don't have their own shops or e-commerce except "la maison de miel " which has its own sales shop. For this beekeeper, 15 to 20% of quantities produced are sold through their own shop (also a website and Facebook account for ecommerce); 60% in super and hypermarkets (in jars with private labels and in bulk); 20 % for pastry shops, hotels and airports (in pots and in bulk) and 5% via delicatessens shops (Grand Tunis and Sfax) using own brand and private label.

Willingness to digital adoption

Beekeepers show great interest in digitalisation and networking with beekeepers and consumers from other countries. Indeed, beekeepers are not currently very connected, but they have positive attitudes towards digital tools. The perceived benefits of digitalisation for beekeepers are mainly associated to the health control of bee colonies, which could decrease their mortality (serious problem for most of beekeepers). Moreover, most of the beekeepers believe that digitalisation offers new opportunities for selling their products and for reaching new markets. However, most of the beekeepers think that the digital tools should be accessible in terms of price and cost because the financial resources of small and medium beekeepers are currently limited due to the high cost of inputs.

Overall change last 10 years

Over the past 10 years, beekeepers mention that they noted a decline in the bee colony due mainly to climate change and pollution. In fact, according to beekeepers, the high temperatures during the last two summers damaged hives and affected the quality of honey. Also, forest fires have increased in recent years in addition to low rainfall, which has greatly reduced the availability of honey plants. All these factors have impacted the number of hives and the quality of the honey. Additionally, the economic and politic conditions in Tunisia (trade balance and inflation) reduced the inputs availability and costs. Thus, the profitability of the beekeeping activity decreased. However, most of the beekeepers mention that even if there is an increasing demand for honey and bee products because of consumers' awareness and demand for healthy products, the increasing number of beekeepers is transforming the market and they are suffering from high and disloyal concurrence (especially from imported honeys of less quality and prices).

Conflict agriculture and beekeeping

Beekeepers sometimes have problems with transhumance because some farmers are not aware of the importance of bees for the pollination. Also, some farmers ask to be paid in return. This can be a major burden for beekeepers in addition to the transport costs.

Organic production

None of the beekeepers interviewed practice organic farming. The reasons behind this are mainly:

- Difficulties in meeting the requirements of the organic farming certification

- Lack of financial resources for certification

- There is no price differentiation between conventional and organic honey

Impacts of COVID-19

According to beekeepers, sales increased during COVID-19 because honey has therapeutic uses for consumers. In fact, it is perceived as a healthy product with real benefits for the treatment of COVID-19. However, the working conditions were more difficult due to traffic restrictions between regions. Beekeepers suffer from difficulties in travelling to ensure the transhumance of their hives, to sell honey products, and to buy inputs and medicines for the hives.

The online sale of honey products has impacted on the beekeepers' sales niches (loss of customers who became used to the online purchase and who developed other niches during two years of COVID19).

SWOT analysis Beekeepers

Table 13: SWOT analysis of beekeepers Tunisia:

Strengths	Weaknesses
• Beekeeping knowledge • Good quality honey • The diversity of the plant cover as a source of food for the bees and for the diversity of the honey (Eucalyptus, thyme, orange, …..)	• Unorganised sector • Low honey prices at beekeepers level • Lack of subsidies and support from the state • Problems in marketing honey products • Unavailable inputs (sugar, pasta, treatments…….) • High price of inputs • Unregistered treatment products on the market that impact on bees and honey. • Equipments are imported and expensive • Loss of hives even with guarding • Mortality in cold (or hot) weather
Challenges/Opportunities	**Threats**
• Labelling and certification of products • Control of quality • Organisation of the beekeeping sector	• All fruit fields are over-treated • Sale of imported honey without specifying its origin • Honey consumption is occasional in Tunisia

4.3.2 Beekeeper Association

Presentation of the associations

Two association of beekeepers were interviewed. The first one is an Agricultural Development Group specialized in beekeeping and created in 2014. It is located in the regions of Joumine and Twanjnia (Bizerte – North of Tunisia). This association is under the supervision of local authority (ODESYPANO – Sejnane) and most of the members are coached by this authority.

The Tunisian Association of beekeepers is an association with a non-profit objective, concerned with beekeeping, preserving bees and biodiversity, and protecting the local breed. The goal of this association is to link between beekeepers, to push cooperation between them and to put forward discussions and dialogues that will develop work methods. This Association was created in 2015. During the years of 2018-2020 was inactive and actually, all members are renovated and are starting a new program of action.

Table 14: Data about beekeepers' association Tunisia

	Group of beekeepers el WIFAK	**Tunisian Association of Beekeepers ATA**
Date of creation	2014	2015
Number of beekeepers	70	40
Total number of hives	2500	No data
Zone of intervention	Joumine – Twajnia (North of Tunisia)	all the region of Tunisia
Production level	8-10kg/hive (good season) and 5kg/hive (bad season)	Depends on the region
Types of honey	Thyme Eucalyptus, Sunflower	Depends on the region

THE MAIN SERVICES OFFERED TO MEMBERS CONSIST IN:

- Training of members in beekeeping related activities
- Exchange of experiences with trainers and beekeepers in other regions
- Provision of equipment: use of extractor
- Assistance and supervision of beekeepers
- Intervention through advice in case of diseases
- Presentation of the beekeepers to the state

PRICE STABILITY AND PRICING

Price is generally fixed according to the market (supply and demand). During the last year it was between 50 and 70 DT /kg. There is high demand for their honey because it is of good quality and sale is guaranteed. In fact, the association el wifak won the bronze medal for thyme honey in the national competition for local products in 2018. The Tunisian competition for local products is part of the guidelines of the Ministry of Agriculture, Hydraulic Resources and Fisheries as well as those of the Ministry of Industry and SMEs in terms of promotion and enhancement of local agricultural and agri-food products. The organization of the competition is supported by the Market Access Project for Agri-food and Local Products (PAMPAT) implemented by the United Nations Industrial Development Organization and financed by the State Secretariat for the Economy. Switzerland (SECO). Actually, they are using this medial to promote the quality of their honey.

Even if the two associations don't ensure the distribution of honey, it allowed the beekeepers who are members of the association to cooperate and to work together for selling their honey.

QUANTITY AND QUALITY PARAMETERS

The Tunisian beekeeping sector suffers from a serious quality problem. The products on the market are sold without any identification (name of producer, type of product, composition etc.). Similarly, controls on the quality of national or imported products are almost non-existent. This is due to the absence of strict control over the products sold on the market, whatever their origin. In addition, a large number of producers are not trained in good practices for the production of quality honey. On the consumer's side, there is a lack of information, which makes it easy for them to be conned by poor quality products. The Tunisian consumer is not demanding either in terms of quality or in terms of information on honey. He buys according to his confidence in the beekeeper.

Any action aimed at improving quality must necessarily require labelling and packaging of honey in order to be able to give on information on the quality of honey to consumers.

CHALLENGES FOR BEEKEEPING SECTOR IN TUNISIA

According to the two associations, the main challenges for the beekeeping association are:

- The organisation and structuring of the beekeeping sector
- Creation of an ecosystem for the beekeeping sector
- taking action against the import of poor-quality honey, especially Chinese honey
- working on hive insurance
- creation of direct sales points: beekeeper - consumer
- creation of collective brands
- make agreements with suppliers, especially for the purchase of inputs

HONEY DISTRIBUTION CHANNELS

The two associations are not involved directly in the marketing and distribution of honey. However, they facilitate the participation of their members in some fairs and exhibition.

IMPORTANCE OF TRACEABILITY

The guarantee of traceability is important for both the consumer and the producer, but two conditions are necessary:

- developing the market for quality products
- support from the state

With the current price, it is not encouraging for beekeepers to join traceability systems. Indeed, the Tunisian consumer is limited by purchasing power and does not encourage the sale of high-quality products.

The current context marked by a lack of connectivity of beekeepers and limitations of financial means also constitute barriers for traceability.

SWOT Analysis for beekeeping association

Table 15: SWOT analysis of beekeeper association Tunisia:

Strengths	**Weaknesses**
• Experience and know-how in the beekeeping sector • The adhesion of beekeepers in associations and groups	• Lack of supervision and support from the state • Lack of policies for the development of the beekeeping sector • Problem of marketing quality honey • Beekeeping is not a main activity • dominance of small beekeepers • No action regarding the marketing of products
Opportunities	**Threats**
• High demand in the market • Good perception of honey as a healthy product • Natural resources favorable for beekeeping (especially forests) • The richness of the plant fauna and muliflora	• Competition from imported honey and poor-quality honey • Climate change • Excessive use of pesticides and plant protection products • Forest losses (fire and deforestation) and lack of replacement by multiflora

4.3.3 Retailer

For the distribution of honey, two retailers were chosen for the in depth interview: la maison de miel and Sidi Zemni.

Selling structure

Sidi Zemni is distributing honey using the brand of sidi Zemni. It consists on buying honey from beekepeers, ensuring the conditioning and the banding of honey.

La maison de miel is also included as beekeepers since it is producing and distributing its own products. They have their own e-commerce channel, a shop in Tunis and they are selling their products in supermarkets. In the following section, we will focus mainly in sidi Zemni interview because the main results corresponding to "la maison de miel" are commented at the beekeepers section.

Market size

Sidi zemni sales different types of honey: eucalyptus, rosemary, orange, thyme, jujube, nigella. They are offering also some hive products like pollen, propolis, royal jelly and wax. The sold quantities are about 700 Kg/year using just online sales through their own Facebook channel. Actually they are preparing their shop in the Marsa city.

- Online sales through Facebook
- Projected sales location in downtown Tunis

Consumers of Sidi Zemni are from all the region of Tunisia. During the last year, 60% of their products were purchased by loyal consumers.

Sources of supply

Regarding Sidi Zemni, they have three suppliers: The first one in the governorate of Bizerte providing about 200Kg/year. The second one from Zaghouan and he provides about 50 to 100 kg/year. The last beekeeper works in the North (Cap-Bon) and the centre (Kairouan) who supplies between 200 and 400 Kg/year.
The purchase prices of honey are between 35 to 40 TND/kg.

Outputs and inputs prices

- Honey: from 60 to 80 DT/kg
- Mixtures of honey and dried fruits and energy mixtures (honey + dried fruits + dried
- fruits + pollen): 80 and 110 DT/Kg

Figure 7: Products of Sidi el Zemni

SWOT Analysis of retailing

Table 16: SWOT analysis of retailers Tunisia:

Strengths of sold honey	Weaknesses
• Good quality • Various types (spices and origin) • Good price-quality rice • Using ecommerce selling Tunisia.	• No quality certification • Basic packaging • No information about the origin of honey • No quality analysis

Opportunities	Threats
• Demand for healthy products • Consumers awareness about local product • Consumers uses of ecommerce	• Imported honey and fake honey • The decrease of national production of honey

Opportunities for traceability

Traceability systems in the honey value chain help to avoid frauds and ensure quality and safety. The strict standards of traceability systems may be negatively perceived by beekeepers because they suppose a lot of work for them, new management practices and rigorous control at all steps of producing honey but sure they will give them new opportunities even if in Tunisia the market is not yet prepared.

Alteration and fraud

According to Sidi Zemni Tunisian consumers are always concerned about the quality of honey. They are afraid to buy fake honey. They don't trust new honey until they have good experience with the product or received positive feedbacks from other consumers. So all honey brands must work hard to ensure product authenticity and avoid fraud.

In Tunisia most of frauds consist of the adulteration of honey (by adding glucose syrup for example). Also some frauds are obtained as a results of beekeeping practices like feeding the bees during the period of production.

Interest of consumers on origin

Actually, consumers of sidi zemni ask about the region of origin of their honey because some consumers have preferences for honey from the north of Tunisia rather than others kind of honey. Tunisian consumers use trust, origin and price as main attributes when choosing honey.

4.3.4 PROCESSOR (BACKERY, INDUSTRY)

Production process and farm size

La reine d'or is a recent unit created 1 year ago. The process is semi-crafted: use of small modern equipment: drying oven and mixer. An approved laboratory is planned for next year. During the last year, la reine d'or produced 400 Kg of processed products:

- Honey sweets
- Dried fruit pastes with honey
- Dried fruit mixtures with honey

To ensure this level of final products, la reine d'or used about 200 kg of honey.

Figure 8: Some products of la reine d'or

Origin of honey and sources of supply

Regarding the origin of honey, la reine d'or is using its own production. In fact, they have an ecological farm with 150 hives in transhumance in the North of Tunisia (Mateur and around). In 2022 they produced 500 kg of honey. 200 kg were used for processing and the remaining quantity sold as honey.

Organic beekeeping

La reine d'or has no organic certification, but it is involved in sustainable production process. In fact, la reine d'or is associated with the Citizen Food Network of the Tunisian Permaculture Association (ATP). For the purchase of raw materials, they buy from local producers or short circuits. As for honey, they use their own beekeeping project produced according to agro-ecological conditions. Their products are distributed in Short circuits: sales on the spot, direct selling at fairs and through the consumer association of ATP.

Quality parameters

Quality is an important issue for honey products because usually consumers seek for typically high-quality products. However, in Tunisia most beekeepers believe that they are producing the best quality product and are unaware of the importance of quality analysis. Unfortunately, quality analysis can be costly, and for small-scale beekeepers, it represents a significant expense. As a result, most of the beekeepers do not perform quality analysis on their honey.

Transparency /Trust

Consumers become suspicious of the products they consume. Even with a slow pace, the Tunisian consumer seeks direct purchase from producers and looks for local one. This allows the establishment of a trusted relationship between the producer and the consumer and which itself plays the role of quality guarantee. La reine d'or is already a member of the Tunisian Permaculture Association and this allows buyers to have access to all product information. It is important for the brand that consumers trust their product and perceive it as high quality and safe brand.

SWOT ANALYSIS PROCESSORS

Table 17: SWOT analysis of processors Tunisia:

Strengths	Weaknesses
• Good quality of raw materials • Having their own production of raw material (honey) • Being member of Tunisian Association of Permaculture	• Lack of financial resources to invest

Challenges/Opportunities	Threats
• High demand for products	• Low planting of honey plants • Insecticides not approved in Europe and sold in Tunisia that kill bees • Forest fires • Lack of incentives and subsidies from the state

4.3.5 HOTEL/RESTAURANT/HOSPITALITY

PRESENTATION OF DAR ZAGHOUAN

Dar Zaghouan[1] is the first guesthouse and ecological farm created in Tunisia in 2006. Dar Zaghouan consists of two buildings (one of which is an ecological chalet), about fifteen rooms (thirty beds) and a very complete offer, including a sustainable wellness centre with a spa and an ecological hammam, and a very popular traditional restaurant, an agricultural museum, a botanical garden, an organic shop (offering olive oil, honey and various local products), and a multitude of nature activities. 80% of the ingredients are produced in the farm and the rest is purchased from local farmers. Most of the products are local.

QUALITY AND QUANTITY OF HONEY USED IN DAR ZAGHOUAN

Dar Zaghouan uses honey to prepare breakfast offered to the guests. The most demanded honeys are those from Zaghouan forest, like monofloral rosemary and thyme honeys. They

[1] https://darzaghouane.com/

buy an average quantity between 800 and 1200 kg/year. Most of the honey is bought in bulk in 1 kg unbranded jars. Regarding the price, they usually pay between 30-40 TD/kg. This price is considered a fair price according to Dar Zaghouan manager since they usually buy big quantity of honey.

ORIGIN

Generally, consumers ask for the origin of the honey especially after consumption when they appreciate the products taste and quality. The clientele of this guesthouse is specific. They are looking for local, authentic, high quality, natural and organic products. Through their dishes, Dar zaghouan encourages local and high-quality product from small beekeepers of the governorate of Zaghouan.

SELLING OF LOCAL PRODUCTS

Dar Zaghouan reserved small shops to sell honey for local beekeepers mainly during summer and autumn. They avoid selling honey during winter because of crystallisation due to low temperature. Also, they distribute small quantity of honey (no more than 100 kg per year).

PRICE STRUCTURE

Dar Zaghouan believe that offering high quality food products will necessarily result in a determined level of price. It is impossible for the guest house to ensure high quality for their consumers while offering fair price to the local beekeepers and farmers without fixing the price of their meals and service as high as to ensure the business profitability.

PROVIDED INFORMATION TO GUEST

Actually, Dar Zaghouan are promoting their business as ecological and where most of the ingredients are produced in the farm and they communicate about this advantage. For the honey they offer information in demand. That means that they don’t display any information about the origin of the used honey unless consumers ask about the origin of the product.

INTEREST IN INFORMATION

Dar Zaghouan are in favor of this kind of information system because it guarantees quality for customers and can play a communication and promotion role for their guesthouses and increases consumer confidence

They are also in favor of a quality certificate and the uses of traceability systems, but they consider that an awareness campaign should be implemented both at consumer and beekeepers levels because it is important to educate them about the importance of these systems and the associated benefits that they can obtain.

SOURCING ROUTE

Dar Zaghouan uses honey to prepare the breakfast offered for visitors. They prefer the direct purchase from small and local beekeepers of Zaghouan. They have an experienced buyer who usually purchases honey from beekeepers they know and trust. Since they don’t ask for quality analysis, they first buy small quantities to test. Once approved from the buyer, they proceed to purchase the whole quantity that they will use during the year.

4.3.6 RESEARCH

EXPERT HONEY

FRAUD / AUTHENTICITY

Honey is a substance secreted by bees from nectar or honeydew. The addition of sugar makes it lose its authenticity: this is called honey adulteration.

The only way to verify authenticity is by laboratory analysis. The analysis techniques are more and more developed but, the principle remains the same: it is to detect the added sugars, enzyme analysis.

Besides, it is recommended to do the pollen analysis in order to detect the presence of pollen grains and to identify the origin of honey.

ANALYTICAL TECHNIQUE

In Tunisia, there is no quality control through laboratory analysis for honey. The analyses are used to detect:

- → Moisture content < 20% (European standard) and < 18% to avoid fermentation. This moisture level can be related to the work of the bees.
- → Enzymes (invertase and proline) should be present in good quality honey.

Feeding the bees during the active season is not recommended as it produces lower quality honey. Bees only require syrup feeding during the winter.

Feeding the bees results in honey that lacks amino acids, vitamins, proteins, and pollen. Some fraudulent practices involve preparing mixtures of sugar with added rosemary and thyme or mixing sugar syrup with honey.

The heating of honey damages the enzymes. Indeed, the crystallization of honey is a natural process, but some beekeepers heat the honey to make it liquid, but honey does not support a temperature > 40°. The HMF analysis (5-hydroxymethylfurfural) indicates the ageing of the sugar and indicates if the honey has been heated.

The beekeeper in Tunisia does not know when to harvest the honey. He does not use the refractometer that allows him to know when to harvest.

The problem of quality is also linked to larvae and insects.

FUTURE CHANGE TO THE NORM

Analysis of honey with wax should be required to analyse pesticides and plant protection products wax in order to analyse pesticides and phytosanitary products because actually in Tunisia there is an overuse of pesticides in farming, and it is damaging the beekeeping sector and the quality of honey. Also, it represents a big issue for human health. Besides, honey traceability systems must be put in place and to do this the sector must be organised and consumers must be made aware.

4.3.7 Expert in blockchain technology

Blockchain Technology in the food supply chain

→ Opportunities

Today's consumers are increasingly focused on quality, safety and sustainability. They also want to know the origin and provenance of food products. Nowadays, food products come from globalized and complex supply chains so, they lose their identity. Taking this into account, it is important to ensure that consumer get the needed information.

The digitalization and blockchain gives comprehensive information about food products from the farm to the fork.

In Tunisia, the only use of a traceability system in the food sector is in the olive oil sector: CHO group[2] is using IBM Food Trust blockchain to ensure the traceability of its Terra Delyssa extra virgin olive oil through various quality assurance and information control points, including the fields where the olives were sourced, the mill where the olives were crushed and the facilities where the oil was filtered, bottled and distributed.

→ Threats

- Low price acceptability
- Local consumer not demanding traceability

→ Weaknesses

- Low connectivity in some rural areas
- Limited education level of farmers
- High average age of beekeepers (prevents adoption)
- Resistance to adoption

4.3.8 Traceability

From the consumer side traceability is synonymous of guarantee and transparency. It increases consumer confidence in food product and makes easy the choice since it is an efficient way to reduce risk when buying and consuming product.

From the producer side, traceability system facilitates the quality labels obtaining and ensure a better management of all the process. Also, it allows meeting specifications in terms of fairness and transparency: better revenue sharing.

Issue of electricity needed for blockchain application

It is clear that in the current context of climate change, all technologies using energy are criticised, but associating BCT with high energy consumption is false. It is clear that people have a negative perception of BTC because they are getting confused by the bitcoin energy

[2] https://group-cho.com/blockchain-end-to-end-traceability/

consumption. Indeed, blockchain technologies are evolving and improvements are being made. We can't speak about homogenous BCT but each technology works differently. In this context, scientific studies are trying to compare the energy efficiency uses for different technologies and recommendations are made based on the research evidence. But it is obvious that the methods for calculating energy uses should be taken into account when analysing these results and recommendations. Moreover, energy consumption is not a constraint for the adoption of BCT compared to the numerous benefits for stakeholders even with energy efficiency associated to the supply chain management.

Best type of blockchain

In this case, the consortium blockchains are more suitable because they are controlled by a group of organizations or stakeholders of honey value chain. They offer greater privacy and control than public blockchains, while still being decentralized, but can be more complex to set up and maintain. Also consortium blockchains are better than private ones where one entity controls the network.

4.3.9 Local authority: ODESYPANO - Sejnane

Presentation

The Office of Sylvo-Pastoral development of the Northwest (ODESYPANO)[3] is a public non-administrative establishment (EPNA) with civil legal personality, financial autonomy and placed under authority of the Ministry of Agriculture, Water Resources and Fishing.

The main fields of the ODESYPANO activity are:

- Increasing incomes through support of agricultural and non-agricultural activities and the improvement of living conditions for the population through the establishment of a socio-economic infrastructure (roads, water supply ...).
- Protection and improved management of natural resources in the intervention zone.
- Structuring the rural environment by the organization of the rural population in the development committees and socio-professional organizations (GDAP et SMSA).
- Institutionalizing of Integrated Participatory Approach and partnership inside all governmental and Non-governmental.

The ODESYPANO has its headquarter in Beja but it has also four Regional Directorates (Beja, Kef, Ain Draham and Sejnane) and a support unit in Siliana. The Regional

[3] http://www.odesypano.agrinet.tn/accueil.html

Directorates (RDs) have a mission to promote local planning with partners, to implement programs and support local organizations.
The ODESYPANO operates in mountainous and forested areas of the Northwest covering, in totality 1.15 million hectares, which represents approximately 60% of the total area of the North West and contains more than 0.5 million hectares of forests and rangelands and principal hydraulic network of the area.
Sejnane is an important honey producing area in Tunisia with a fairly large number of beekeepers. For that, Odesypano has created a follow-up group specialized in supporting beekeepers. Odesypano plays a role in training and advising beekeepers in the region with a core group of beekeepers. Since 2004, it has coached a group of beekeepers for 4 years to provide technical assistance and help them achieve yield objectives. Thus, it has supported at least 30% of the region's beekeepers, which has about 15,000 hives.

Role in the beekeeping sector at the local

• Follow-up of beekeepers

• Development of honey-producing plants

• Training and coaching of beekeepers for technical improvement

• Assistance to Group of Agricultural Development

The intervention of the Odesypano as a support structure and the accompaniment of beekeepers is notable. Thus, it should be included in the TECHONEY Living Lab.

Beekeepers in the region of Sejnane

The region of Sejnane is caracterised by family beekeeping with integrated agriculture <50 hives. On average, each beekeeper in this region has about 24 hives. Those with more than 100 hives are considered professionals and are not followed by Odesypano.
The local production levels are:

• 10 kg/hive with transhumance
• 6 kg/hive with Odesypano follow-up
• 3 kg/hive without transhumance and without follow-up by Odesypano

Table 18: SWOT analysis of Experts Tunisia:

Strengths	Weaknesses and Threats
• The know-how of Odesypano • Honey has been the region's flagship product since the early 1980s • The presence of PAM (thyme), Eucalyptus forests, Fodder plants (Sulla and Bersim), Heather, forest	• Climate change affects sustainability (heat and water availability issues) • The density and importance of honey-producing plants are starting to decrease • The management of hives is becoming more critical

shrubs (lentisks, Myrtle, Erica) • Honey is an important source of income It generates 10 to 20% of revenues • The activity creates jobs (about 600 beekeepers in Sejnane) • The region has a good reputation for its honey production.	• No mono-floral honey at the regional level because there is no dominance of a single species. • Absence of SMSA[4] that can bring the commercial side • Lack of quality analyses done to determine the honey quality (expensive) • The cost of transhumance (1kg of honey /hive)

Many companies are involved in the honey sector at the regional level:

- 3 specialized equipment companies (just for beekeeping equipment)
- 5 agricultural equipment companies
- Many intermediaries outside the region for marketing and selling

LAND CONFLICTS AGRICULTURE AND APICULTURE

→ At the regional level, there are no conflicts between agriculture and beekeeping: the land is generally used for fodder for livestock, and beekeeping benefits from these crops. The region is a dairy basin with small farmers and an important honey-producing zone. In some cases, farmers may ask for remuneration when beekeepers deposit their hives on their farms.

→ Traceability would be interesting for small beekeepers who produce a regional and local product. It helps them to avoid disloyal competition from imported and fraudulent honey. In Tunisia, the problem of fraud in honey is very important. Honey is sold at 12 DT/kg in some regions of Tunisia.

4.3.10 FOOD QUALITY CERTIFICATION/ FOOD SAFETY AUTHORIZATION

PRESENTATION OF THE LCAE

The Central Laboratory of Analyses and Tests[5] is a Public Establishment of a Non-Administrative Nature (EPNA) created by law n° 88-24 of 14 April 1988. It is placed under the supervision of the Ministry of Industry, Mines and Energy. To carry out its missions of quality control and product safety, and to fight against fraudulent practices, the LCAE relies on a network of 50 laboratories distributed in centre's in TUNIS, accompanied by a regional presence in Sousse, Sfax and Gabes. Its role is to respond to requests for analysis and expertise from administrations and economic operators. The LCAE is particularly in charge of carrying out studies, research, analyses and tests of any kind allowing the promotion of the industry, the quality control and the application of the regulation. It carries out analyses and tests for:

[4] Societé mutuelle des services agricoles
[5] https://www.lcae.nat.tn/index.php/fr/lcae/missions

- Quality control in general.
- Conformity to export and import standards of products.
- Detection of fraud in the trade of goods.
- Detection of falsification of agricultural and industrial products.
- Expertise of products and materials at the request of courts, public services and private individuals.
- Controls and tests by destructive and non-destructive methods of works, equipment and various materials.
- Spraying of tanks.
- Verification of meters.
- Calibration of equipment.
- Smelting and refining of scrap gold and other precious metals

Fraud detection techniques

The main kinds of honey analyses ensured by the LCAE are: Sugars, Moisture, Conductivity, pH meter, Granulometry, Indices, Pollen analysis, Impurities, Proline (amino acid, indicator of honey maturity),

According to LCAE, honey analyses are often requested by customers, intermediaries, retailers and the ministry of agriculture or trade.

Standards related to quality

The Tunisian standard approved under the number NT 56.12 (1987) defines honey, its description, composition, hygienic conditions, labelling conditions, and analysis and sampling methods.

- Moisture 20% up to 28%? Heather honey (the best honey is that with moisture <18%
- Acidity <50 meq/kg
- pH 4.5 honey of miella
- Specification standards: NT 56-34 and NT 56-12

The honey quality should be monitored from farm to fork. All stages of production, extraction, packaging, storage, and consumption practices can alter honey quality.

Frauds

According to the LCAE, they receive fraudulent honeys but it is not necessarily an intentional fraud. Indeed, some beekeepers are not aware of good beekeeping practices, which leads them to commit unintentional fraud.

→ Intentional frauds:

- Preparations based on sugar, spring water, and PAM or essential oils
- False advertising
- Honey substitute (such as tartimiel)

• The technique of feeding honey consists of adding sugar in the form of small amounts of syrup for the survival of bees during the dormant period. A bad practice can be linked to the addition of huge amounts of sugar, which results in a high level of sucrose in honey.

→ Non-intentional frauds:

• Collection of swarms or pollen with honey
• Heating honey, which crystallizes naturally, leading to the destruction of fructose
• Unstable honey that crystallizes quickly or ferments
• Harvesting before honey ripens, before percolation of the frames

PROBLEMS RELATED TO CERTIFICATION

For organic certification, the beekeeper submits a file to the "Office De L'elevage Et Des Paturage- OEP [6]», which carries out an audit and takes samples sent to Ecocert in Tunisia and abroad (2 Italian and German laboratories). To produce organic honey, there must be no chemical contaminants (pesticides, drugs, untreated sugar and wax).

Organic must comply with specifications.

It is the ministry of agricultural and fisheries that legally controls honey quality

• Authenticity is an important analysis
• The analysis process is too long: 6 months between honey collection and the end of analysis.

Regarding certification, the LCA does not ensure quality certification.

SECTOR CHALLENGES

The main challenge for the beekeeping sector is to ensure training of beekeepers for quality. In fact, 80% of beekeepers in Tunisia are amateurs and most of them are unaware of good practices that produce good quality honey. There are behaviours that produce poor-quality honey.

SECTOR STRENGTHS

Tunisian honey is of very good quality. In fact, Tunisia benefits from 4 seasons with 4 different climates, a diversity of fauna and flora which gives us a special taste for honey. Tunisian honey can compete with the best honey (from Yemen (jujube), African jungle (wild bee honey) and Australian honey. Some medals in international competitions were awarded to various honey producers. In 2022, Maison du Miel was awarded a gold medal at the London Honey competition, while Chammakhi Bio has won numerous medals.

[6] Public company of a non-administrative nature, under the supervision of the Ministry of Agriculture, the OEP is responsible for the development and promotion of the livestock and pasture sector and plays a role of adviser and technical reference for the public authorities.

PROBLEM WITH CHINESE HONEY

The imported honey, it is often used as a substitute for pure honey in Tunisia. The imported honey is packaged and sold in large quantities for confectionery purposes. However, some imported honey from China is not naturally produced by bees, but rather created in laboratories by machines. The origin of this honey is often filtered out in the process.
LCA don't have official statistics about Chinese honey but they believe that a big quantity of sold honey in the Tunisian market is Chinese (even if the origin of importation is Saudi Arabia or Turkey) and that consumers are usually confused about the quality of these products.

4.3.11 CONSUMER ASSOCIATION

PRESENTATION

The Tunisian Permaculture Association created the Citizen Food Network. It consists of a network of farmers and consumers working towards the transformation of agricultural and food systems towards more just and sustainable systems for future generations, through the adoption of agroecology and fair consumption.
The objective of the network is to create sustainable consumption communities, detached from the fluctuations of traditional markets, that support farmers in their transition to sustainable production systems and that guarantee a fairer redistribution of the risks and benefits of food production.
The consumers' community is a "consumers club" belonging to the Tunisian Permaculture Association. Consumers have to join first ATP (membership fee of 20 dt/year) than to pay 10 DT/month as a fee for the club membership to be able to buy products from the market of associated farmers. The club members have access to consumer activities (awareness raising, farm visits, participation in the eco-construction weekend, etc.). This club was launched in December 2021.
The Club has a messenger group with 72 consumers but just 40 are really active.

TRACEABILITY, TRUST, IMPORTANCE OF ORIGIN

In order to consolidate trust between consumers and producers, the association created a Participatory Guarantee Label. The « Nourriture Citoyenne Label » is a collective mark that is awarded by the members of the Nourriture Citoyenne Network to farms that produce food according to agroecology conditions. This label serves to support alternative and sustainable production methods that protect human health, biodiversity, resources and the soil and value the local product and the farmer's effort.

Participatory Guarantee Systems are based on 6 principles:

- Shared vision
- Participation
- Transparency
- Continuous learning
- Horizontality

- Trust and integrity

Actually, two beekeepers of the network are working under this label. As a result, they are able to offer a honey:

- Healthy and natural
- Locally produced
- Of known origin
- Without intermediaries
- At a fair price for the producer and the consumer

DIGITAL APPLICATIONS FOR TRACEABILITY AND IMPORTANCE OF ORIGIN FOR CONSUMERS

The communication between producers and consumers is done through an order file on google docs. There is a list of products, prices and available quantities posted by the farmers and the orders of the consumers are made according to the available quantities.
The consumers can visit the farm for educational purposes or for mutual aid and solidarity, also they meet the farmers during the weekly market in ATP. The network is working according to a responsible consumption mode. Thus, consumers are informed about the origin of the products and they have direct contact with farmers.
Consumers are looking for traceability of products and local products (traditional, natural).
The beekeepers respect the rules of hygiene during the transformation by sterilization and the good practices).

CHALLENGES IN TERMS OF DIGITAL APPLICATIONS

For consumers, there is an easiness regarding the adoption and the uses of digital tools but there are still barriers from the farmers' side since in rural areas, connectivity isn't always guarantied also because of farmers age and level studies.
As an association of consumers, they believe that the use of ITC tools can bring benefits for all stakeholders in honey value chain, not just for consumers.

INTEREST OF CONSUMERS AUTHENTICITY

CHANGES WITH COVID-19

The consumers club was created in December 2022, they don't know the situation before COVID 19, but they think that with this pandemic, consumers became more interested in healthy products (like honey) but also in local foods because during the lockdown people mainly buy from local producers.
They believe also that the pandemic covid-19 has increased consumers uses of digital tools and e-commerce for buying even for fresh food like fruits and vegetables, fish, etc.

4.4 Deep Interviews Luxembourg

Until the publishing of this Deliverable, Deep Interviews were conducted with the organisations and persons listed below. More interviews are planned in conjunction with the survey. To reach out for beekeepers, an invitation to participate in interviews has been published in the news section on the website of the national beekeeping association FUAL. So far, only one beekeeper has replied, but he provided further contacts that will be followed. The consumer association ULC declined our request for an interview. The results of the interviews are summarized in the SWOT analysis and integrated in the report on the Luxembourgish Beekeeping and Honey Secot in Section 5.4.

ASSOCIATIONS:

- Letzebuerger Hunneg (Sales association), Jeannot Glodé, President

AUTHORITIES:

- ASTA Marque Nationale Ingénieur, Francois Kraus, Chef de service LE GOUVERNEMENT DU GRAND-DUCHÉ DE LUXEMBOURG, Ministère de l'Agriculture, de la Viticulture et du Développement rural, Administration des services techniques de l'agriculture, Service de l'horticulture

EXPERTS:

- Andreas Reichart (FUAL consultant for beekeeping)
- Adnan Imeri (Infrachain, expert for Blockchain technology)
- Marco Beyer (LIST, expert for bees)

BEEKEEPERS:

- Anonymized (private business)

Table 18b: SWOT analysis deep interviews Luxembourg:

Strengths	Weaknesses
• Traceability of the honey supply chain implemented by ***Marque Nationale*** quality process and label. • Sales association supports small beekepers to negotiate prices with retailers, balance production vs. demand, mitigate seasonal effects.	• No smart hives available to support remote monitoring of spread hives. • Huge cost of current quality controls (about 1 EUR per jar) • No liquid honey products made in Luxembourg, only creamy honey.
Opportunities	**Threats**
• Promote national honey to consumers that buy imported products of lower quality. • Blockchain has potential to enable	• Varroa destructor • Asiatic hornet is spreading as invasive species and killing whole bee colonies.

traceability for mixed, homogenized honey as new product line.
- IT solution has potential to increase efficiency of the current quality management.
- Digital marketplace has potential to support beekeepers with direct sales, connecting with farmers for pollination services, and hiring seasonal staff on demand.
- Young generation of beekeepers is interested in IT and IoT solutions.

4.5 Deep Interviews Algeria

Partner Algeria synthesised and decided to mix the context analysis with the deep interviews in one document and report. Results are in chapter 5.5.

4.6 Deep Interviews Morocco

Info: Contribution sent from Moroccan partners was not including the deep interviews and SWOT analysis for presenting these section here until the final deadline of the report.

5.CONTEXT ANALYSIS HONEY SECTOR

The context analysis of the honey sector with its separate analysis of each of the case study-country partners aims to provide a comprehensive understanding of the sector's current situation, including production, consumption, trade patterns, current data and some regulatory frameworks. Within the context analysis the case study countries are the same of which have given an insight with the deep interviews into the honey market: Algeria, Luxembourg Morocco, Spain, Tunisia and Türkiye.

Info: The honey context analysis report could be received from all case study partners: Algeria, Türkiye, Tunisia, Luxembourg, Morocco and Spain.

By analysing the current honey sector in case study countries Türkiye, Tunisia, Luxembourg, Morocco and Spain, the report gains additional insights besides the deep interviews into the challenges and opportunities facing the sector and provides grounds for developing strategies to promote the TECHONEY project. The context analysis supports the way for investigating parameters necessary to adopt the current honey supply chain towards distributed ledger technology applications for a more traceable, trustworthy, secure, immutable and stable value-added honey-supply chain.

Currently many adverse factors impacting the sector to be threatened. Intensive agriculture in terms of land-use change, pesticide applications and lack of natural habitats due to intensification of cropping practices (FAO, 2014) (Kremen et al., 2002). Key challenges facing the honey market flow sector and beekeepers operations on production level are e.g. the widely known mysterious colony collapse disorder (CCD) starting 2006 in the US (Cox-Foster et al., 2007), where beekeepers reporting unusual weakening and mortality in colonies and losses of up to 80% have been seen. Mysterious, as it affected mainly working bees who die but no dead bees are found in front and in the hive, finally the queen bee survives alone and is attended only by a few newly emerged adult bees in the hive. Even the eusocial organisation would have enough food resources stored and ongoing brood is seen (immature bees), the hive collapses due to no working bees coming back to the hive (Oldroyd, 2007). Mortality has been especially extremely high when activity is resumed at the end of winter and the beginning of spring (Pascal Peduzzi, 2011). Besides possible noticeable microbial infections also general habitat loss and intensive pesticide application of conventional industrial agriculture might play its role (Goulson et al., 2015). Today there is also a clear evidence, that applied neonicotinoids (direct and on seed coatings) in agriculture, first found and synthesized in Japan in the 90ies, for controlling of pests in rice fields, affect non-target organisms as honey bees and many other pollinators. It is worth to mention a study with realistic infield simulation of a corn field in Canada from Tsvetkov et al. (Tsvetkov et al., 2017) as there was strong criticism and discussion around the harmfulness of neonicotinoids with arguments of only showing the toxicity in lab conditions and not within realistic experimental conditions.

Another challenge along the honey production is the strong increased adulteration and fraud of honey in the supply chain, with a growing concern over the authenticity of honey products. Advanced food analytic techniques already revealed 2010 that honey adulteration is practiced (Chen et al., 2011). The report gives the complexity of fraud and adulteration an own chapter (5.3.7) dealing with latest findings on EU level, as it is highly relevant for the TECHONEY project and the current situation of the honey sector.

This issue not only undermines consumer trust, price distortion but also affects the livelihoods of legitimate beekeepers and honey producers which might result in lower numbers of bees and bee hives. In the long run with such a strong decrease of bees scenario, the very important overall pollination services decline and putting ecosystem services and function at high risk (Klein et al., 2007; Kremen, 2002). Not to mention a decreasing yield if plants related to animal pollination lacking wild and honeybees.

Overall, the apiculture sector itself is, compared to other agricultural sectors, as small as it can appear but plays a very important role to almost all agricultural sectors: next to providing honey and other bee products (beeswax, propolis, pollen etc.), honeybees and apiculture contribute as mention to a vast amount of pollination of crops, fruits, vegetables and wild plants (European Commission, 2019). It is also suggested that beekeeping is one of the climate friendliest agricultural sector in terms of input and output. . It also witnessed constant growth on the global market in the last decades around the world (García, 2018; Pippinato et al., 2020). Similar equipped is the honey export market, compared to other agri-food supply chain products e.g. in value traded and consumed, a niche market within most food systems. It accounts of less than 1% of total agri-food exports with an estimated value of 2.2 billion US dollars in 2016 (Pippinato, 2020). Nevertheless, it is of highest importance to ecosystem services and their functioning in all countries involved in the project. In a recent article in the financial times pollination is estimated up to 80 billion US dollars each year to European agriculture.

Finally, the honey and the honey bee has its very unique standing as it is was already used in ancient Egypt and found in several cubiculum of Pharaohs.

5.1 Apis Melliferra

The Honeybee *Apis Mellifera (Linnaeus 1758)* or simply the *European Honey Bee,* as stated in the report, has a strong economically and environmental importance. It can be found on every continent except Antarctica. Honeybees, mainly Apis mellifera are one of the most important pollinators in agricultural crops and monocultures worldwide (Klein, 2007). Pointing out the essential pollination and plant-pollinator interactions which are fundamental for reproductivity of many flowering plants. This ecosystem service supports the existence of plant biodiversity and is strictly linked to all the supporting, regulating and provisioning services that flow from terrestrial ecosystems (Papa et al., 2022).

They improve the quality and yield of many vegetables and fruit trees. A well-known example is the almond production of California where beekeepers from all over the US come every year to California when the flowering period of the almond trees starts to offer their pollination services (Goodrich et al., 2016). Even in an almond variety named *Independence* which is alleged to be pollination-independent and nowadays the newest planted variety, Saez et al. shows that within honey bee pollination an increase of 60% in yield and kernel could be reached (Sáez et al., 2020). In other words, they are essential and dominant pollinators to more than half of animal-pollinated crops worldwide. Their role in pollinating a vast amount of crops and among other insects and animal pollinators, they are known as the most important group of pollinators worldwide (Stein et al., 2017). In total, 39 of the leading 57 world crops for human consumption rely on or increase their production when animal pollinated. Aggregated, these crops account for a total of 35% of the world food production (Klein, 2007).

Overall, as suggested from Papa et al. (Papa, 2022) and the report´s author acclaiming to this point, that besides other important ecosystem service roles, the symbolic value of the honey bee is possibly the most important role played by this insect species. “It may help revitalise and strengthen the intimate and reciprocal relationship between humans and the natural world, avoiding the inaccuracy of considering the ecosystems are mere providers of services to humans" (Papa, 2022).

5.2 The Mediterranean Beekeeping Sector

For a synthesized overview of all involved partners of the TECHONEY project the interactives graphs of production, import and export destinations including their economic values are visualized below:
Figure 9 shows the current production [in tones] in the Mediterranean countries and Luxembourg involved in the TECHONEY project of the case study countries as well as the other partner countries as Italy or France involved in other work packages of TECHONEY.

Honey production of all Techoney project partners countries:

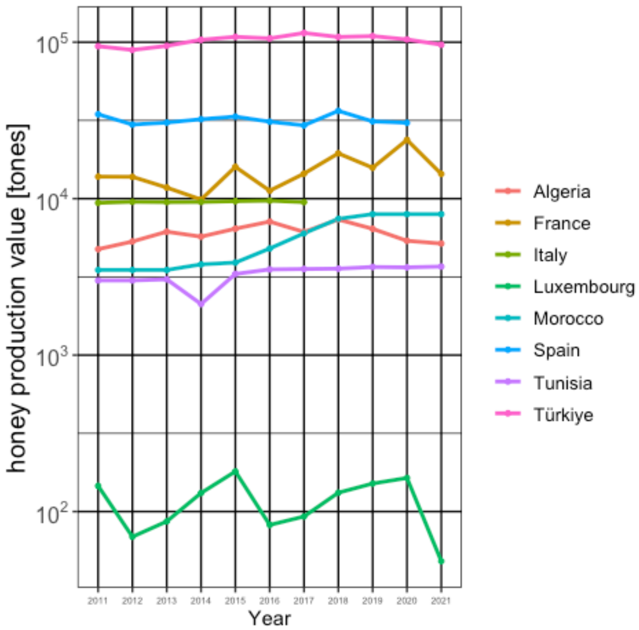


Figure 9: Honey production in thousand tonnes from 2011-2021 in all Mediterranean Countries and Luxembourg involved in the project. Own Representation, Data: FAOStat 2023.

ALGERIA

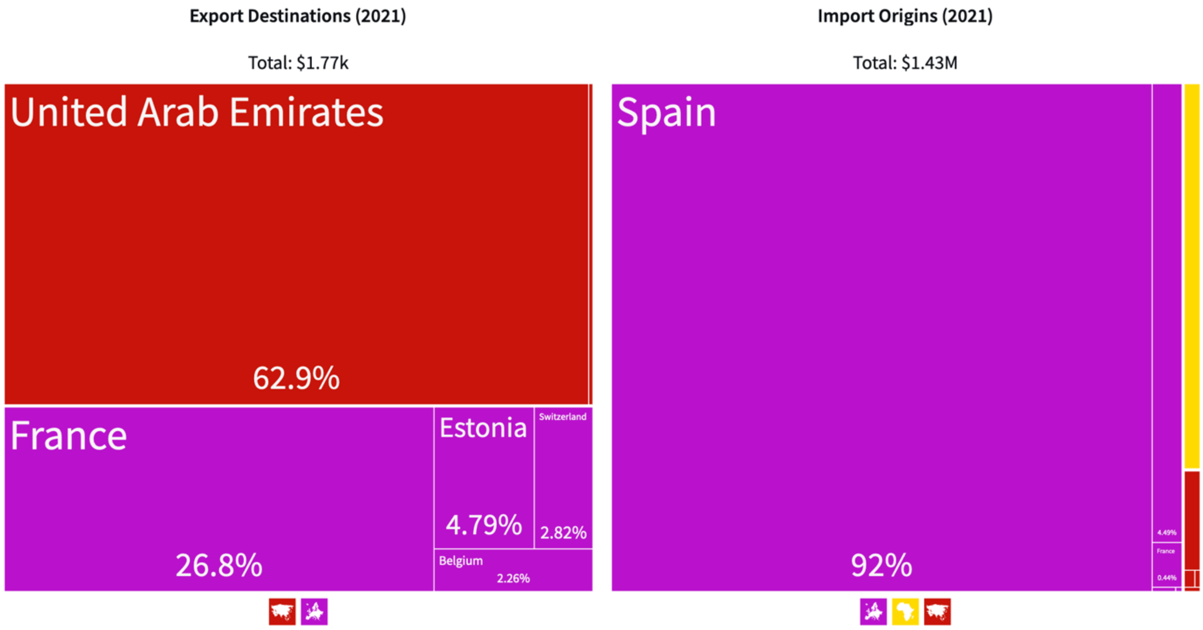


Figure 10: Percentage of Exports (Left) and Imports (right) of honey in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC, 2023. Data from BACI HS6 REV. (1992-2021).

LUXEMBOURG

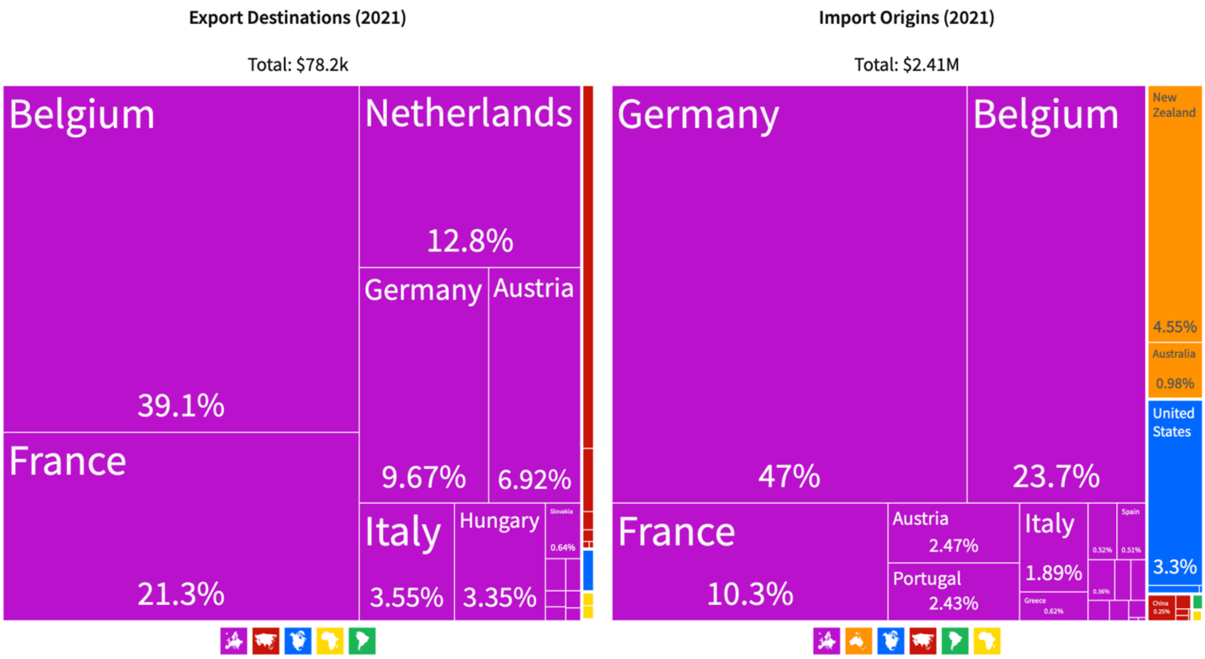


Figure 11: Percentage of Exports (left) and Imports (right) of honey in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC, 2023. Data from BACI HS6 REV. (1992-2021).

MOROCCO

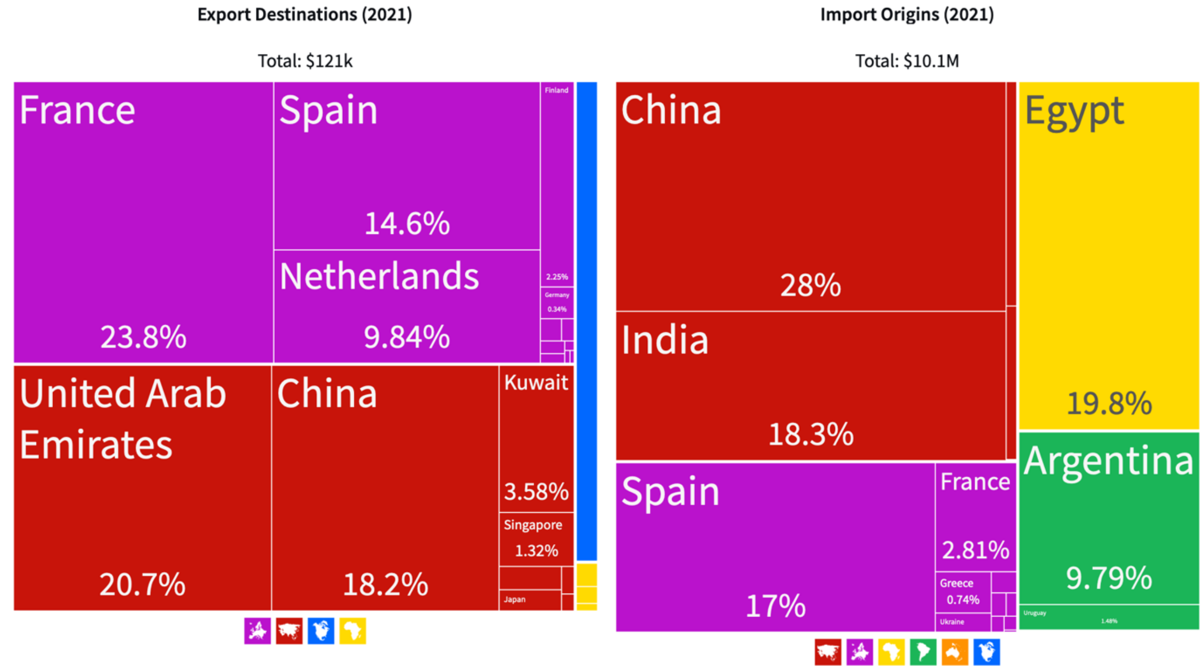


Figure 12: Percentage of Exports (left) and Imports (right) of honey in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC, 2023. Data from BACI HS6 REV. (1992-2021).

TUNISIA

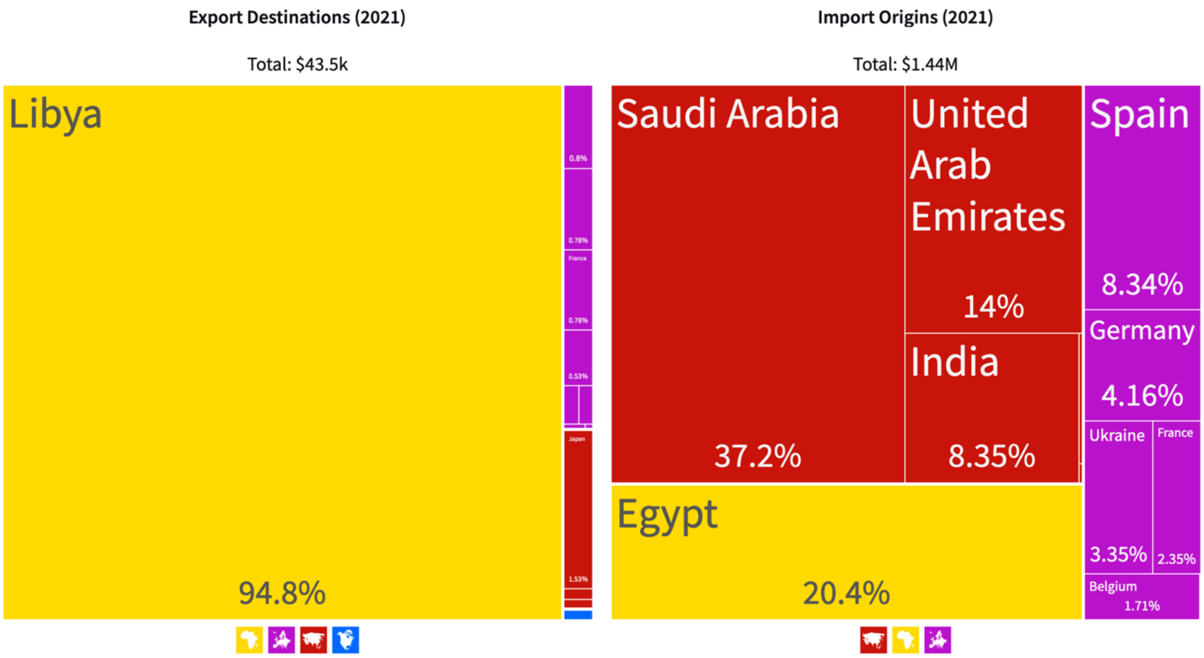


Figure 13: Percentage of Exports (left) and Imports (right) of honey in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC, 2023. Data from BACI HS6 REV. (1992-2021).

TÜRKIYE

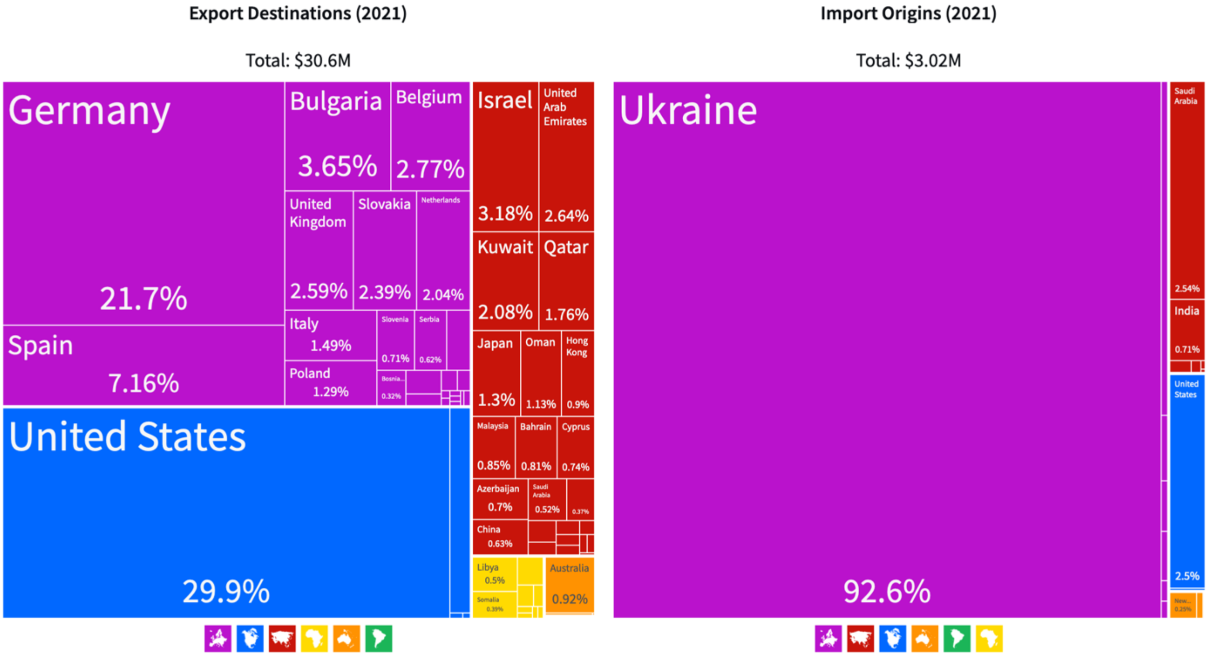


Figure 14: Percentage of Exports (left) and Imports (right) of honey in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC, 2023. Data from BACI HS6 REV. (1992-2021).

5.3 The Spanish Beekeeping and Honey Sector

Honey production in Spain has a long history, dating back to ancient times and evolved nowadays to a modern sector and industry with diverse types of produced honey. The Spanish honey sector is a significant contributor to the country's agricultural industry, especially when counting the pollination services bees do for many crops, while searching for nectar to produce honey. Spain ranks as one of the top honey producers in the world. In Europe Spain is the country with the most hives (2.96 million hives) in 2022 (European Commission, MSs notifications under Reg. 2015/1366). Although, compared to other agricultural goods and their economic output, the beekeeping sector accounts for around 0.44% of all livestock production in the country and 0.17% of the total agricultural production output. The total beekeeping sector annual production output (mainly honey, pollen and beeswax) in 2022 was estimated on 62 million Euro (MAPA, Spain).

Another speciality of the Spanish honey sector is the fact that besides a total share of 17% of all hives in the European Union (2nd Romania 11%, 3rd Poland 9% of total shares of hives) the number of beekeepers (28776 is compared to the population very low. In Austria with a population more than 5 times lower than Spain the number of beekeepers is higher with 29745 (National Apiculture programme, EC).

However, therefore the number of professional beekeepers managing more than 150hives per apiculture is greater than 80% in Spain. Which concludes that the sector is run by mainly full-time beekeepers.

Most of the beehive census of honey and wax production is concentrated in the regions of Andalusia (25.1%), Valencia (19.9%), Extremadura (14.6%), and Castilla y León (7.6%). These four regions account for more than 70% of total honey production in Spain (Ballco et al., 2022) (MAPA 2021).
However, since beekeeping plays an essential and fundamental role in pollinating a vast amount of crops and are known, among other insects and animal pollinators, as the most important group of pollinators worldwide (Stein, 2017). Overall, 39 of the leading 57 world crops for human consumption rely on or increase their production when animal pollinated. Aggregated, these crops account for a total of 35% of the world food production (Klein, 2007). Beekeeping plays a fundamental role not only in pollinating crops but also in the conversation of the natural environment and maintaining biodiversity. In recent years the sector has been maintaining constant growth, both in number of hives, apiaries and beekeepers.

There are two different beekeeping systems or practices:

(i) In the north, northwest and insular regions; characterized by the high degree of small beekeepers who do not practice transhumance a lot.
(ii) the predominant in the centre and south/southeast; with a higher degree of professionalization and often high degree of transhumance activities.

Beekeeping, in line with most of the Spanish primary sector, has made internationalization a key strategy for its growth and revaluation. This is reflected in the growing evolution of the foreign trade balance of honey, both in terms of volume and economic value (see Figure 18).

5.3.1 The Spanish Honey Market:

The Spanish honey market is characterized by a strong tradition of beekeeping and honey production, with a rich diversity of honey types and flavours. Spain is one of the largest honey-producing countries in Europe and the world, with an annual production of over 32,000 tons in 2020. With an annual estimated consumption between 0.66 to 0.9kg per capita, Spain´s self-sufficiency is at a negative rate of under 85%. Important to mention that although the country has a favourable climate and landscape for beekeeping, with vast areas of natural vegetation and a long history of agricultural practices that support bee colonies (fruit tree production or natural vegetation areas) the amount of harvested honey fluctuates as other crop yields per year.
While the yield per hive (10kg/hive in 2018) is below the European Union average (22kg in 2018) the production costs are more favourable with estimated 2,73€/kg compared to the average in the EU of 3,90/kg honey produced. This underlines the fact of economics of scale in production. Production data was assessed form global agricultural statistic database of FAO (FAOStat 2023, from the Ministry of Agriculture, Fisheries and Food MAPA, 2023 and the Observatory of Economic Complexity OEC) and subsequently computed with

programming language R for better visualisation of data (The R Development Core Team, 2005).

5.3.2 Production:

Overall production of natural honey in Spain of years 2010-2020 in thousand tones:

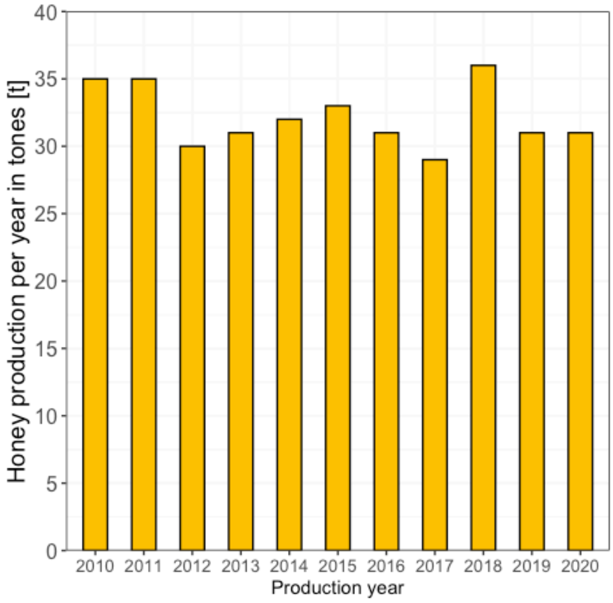


Figure 15: Honey production per year in Spain in thousand tones. Source FAOSTAT 2023.

The Spanish honey production and beekeepers could produce, except 2017 every year more than 30 thousand kilograms in the years 2010 – 2020.

5.3.3 Imports

In 2020, Spain imported natural honey worth $70.8 million dollars, becoming the 10th largest importer of natural honey in the world. At the same year, natural honey was the 782nd most imported product in Spain. The main import countries of honey in Spain are: Uruguay ($11.7million), Portugal ($10.8million), Poland ($8.92million), China ($7.85million), and Germany ($5.58million) (Simoes, A. J. G., & Hidalgo, C. A., 2011).
The fastest growing import markets of natural Honey for Spain between 2019 and 2020 were Uruguay ($5.95million), Poland ($4.62million), and Portugal ($2.37million) (OEC).

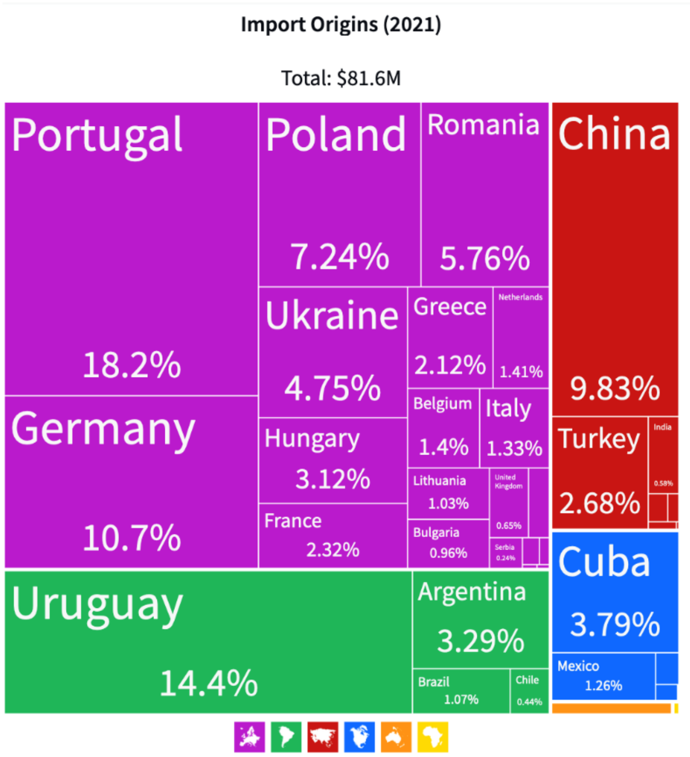


Figure 16: Percentage of Spanish honey imports in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC. Data from BACI HS6 REV. (1992-2021).

5.3.4 Exports

On the export side, Spain exported natural honey worth of $111million dollars in 2020, making it the 6th largest exporter of natural honey in the world. At the same year, natural honey was the 497th most exported product in Spain. The main destination of natural honey exports from Spain are: France ($34.3million), Germany ($19.3million), United States ($5.84million), Saudi Arabia ($5.63million), and Italy ($5.62million). The fastest growing export markets for natural honey of Spain between 2019 and 2020 were Germany ($8.29million), France ($5.15million), and Saudi Arabia ($2.53million) (Simoes, A. J. G., & Hidalgo, C. A., 2011).

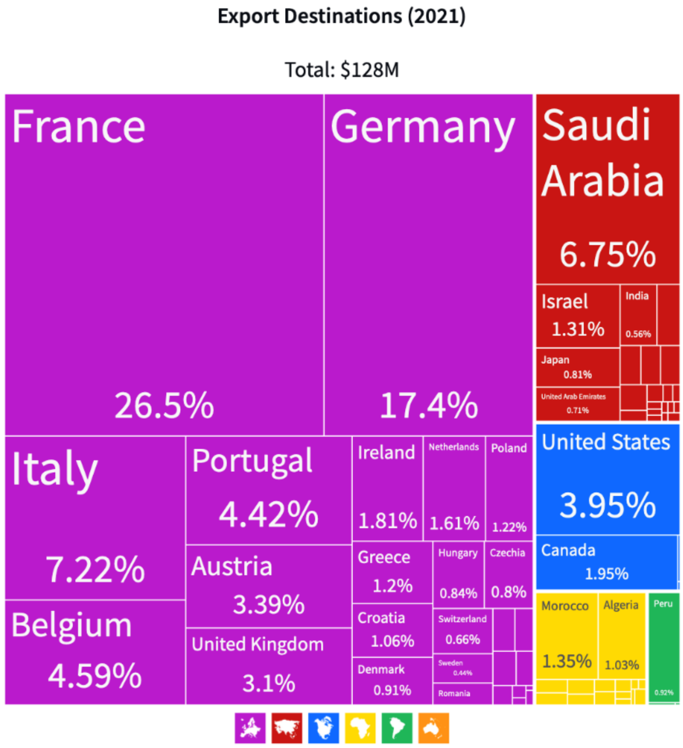


Figure 17: Percentage of Spanish honey exports in 2021. Different colours showing different continents. Values in USD. Source: Observatory of Economic Complexity OEC. Data from BACI HS6 REV. (1992-2021).

5.3.5 Tariffs

In 2017, the average tariff for Spain on natural honey was 6.99%. The countries with the highest import tariffs for natural honey are the Republic of the Congo, Algeria
Western Sahara, Gabon, Libya (most favoured nation duty rate treatment, 17.3%. (Simoes, A. J. G., & Hidalgo, C. A., 2011).

When comparing import and exports of honey of Spain the following graph shows the trade balance from the years 2010 until 2020.

While there was an increase in both imported as well as exported honey in the first years of the 2010 decade, from the middle of the 10 decade a surplus in the country was produced.

TRADE BALANCES OF IMPORT AND EXPORT OF HONEY FROM SPAIN IN THE YEARS OF 2010- 2020:

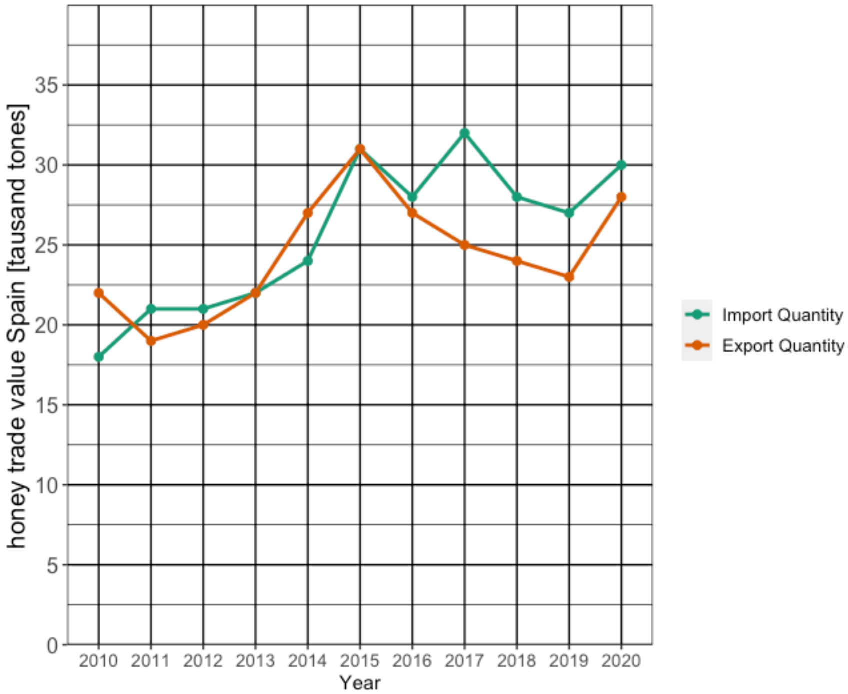


Figure 18: Trade balance import/export of honey from Spain 2010-2020. Data FAOSTAT, 2023, own representation

To conclude, it will require ongoing efforts to keep the pace in competitiveness and the standing of Spain in the market. Nevertheless, it is important to adopt early in terms of advanced origin and traceability systems to not lose competitiveness and share on the global market. The chance of ensuring more transparency and authenticity in the honey-supply chain will keep the pace in the middle and long run.

5.3.6 ENVIRONMENTAL CHALLENGES IN THE SPANISH HONEY SECTOR

The honey sector faces also a number of environmental challenges, already discussed in the report. Including most driven and impact exerting climate change, ongoing land-use change, intensified industrial agricultural practices and pesticide usage as well as strongly linked to climate change promoting extended periods of droughts in Spain.
2022 was the warmest ever measured summer in average temperature so far, resulting in try conditions in many areas of the country and less flowering plants.

5.3.7 FRAUD

A recently reported study led by the European Commission (JRC) together with European Anti-Fraud Office (OLAF) and the Joint Research Centre (JRC) in Geel, Belgium revealed a high number of adulterated imported honey directed to the European Union. The coordinated operation called "From the Hives" in which 15 EU member states plus Switzerland and Norway embarked on a testing campaign revealed alerting results. In total 320 samples are analysed originating from 20 different countries. Highly sensitive testing

methods allowed the Joint Research Centre Geel, in Belgium to detect suspicious imports. Advanced methods as Elemental Analyser/Liquid Chromatography – Isotope Ratio Mass Spectrometry (EA/LC-IRMS) for stable isotope rations of protein and sugar compounds, High-Performance Anion Exchange Chromatography - Pulsed Amperometric Detector (HPAEC-PAD) for polysaccharides and polymerisation, Liquid Chromatography - High Resolution Mass Spectrometry (LC-HRMS) for oligosaccharides and finally for profiling the honey Proton Nuclear Magnetic Resonance (^{1}H-NMR) Spectroscopy, to create a finest and detailed fingerprint of the different honeys sampled (Ždiniaková, T., Lörchner, C., De Rudder, O., Dimitrova, T., Kaklamanos, G., Breidbach, A., Respaldiza, A., Vaz Silva, I.M., Paiano, V., Ulberth, F., Maquet, 2023).
The coordinated action also included a collection of traceability information and investigations at the place of import, processing, blending, and packing (Olaf, 2023). While in the results of a Coordinated Control Plan organised in a campaign in 2015-17 at the EU level plus Norway and Switzerland, showed that at least 14 % of the checked samples did not conform to the purity benchmarks, the results of the recent campaign "From the hives" are high alerting. Out of 320 tested samples 147 (46%) were suspicious of being non-compliant with the provisions of the EU Honey Directive 2001/110/EC (Ždiniaková, T., Lörchner, C., De Rudder, O., Dimitrova, T., Kaklamanos, G., Breidbach, A., Respaldiza, A., Vaz Silva, I.M., Paiano, V., Ulberth, F., Maquet, 2023).

> *"The important price difference between authentic honey and sugar syrups explains why fraud in honey is highly profitable. Figures speak for themselves: the EU average unit value for imported honey was 2.32 €/kg in 2021, whereas sugar syrups made from rice are available at around 0.40 – 0.60 €/kg"* (JRC, 2023).

In total, more than half (57%) of the operators had exported honey consignments suspected of being adulterated with extraneous sugars, while more than 60% of the operators imported (Figure 20) at least one suspicious consignment.

> *"In total, 123 exporters were controlled of which 70 were flagged as having exported consignments of honey suspected of being adulterated with extraneous sugars (Figure 19) Of the 96 EU importers concerned, it transpired that two-thirds of them (63) had imported at least one suspicious consignment" (Figure 20).*

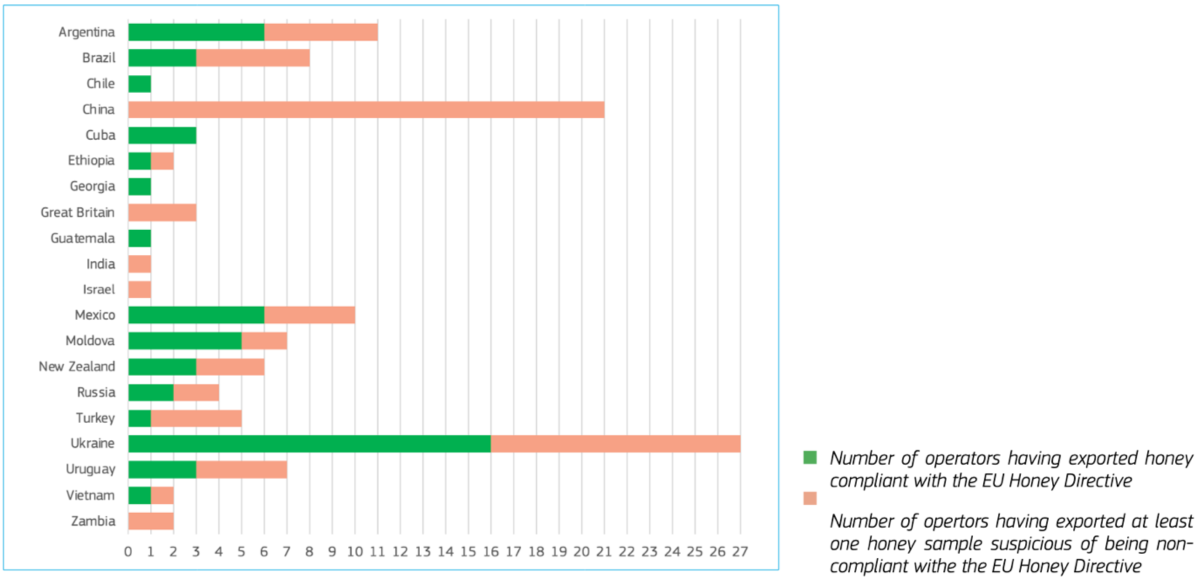


Figure 19: Profile of exporters to EU. Source and graph: European Commission, Coordinated action “From the hives” 2023.

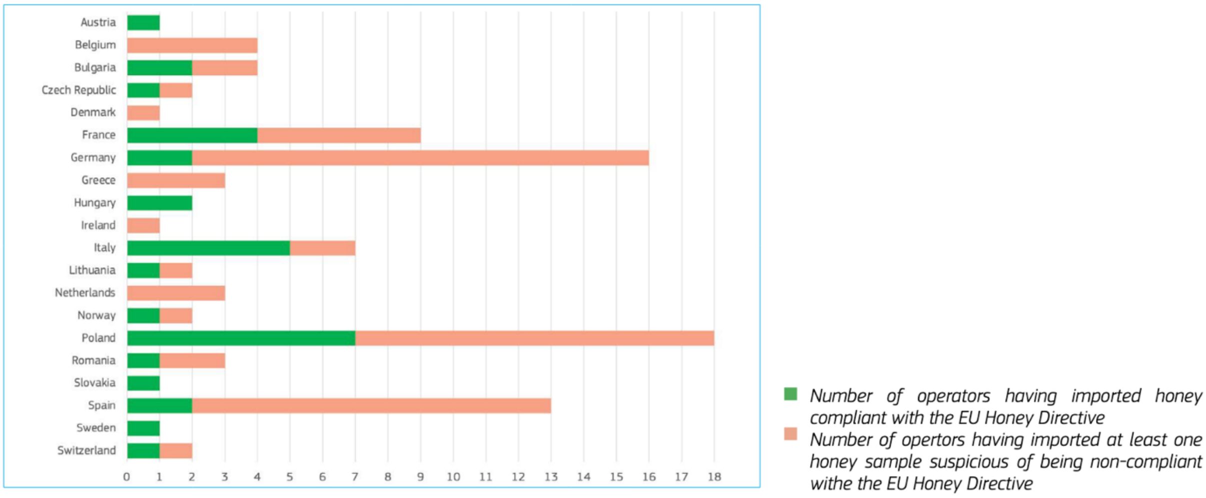


Figure 20: Profile of EU importers. Source and graph: European Commission, Coordinated action “From the hives” 2023.

5.2 The Turkish Beekeeping and Honey Sector

Authors Content and Text: Case Study Leader Seval Mutlu et al. Ordu University
Formatting: Thomas Wassermann, CREDA

Turkey has an important position in the beekeeping sector worldwide. Turkey's geographical location, climate and vegetation increase the productivity of bees (Sıralı, 2010). In terms of honey production in Turkey, it ranks second in the world after China (FAO, 2023). However, Turkey could not use this potential in exports. Turkey ranks 25th in the world in honey exports (Trademap, 2023).

In recent years, Turkey has faced problems such as decline in bee populations and loss of bee colonies. The beekeeping sector in Turkey is economically important and there are 89,361 registered beekeepers and 8.7 million registered beehives (Turkstat, 2023). Turkey produces 92 percent of the world's pine honey, specifically in its West Mediterranean and South Aegean regions. Twenty percent of the world's 25 bee subspecies can be found in Turkey. The yield per hive is lower than the world average (20 kg per hive). In comparison, the yield per hive in Turkey is approximately 15-17 kg (USDA, 2015).

Table 19: Beekeeping sector in Turkey

Year	Number of Beekeepers	Total Number of Hives	Honey Production (tonnes)	Honey wax Production (tonnes)
2015	83,467	7,748,287	108,128	4,756
2016	84,047	7,900,364	105,727	4,440
2017	83,210	7,991,072	114,471	4,488
2018	81,830	8,108,424	107,920	3,987
2019	80,675	8,128,360	109,330	3,971
2020	82,862	8,179,085	104,077	3,765
2021	89,361	8,733,394	96,344	3,766

Source: Turkstat, 2023.

The number of beekeepers in Turkey increased to 89,361 according to 2021. Turkey's total hive has increased to 8,773,394 in 2021. Total honey production in Turkey reached approximately 96,000 tons in 2021.

Developments in beekeeping activities in Turkey have been observed over the years. However, even if there is an increase in production, the production is behind the increase in the number of hives. The reasons for this are due to the problems experienced in beekeeping, as well as environmental problems and climate change, which are a worldwide threat. Beekeeping is a preferred agricultural activity with its features such as providing income in a short time, being able to be done with a small capital and not being dependent on the existence of land. This sector provides employment, income and healthy nutrition opportunities to the rural population due to the low production costs of beekeeping, the use of less labour compared to other agricultural production, the easy storage of products and the ability of trading at value prices (Uzundumlu *et al.,* 2011).

A total of 3,766 tons of beeswax was produced in Turkey in 2021 (Turkstat, 2023). The beekeeping sector in Turkey also tends towards the production of honey products. In this direction, the production of bee products such as royal jelly, propolis and bee venom is becoming widespread (TKDK, 2016).

However, there are developments that adversely affect the health and productivity of bees in Turkey. For example; such as the decrease in the habitat of bees, pesticide use, climate change (Polat & Çetin, 2020). Due to forest fires and seasonal high temperatures in 2021, there has been a serious decrease in the population of *Marchalina Hellenica*, which is the most important insect for pine honey production in Turkey. This situation negatively affected the production of pine honey and caused a decrease of 7.4% in honey production (TÜP, 2022).

Beekeeping is a traditional agricultural activity that is carried out in almost every region of Turkey. Turkey has strong prospects in beekeeping since all regions of Turkey are available for this activity and 75 percent of beekeepers are migration (USDA, 2015). The beekeeping sector in Turkey mostly consists of small and medium-sized beekeepers. In recent years, modern beekeeping methods and technologies have become widespread (Kekeçoğlu et al. 2007).

Honey foreign trade in Turkey is carried out in two ways as strained and combed honey. 80% of honey exports are strained honey. When the import amounts are examined, it is seen that the highest import amount was 31.5 tons in 2019 and there was no significant honey import in Turkey.

Table 20: Turkey honey export

Export (Kg)					
	2017	2018	2019	2020	2021
Natural honey; combed	952,759	1,220,477	1,696,771	2,114,870	2,288,570
Natural honey; strained	5,495,389	5,193,022	3,845,988	3,896,227	7,687,177
Total	6,448,148	6,413,499	5,542,759	6,011,097	9,975,747

Source: Turkstat, 2022

Table 21: Turkey honey import

Import (Kg)					
	2017	2018	2019	2020	2021
Natural honey; combed	-	22,334	21,368	994	23,459
Natural honey; strained	267	-	10,147	15,238	5,882
Total	267	22,334	31,515	16,232	29,341

Source: Turkstat, 2022

A large part of the honey produced in Turkey is consumed in the domestic market and the remaining part is exported (TEPGE, 2020).

The United States ranks first among the countries that Turkey exports honey to in the world. The United States exported 2,916 tons of honey from Turkey in 2021. The value of exported honey is US$ 9,231. Its share in Turkey's exports is 29.6%. The growth in export value between 2020 and 2021 is 68% (Trademap, 2023). Germany ranks first with 933.6 tons of combed honey export in 2021. The United States ranks second with 652.1 tons. In the export of strained honey, the United States ranked first with 2,264 tons. Spain ranks second in Turkey's export of strained honey with 1.009 tons (Turkstat, 2022).

The value of honey imported by Turkey in 2021 is 378 thousand US dollars. In 2021, a total of 62 tons of honey was imported. Germany ranks first with 33 tons of imported honey.

According to Turkstat data, the consumer price of honey in December 2021 was realized as (62.18 TL/kg). In the same month, the producer price of honey was (56.73 TL/kg). In the following years, honey prices tended to increase continuously due to the inflationary economic conditions in Turkey.

Within the scope of the TECHONEY project, beekeepers in four important producer provinces in Turkey were included in the sampling. These provinces consist of Ordu, Mersin, Sivas and Muğla. The reasons for choosing four provinces are that they have significant shares in the number of beehives, honey production and export.

According to honey production data in Turkey, Ordu ranks first in 2022 natural honey production (Turkstat, 2023). Beekeeping is carried out with a total of 669,367 hives in 3,079 beekeepers in Ordu, and 19,098,341 tons of honey has been produced from this activity. In 2022, a total of 277.8 tons of beeswax was obtained. 773 tons of honey was exported from Ordu in 2022. With the establishment of the honey packaging facility in Ordu, honey exports have increased every year. More than 80% of honey production is carried out by migratory beekeepers. The Mobile Beekeeping System (MAS), which was developed for the first time in Turkey by the Ordu Apiculture Research Institute and the Special Provincial Administration of the Ordu Governorship in 2005 and was successful as a result of the application, started to be produced in 2009. Thanks to this system, it provides great convenience in transporting beehives, setting up barracks and accommodation, which is a major problem for migratory beekeepers. There are honey filtering unit and storage tanks on the mobile beekeeping system and it is designed to meet all the needs of the beekeepers (OTB 2020).

According to Turkstat data in Mersin province, beekeeping is carried out with a total of 267,251 hives in 2,237 beekeepers, and 3,295,269 tons of honey and 284,878 tons of beeswax are obtained from this activity. Mersin ranks 7th in 2022 natural honey production in Turkey (Turkstat, 2023). Beekeeping activities are carried out in 13 districts in Mersin. Different types of honey can be obtained in Mersin, such as flower honey, pine honey, carob honey, citrus honey, sandal flower honey, depending on the blooming time. Its biodiversity and suitable climatic conditions for beekeeping make Mersin an important beekeeping region (Öztürk and Görhan, 2021).

According to Turkstat data in Sivas province, beekeeping is carried out with a total of 287,104 hives in 3,552 beekeepers and 6,078,821 tons of honey and 384,936 tons of beeswax are obtained from this activity. According to the result obtained by taking the honey production data of 81 provinces in Turkey, Sivas is in the 4th place in 2022 natural honey production (Turkstat, 2023).

According to Turkstat data in Muğla province, beekeeping is carried out with a total of 884,096 hives in 4,894 beekeepers, and 6,577,759 tons of honey and 371,34 tons of beeswax are obtained in this activity. Muğla ranks 3rd in natural honey production in 2022. Beekeeping operations are carried out in 13 districts of Muğla province. Among the districts, Milas district has the most beekeeping activities with 740 beekeepers (Turkstat, 2023).

5.3 The Tunisian Beekeeping and Honey Sector

Authors Content and Text: Case Study Leader Yamna Errach et al. INAT
Formatting: Thomas Wassermann, CREDA

5.3.1 Introduction

Tunisia's geographical location on the Mediterranean coast allows for a wide variety of vegetation to flourish. The country's climate is predominantly arid, with hot summers and mild winters, which is ideal for beekeeping.

The most common type of honey produced in Tunisia is wildflower honey, which is made from the nectar of various flowers found in the country's natural habitats. Other popular types of honey produced in Tunisia include thyme honey, rosemary honey, eucalyptus honey, and orange blossom honey.

Tunisia has several regions that are particularly well-suited for beekeeping, including the mountainous regions of the north and central areas, which offer ideal conditions for honeybees. In the last decade, many beekeepers are developing a high-quality honey, and several cooperatives have been established to help support and promote the industry.

Below is the outline of this report, which is divided into 4 sections:

1. The honey production in Tunisia
2. The evolution of the beekeeping industry in Tunisia
3. A description of the primary plants and trees that are used in honey production, along with a honey calendar.
4. Standards and regulations that govern the beekeeping sector in Tunisia.

5.3.2 The honey production in Tunisia

Evolution of the number of modern and traditional hives

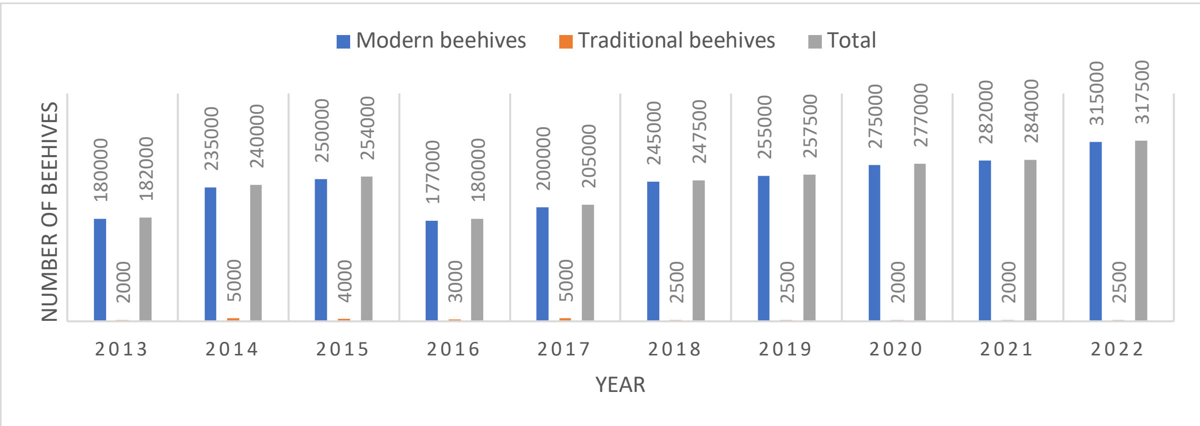


Figure 21: Evolution of the number of hives used in honey production. Source: OEP 2022

The histogram depicted above illustrates the evolution of the number of modern and traditional hives over the past decade. Over this period, the number of hives has increased by 42%. The annual growth rate remained relatively constant, with a rise from 180,000 in 2013 to 315,000 in 2022.

Regarding traditional hives, the number of hives reached a maximum of 2,500 in 2022, with a peak of 5,000 hives in both 2014 and 2017. In total, the number of hives has risen from 182,000 in 2013 to 317,500 in 2022.

THE EVOLUTION OF BEEKEEPER'S NUMBER

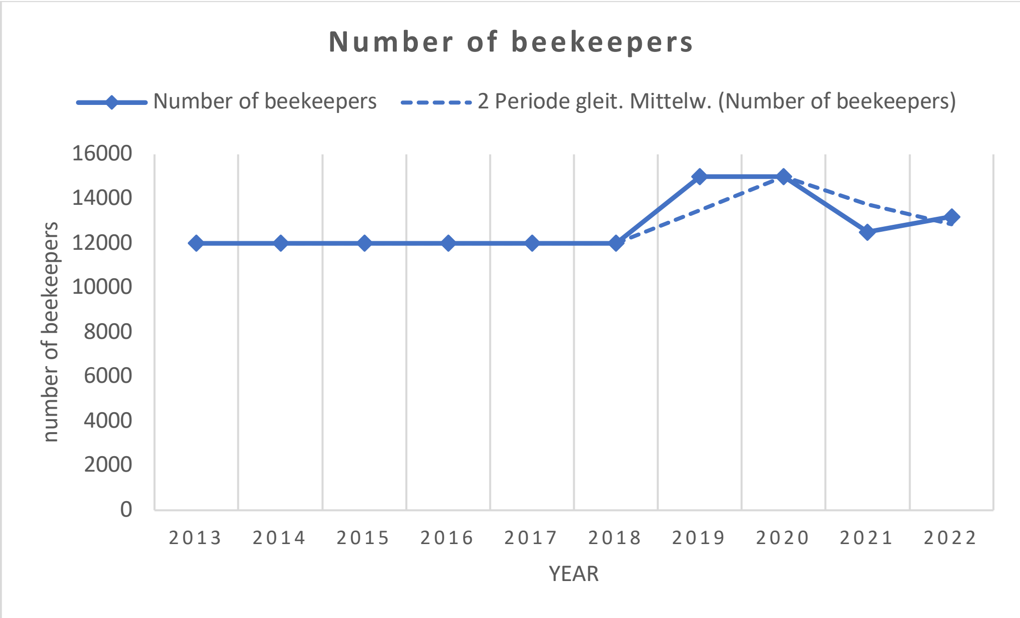


Figure 22 : The number of beekeepers in Tunisia , Source: OEP 2022
(Please note that these figures (numbers) are estimations)

The graph presented displays the variations in the number of beekeepers over a decade, spanning from 2013 to 2022. For the first six years, 2013 -2018, the number of beekeepers remained relatively constant at approximately 12,000 beekeepers. In 2019 and 2020, there was an increase in the number of beekeepers, with the total reaching 15,000. However, the number of beekeepers dropped by 2,500 in 2021. In 2022, the census services recorded an additional 700 beekeepers, bringing the total number of beekeepers to 13,200.
The beekeepers are the key actors of the honey supply. We distinguish two types of beekeepers. The traditional ones who are constituted by small beekeepers, for whom the activity represents a complement of agricultural income rather than an activity with whole share. A part of these farms has a social character, and they are supported by the NGOs, the Tunisian Bank of Solidarity (BTS) and the programs of integrated rural development.
Then, the modern beekeepers who are differentiated into three types: amateurs, professionals, or semi-professionals. They can apply modern techniques, operate full time or part time and their hives generate a main or secondary source of income. The main concern of some of them is the search for profitability, niche and new markets. Others seek to keep abreast of the latest product techniques and are in favor of new products.

HONEY PRODUCTION:

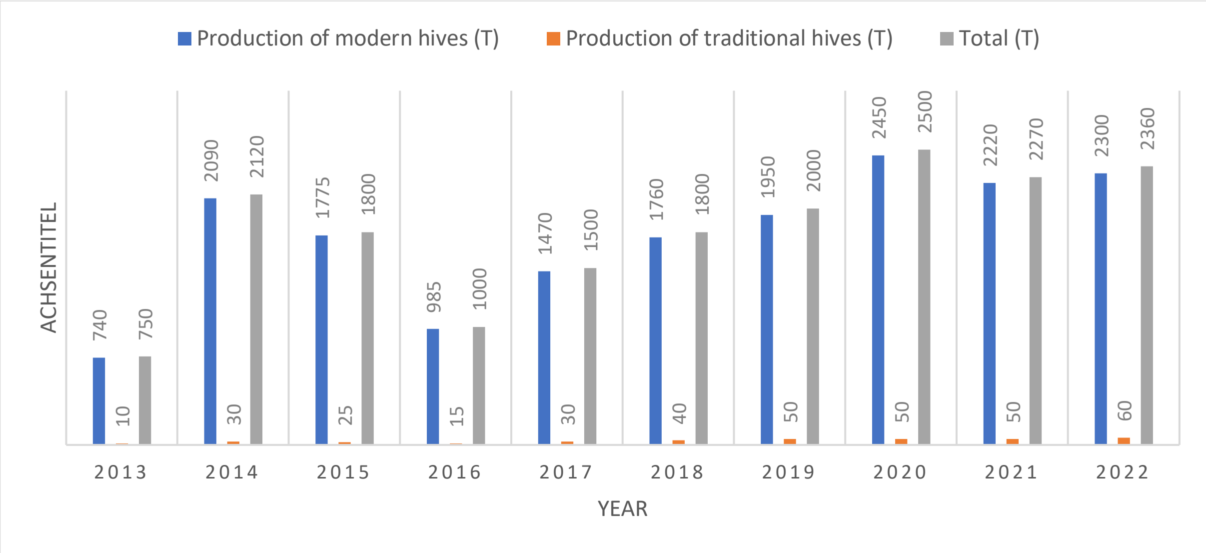


Figure 23: History and growth of honey production in Tunisia 2013-2022. Source: OEP 2022

The above graph displays the production trends of modern and traditional hives. Traditional hive production has remained low and unstable over time, ranging from 10 tons in 2013 to 60 tons in 2022. In contrast, modern hive production has been higher, though less consistent, fluctuating between 740 tons in 2023 and 2450 in 2020. However, there was a 220-ton decrease in production in 2021, followed by a 70-ton increase in 2022, resulting in a production of 2300 tons.
The growth trend has decreased in 2021 and 2022 due to Cov-19 pandemic because the transhumance had been in trouble. Also, there have been disturbance in the sugar supply.

5.3.3 THE TUNISIAN HONEY EXCHANGE

EXPORTS

Tunisia's top export destination for honey is Libya. The value of Tunisian honey exports has fluctuated over the last five years. After the Cov-19 pandemic, the value had decreased. However, the value of exports has increased considerably in 2021.

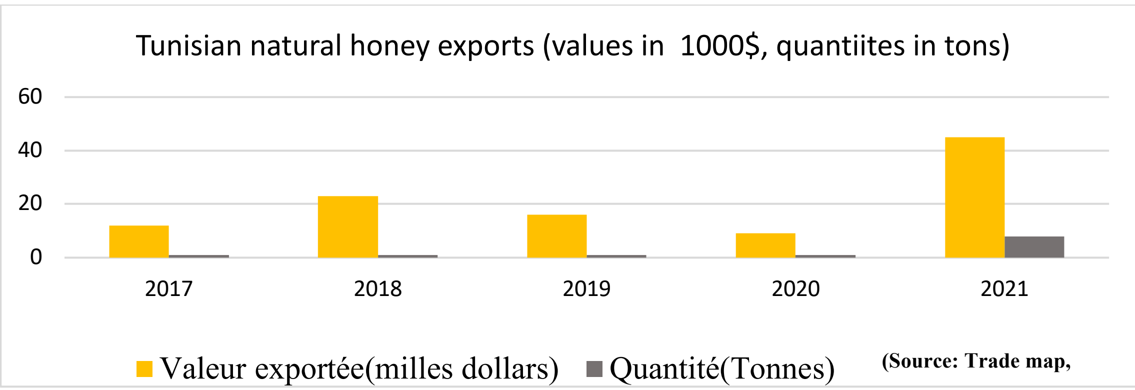


Figure 24: Evolution of honey export values, Source: The International Trade Centre (ITC)

IMPORTS

The Tunisian top five source of honey suppliers are Egypt, Saudi Arabia, India and Spain. The import values and quantities had been stable during the last three years.

Thus, despite with Lybia, the Tunisian bilateral trade balance for natural honey had been negative.

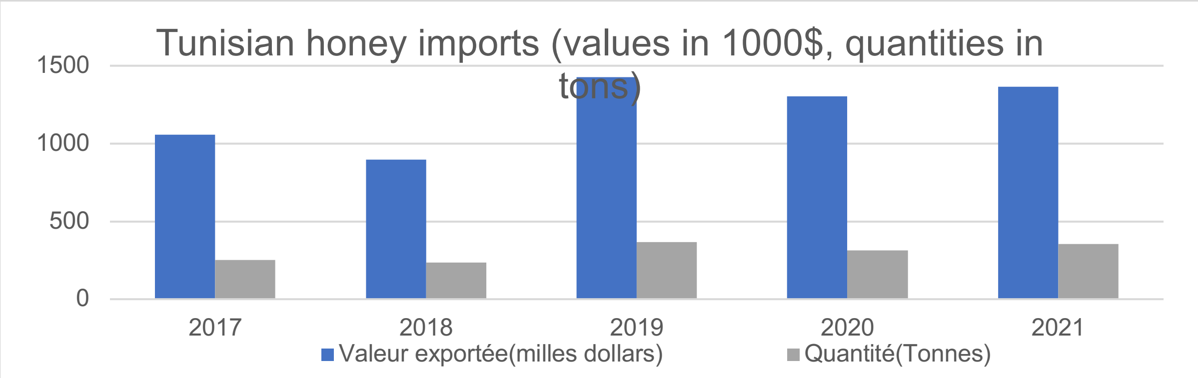


Figure 25:: Evolution of honey import values. Source: Trade map 2022

5.3.4 THE TUNISIAN FLORA

THE HONEY USED FLORA

The Tunisian Ministry of Commerce and Industry published the Tunisian Standard for honey in 2018, which includes information on the primary plants and trees utilized in honey production:

- Thyme (Thymus spp.)
- Lavender (Lavandula spp.)
- Eucalyptus (Eucalyptus spp.)
- Citrus trees (Citrus spp.)
- Almond trees (Prunus dulcis)
- Carob trees (Ceratonia siliqua)
- Acacia trees (Acacia spp.)
- Cactus (Opuntia ficus-indica)
- Wildflowers

5.3.5 HONEY CALENDAR

The flowering seasons of these plants and trees determine the honey production calendar in Tunisia. The following is a general honey calendar based on the flowering periods:

Table 20: Honey Calendar

Month	Honey type
January-February	Thyme honey, almond honey

March-April:	Carob honey, almond honey
April-May	Citrus honey, Harmel honey
May-June	Acacia honey, Harmel honey
June-July	Lavender honey, Eucalyptus honey, thyme honey,
July-August	Cactus honey
September-October	Wildflower honey, Eucalyptus honey
October-November	Heather honey

Source: TSH,2018

5.3.5 Standards and regulations for beekeeping sector

The competent technical standardization commission, CT 56 "sugars and derivatives," has recently approved a Tunisian standard that consolidates different testing methods for evaluating honey characteristics. This standard aims to standardize the testing procedures used by laboratories and to ensure that honey meets the requirements specified in the Tunisian standard NT 56.12, which sets out the specifications for honey.

This document describes testing methods used to determine the composition and quality factors of marketed honey, as well as to identify its botanical origin. The aim is to protect consumers from fraudulent commercial practices, such as adulterated honey, fake honey, artificial honey, false denomination or non-compliant labeling, and to combat unfair competition in the beekeeping sector in Tunisia, which could undermine the deserved place and values of Tunisian honey in particular.

The following standards refer to their most recent editions:

NT 15.23 - General standards for labeling and presentation of pre-packaged foodstuffs.

NT 16.39 - Microbiological specifications - Interpretation of analysis results.

NT 46.01 - Foodstuffs - General principles of food hygiene.

NT 117.02 - List of maximum concentrations for contaminants and undesirable substances.

NT 117.03 - Maximum residue limits for pesticides.

→ The standard: testing methods

The various testing methods described in the standard are summarized in the following table:

5.3.6 The honey supply chain challenges

The production is confronted with a problem that is continually worsening. Indeed, the productivity of bee colonies depends directly on the supply of honey plants and this resource is decreasing every year.

The transhumance to other regions is little practiced by the small beekeepers who cannot bear the costs of transport. In addition, most of beekeepers complain about excessive loads exceeding 100 hives/ha (especially in spring and summer).

Tunisia's honey industry has faced several challenges in recent years, including competition from cheap imports and declining bee populations due to environmental factors such as pesticide use, climate change and habitat loss. However, the government and beekeeping

associations are working together to address these issues and support the growth of the industry.
With continued support and investment, the industry has the potential to thrive and continue to provide high-quality honey to consumers both domestically and abroad.

5.4 The Luxembourg Beekeeping and Honey Sector

5.4.1 Honey production in Luxembourg

There are an estimated 500 beekeepers in Luxembourg that are organized in the national beekeeping association "Fédération des Unions d'Apiculteurs du Grand-Duché de Luxembourg" (FUAL, http://www.fual.lu), which consists of twelve regional associations (Kantonalvereine). Luxembourg has a significant market share of small and amateur beekeepers (85% have less than 10 hives) that are competing against each other and aim to fully sell their production to cover the cost of production (time, equipment, treatment of the bees), rather than making a profit. Hence honey prices are stable on a relatively low level compared to other regional food products in Luxembourg. In 2023, the retail price was increased first time moderately from 6.00 to 6.45 EUR per jar (500g) to compensate for inflation. In general, honey is harvested and bottled individually by the beekeeper. In contrast to other countries, there are no organizations that buy honey from the beekeepers for further processing.

Luxembourgish honey is mostly produced from a variety of flower and fruit blossoms, since there are not many forests in the country. The honey is classified for the consumer in three types: spring honey, summer honey, and organic honey (Bio). The spring honey has brighter color and is made from early flowers and fruit blossoms. The summer honey is darker and is made from summer flowers, tree and berry blossoms. The taste can be very different depending on the season and source plant, which usually remains unknown, since the bees typically collect pollen in a radius of 2-3 km. In contrast to Germany, no monofloral honey is produced and sold.

All honey is traditionally produced and sold as creamy honey to avoid the crystallization process that would inevitably occur with flower honey. After the harvest (by centrifugation process), the producers add 5-10% of honey made from rape blossoms to seed the crystallization process and then stir the honey for some time in the container until crystallization has ended. This crushes large crystals before the honey is filled in jars, and the honey always stays creamy.

Germany has different plants that allow for liquid honey (Arcacia, Linden) and white creamy honey from rape. South Germany prefers forest honey from fir trees (Tannenhonig). Small beekeepers also sell direct to regional consumers. The big brands of the German food industry (e.g. Langnese) import honey from South America in large quantities in order to keep the look and taste constant over years. This is not possible with local blossom honey. No comparable products are produced in Luxembourg, i.e. no liquid or homogenized honey. In France honey is mostly produced by professionals with their own brands, labels and shops. The experts reject the idea that Germany drives the honey market.

The invasion of asiatic hornets is a recent threat to honey bees and wild bees in Europe. In Germany it appeared in 2014 and has spread to Belgium, Luxembourg, France and the Netherlands. The hornet originates from China and has been imported with food. It eats bees and sometimes kills whole colonies.

Climate change is not yet considered to be much of a problem, but there is a noticeable shift of the seasons from summer to spring. Regarding summer heat, the expert recommends for hot conditions to paint the hive top cover in white color, provide shadow from above to protect the hives from sun exposure at noon, and some thermal insulation in general.

In 2022, the spring season had strong vegetation (no frost periods) and exceptional harvest of honey. The summer season however suffered from drought, many flowers died, and no honey harvest was possible towards the end of the summer. In total, honey production was less than usual, despite the increased production in spring. In contrast to 2022, the spring in 2023 was difficult for the bees so far. It was too cold (frost in the nights until end of April) and wet for the bees to fly out and collect pollen.

HONEY QUALITY ANALYSIS

The honey quality in Luxembourg is regulated by the label „Marque Nationale du Miel du Grand-Duché du Luxembourg", and compliance is mandatory for beekeepers to sell their honey through the sales association. The beekeepers have to register their colonies and harvest prior to the season. It is not allowed to use chemical treatments, and hives must not be placed next to polluted areas. During the harvest, an official inspector from the ministry of agriculture and viticulture (Ministère de l'Agriculture, de la Viticulture et du Développement rural, Administration des services techniques de l'agriculture, Service de l'horticulture) must be present to monitor the process and check the facilities and equipment for compliance with food safety standards. Besides, additional inspections are possible at any time during the season. The inspector provides a number of "Marque Nationale" quality labels with the lot number and documents the hive location and honey water content. One lot refers to the container used for the harvest of an apiary, or a mix of up to 20 colonies, and depends on the size of the container (up to 600kg). The water content is measured with a refractometer and must be below 18%, aim is 17% or less. Invertase must be above 64, and the honey must be clean, no dirt or air must remain in the honey. The inspector also collects a sample of each lot for a more detailed lab and taste analysis. The lab can measure for example the relationship between fructose and glucose to identify potential fraud. Pollen can also be analysed to proof regional origin of honey. EU Food safety regulations apply and are tested in small sample sizes. The level of pesticides is expected to be low because pesticides are applied carefully on the ground, not on the blossoms of plants. This is more of a problem in tree cultures for fruits. Bees also filter the honey. Organic honey production follows strict rules, producers have to extensively document their hives, location, and all measures (no pesticides allowed, only formic acid (Ameisensäure) and Oxalacid) allowed for the treatment of bees. The organic honey is marketed by the brands Demeter, Alnatura, and BIOG. The taste of the honey is tested by a commission of three experts, but not rated on the label. The beekeeper finally fills the honey in jars for sale using the quality labels provided by the inspector. The labels include the logo, lot number, and name of the producer for traceability.

Since April 2023 the honey quality is managed by the sales association as "Marque Nationale Lëtzebuerger Hunneg" without the support of the ministry. Until now the cost for the controls were covered by the government, approximately 1 EUR per glass. This effort will be reduced, and lab measurements will only be made for random samples. Water content and taste will still be tested for each lot. It is planned to register the new quality label as Appelation d'Origine Protégée (AOP) on EU level.

Honey fraud

It is normal that bees are fed during the winter months with sugar to replace the honey taken from them in the summer, but the sugar should be removed in spring to avoid its continued use by the bees. However, some beekeepers intentionally "forget" to do so to strengthen the bees and increase the harvest. According to the interviewed experts, feeding bees systematically with a special syrup on larger scale is a known fraud schema in eastern Europe, i.e. Hungaria and Ukraine, to increase the harvest, and it is difficult to detect. In Luxembourg however the experts expect no such systematic fraud schemas, since the beekeeping community is rather small and unusually high production volumes would raise attention.

Distribution channels

Letzeburger Hunneg (https://www.hunneg.lu/) is a sales association with 80 members that distributes about half of the Luxembourgish honey production volume – about 40.000 jars per year – to large retail stores (Supermarkets with more than 200m^2, i.e. Cactus, Match). The honey quality must comply with the "Marque Nationale" food label crtieria. The jars of 500g show the Marque Nationale label and provide the full name of the producer, as well as a serial number that uniquely identifies the production lot, for full traceability of the supply chain. From the 2023 season on an additional QR code will link to the website of the association to provide additional information about the product. Individual QR codes could link to details about the producer and lot, but this is currently not implemented due to the expected efforts to maintain and update the data.
Furthermore, the sales association created the new brand "Letz Hunneg" for larger bins of honey that are distributed by the Luxembourgish wholesaler Provencal for commercial use, e.g. gastronomy or bakery. A third product type is organic honey, produced according to EU regulations.

The other half of the annual production is sold by small holders privately or directly to consumers through small regional shops or markets. Other typical national products are honey spirits and liqueurs.
In exceptional years, the volume can exceed the domestic demand. In this case, large quantities are exported to wholesaler in Germany and France for a very low price (3.50 EUR/kg), since the honey is not monofloral.

Homogenized honey made in Luxembourg could be established as a new product in the future to serve the demand of customers for honey with continuous taste, independent of local and seasonal changes. However, mixing honey from different lots and seasons requires new quality management besides the current procedure and poses new challenges to the traceability process. This could be a potential application of TECHONEY technologies.

Regarding consumer needs, a recent study from 2018 has been published by FUAL (https://apis.lu/docs/Broschüren/14_1_miel-rapport-1204-2018.pdf) in which 600 consumers have been asked about their honey consumption habits and needs. Some consumers would prefer smaller jars of 350g instead of 500g. The honey produced by Marque Nationale is mostly known and bought by elderly residents of Luxembourgish nationality, whereas inhabitants originating from France and other countries prefer imported honey. In the future, new products and marketing campaigns will be necessary to promote the Marque Nationale.

Table 21: Labels and Logos Luxembourg

		LU-BIO-05 Agriculture Luxembourg
Fig. a. Luxembourg produces spirits and liqueurs based on honey.	Fig b. Logo of the sales association.	Fig. c. Label for organic honey.

USE CASE OF TECHONEY FOR SCALING UP A HONEY BUSINESS (ANONYMIZED)

Vincent is a young IT expert working for Microsoft in the city of Luxembourg. In his spare time, he continues with his father the family tradition of beekeeping with currently 10 hives, which produced 100kg of liquid honey in 2022. In the last 100 years, almost everything has changed, from hand-made apiaries of his grandfather to industrialized hives monitored by IoT. Vincent recently registered a startup company to benefit from public funding to double his capacity to 20 hives in 2023. His goal is to scale-up his business to 200 hives, which he considers to be manageable without staff. In order to make beekeeping his main profession, he estimates a needed capacity of about 500 hives and seasonal support staff. However, Vincent is facing many challenges. Since his family owns no significant land in Luxembourg, he must cooperate with famers to deploy his apiaries. Reaching out to them is time-consuming, he has to tour the country to meet and negotiate with them. Not everyone is interested in his pollination services. The distribution of his hives across the country also requires technical support to monitor their condition, e.g. temperature, humidity and honey mass. For his business plan, Vincent already performed market research for IoT technology, but current products (https://www.beehero.io/beekeepers, https://www.beewise.ag)and pricing models target mainly larger businesses. Besides the production, also selling larger quantities of honey is a challenge for Vincent besides his current channels of direct sales. He is currently setting up an online shop, but shipping costs of 5-8 EUR makes it very unattractive for end users to order a single jar. Vincent also considers other products based on honey for pharmacy, cosmetics, and wellness, but it’s difficult for his start-up to get in contact with the industry. In conclusion, the TECHONEY marketplace could help Vincent to overcome the challenges of scaling up production with monitoring of his decentral hives, collaborating with farmers, and promoting his products to consumers. Further, the marketplace could support the hiring of seasonal staff to support the maintenance of hives, and promoting his honey for industrial use.

5.5 The Algerian Beekeeping and Honey Sector

Analysis of the honey value chain in Algeria: Strengths, Weaknesses, Opportunities and Threats "SWOT": Object of consultation among professional beekeepers and actors in the sector.

5.5.1 Historical overview of Algerian beekeeping

In time, North Africa and particularly Algeria, represented a "honey tank" for the Roman Empire. This activity has gone through several important stages, the main ones being the stage before, during and after the war of liberation.

During French colonization

Before 1954, traditional beekeeping was important among Algerian peasants, but modern beekeeping was essentially carried out by the settlers without transferring knowledge to the indigenous populations.

In 1954 came the war of national liberation and a large part of the traditional hives was destroyed by the French army which considered that each hive could serve as a hiding place for weapons and whose situation was critical at independence!

AFTER INDEPENDENCE

After independence, the state looked into the problem of the beekeeping sector while solving it by developing various development programs. He focused his efforts on the multiplication of the herd, moving towards the importation of foreign bees and also towards the construction of a so-called "Algerian" hive as well as the creation of beekeeping cooperatives.

FROM INDEPENDENCE TO 1999:

Several programs have been initiated by the Algerian State with the creation of numerous cooperatives offering multiple services to beekeepers: 1.- Manufacture and supply of modern beekeeping equipment; 2.- Marketing of hive products; 3.- Training and support for new beekeepers. But beekeeping has remained a secondary activity, marginalized and complementary to other agricultural products.

2000-2008:

National Agricultural Development Plan "PNDA" transition from a secondary activity to a beekeeping sector.

- Increase in beekeeping livestock by 200%.
- Honey production tripled
- Creation of ~300 beekeeping nurseries.
- Replacement of a large number of traditional hives (sources of disease contamination) by modern hives.

2008 -2014:

Launch of an Agricultural and Rural Renewal (RAR) strategyand sustainable development aimed at food security through the rational use of natural resources.

- 1.3 million colonies: +30% between 2008 -2014 • 6000 tons of honey.
- Diversification of bee products (Pollen, royal jelly, propolis, wax)
- Training in beekeeping provided by different institutions (ITMAs, ITELV, and CFVA).
- The beekeeping sector is classified among the priority sectors.

2014-2023:

Beekeeping is now present in all areas (agricultural, mountains, forests, steppe and Saharan areas) and guarantees this biodiversity through pollination.

5.5.2 PROFESSIONAL ORGANIZATIONS REPRESENTING THE BEEKEEPING SECTOR IN ALGERIA

After independence, the Algerian state looked into the problem of the beekeeping sector with the establishment of certain organizations to supervise the beekeeping sector in order to increase the evolution of its production.

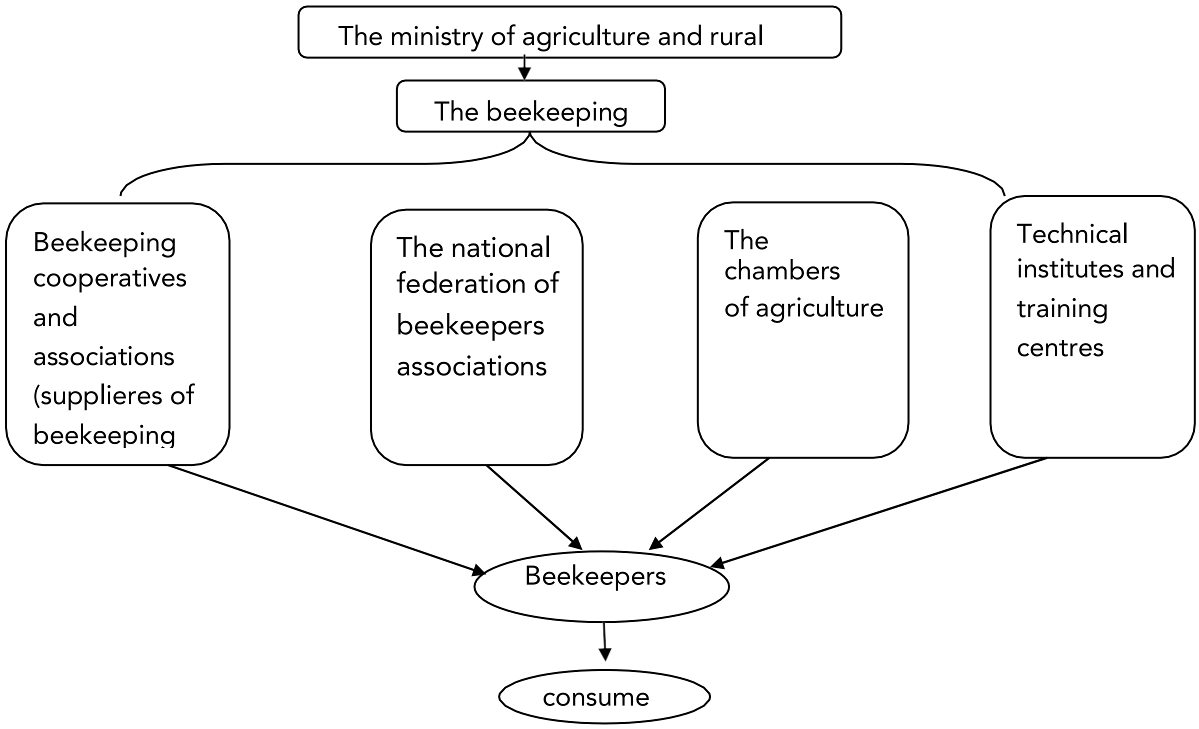


Figure 26: General diagram of the beekeeping sector in Algeria

5.5.3 Current situation of the beekeeping sector in Algeria

Benefits of the beekeeping sector

It is quite certain that Algeria justifies major assets for beekeeping. First the ancestral antiquity of the practice; then, the size of the country with its different geographical stages from the plains of Tell, to the immensity of its Sahara and its steppe, the mildness of its climate and its floristic diversity make beekeeping possible in 43 of the 48 Wilayas (departments).

MAP REPRESENTING THE DISTRIBUTION OF HONEY PRODUCTION IN ALGERIA

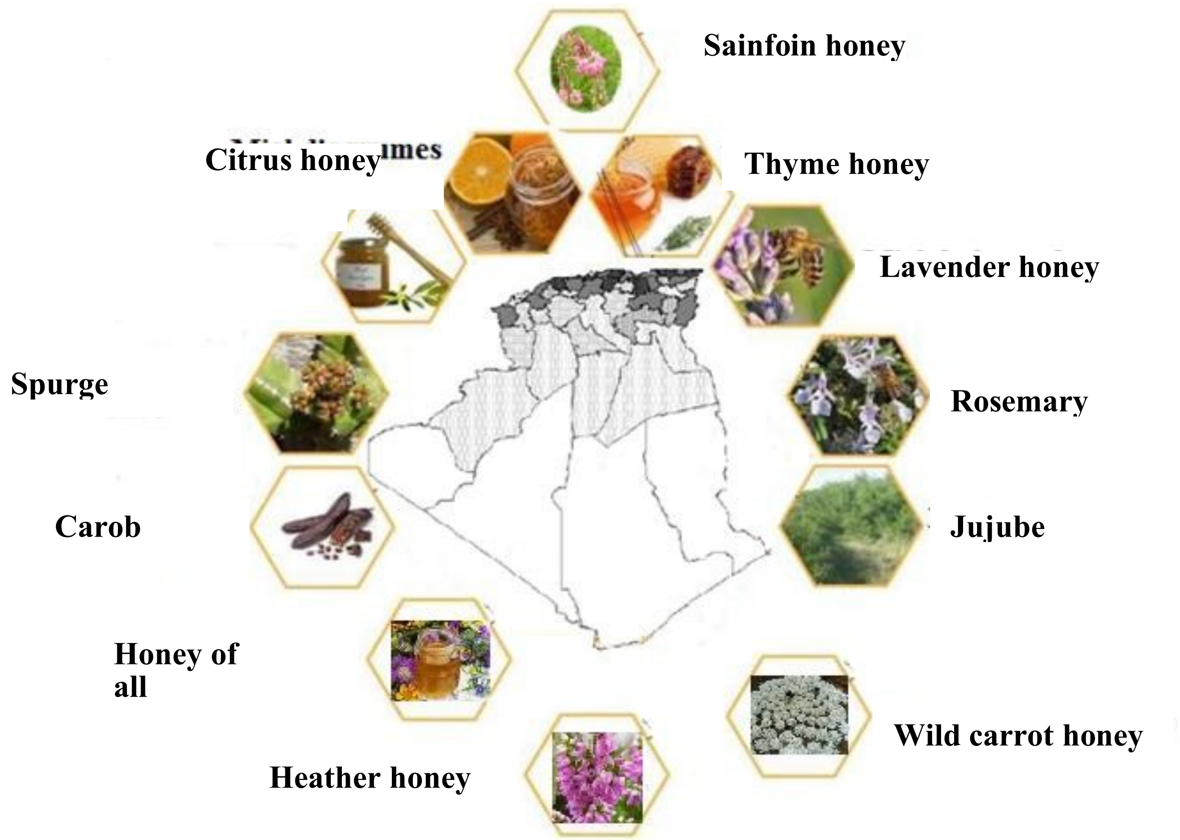


Figure 27: Distribution of honey production in Algeria

CURRENT SITUATION

Beekeeping has remained on the sidelines of the formidable development momentum of Algerian agriculture over the past fifty years and unlike other animal and plant sectors . State incentives in favor of beekeeping through the launch of several programs (PNDA, PPDRI) and projects supported by ANSEJ, ENGEM and CNAC as well as the FILAHA Strategy: 2015-2019 objectives, greatly encouraged young people to turn to beekeeping. But, as a result of the successes recorded, the beekeeping sector remains confronted with major constraints which constitute as many obstacles to its growth and which explains the low beekeeping productivity and the high level of imports, as well as the prices practiced on the market.

The inventory drawn up through the survey carried out in the field. The surveys were carried out in the form of a personal interview lasting several hours with each beekeeper (148) and the other actors involved in the sector in the Kabyle region (Tizi-Ouzou, Béjaia), based on a questionnaire previously established comprising questions aimed at describing the human and social aspect, the economic aspect, and questions concerning the management of apiariesv(breeding practices). The data thus collected were the subject of a series of analyzes to highlight the weaknesses and opportunities of the Algerian beekeeping sector.

The descriptive analysis of our surveys reveals that : 92.90% of beekeepers surveyed are private, with an average age of about 46 years. 75% of them have a seniority of more than 15 years. The main results show that beekeeping is practiced overwhelmingly by men (95%), on the other hand with regard to the mastery of beekeeping techniques, all the beekeepers questioned use the langstroth hive. The number of workers in these farms is adapted to the size of the hive park and to the work to be carried out, which is most often seasonal. In addition, the number of hives per beekeeper is more than 120 hives on average, however, many beekeepers have less than 100 hives. The most produced hive products are: pollen, swarms and honey. Honey yield averages 6-7 kg/hive/year. The types of honey are diversified by the practice of transhumance, observed among many beekeepers. This one knows several destinations and locations such as the orchards of the North, the mountains, the forests and the South of the country. The Kabylia region can claim to be the country's leading honey producing region. It has significant honey potential with an annual honey production estimated at more than 2000 quintals for the year 2020.

Typology of farms: 5 classes of farms

Class 1: Sedentary beekeeping, associated with agriculture, low number of hives and low honey production.
Class 2: Transhumant beekeeping, with a low number of hives and average honey production.
Class 3: Transhumant beekeeping, with an average number of hives and average honey production. In addition to their movement in the orchards of the North, some of them also transhumant towards the South, the mountains and the forests.
Class 4: Transhumant beekeeping, with a large number of hives and average honey production.
Class 5: Transhumant beekeeping associated with agriculture, with a large number of hives and with significant honey production.

The majority of beekeepers (99/148) started their activity after 2000, at the end of the dark decade which had seen the abandonment of part of the exploitation of hives. However, 39 of the 148 declare having a secondary activity. What all beekeepers have in common is their passion for their bees. The vast majority of beekeepers are not satisfied with the services of their chamber of agriculture to which they belong (83 not at all satisfied and the rest not very satisfied or not at all) and only 64 out of the 148 are attached to a professional association, which constitutes an indicator of social sustainability, it helps break their isolation and stay informed of developments in the profession.
The problem of the anarchic spreading of pesticides and other toxic phytosanitary products which decimate entire colonies of bees is, however, beginning to be raised throughout Algeria and a decline in national honey production since 2018 has been recorded. This is also due to "climate change, drought, the proliferation of insect pests and the regression of

melliferous grassland areas due to forest fires recorded in the country. For some years, we have been witnessing an unexplained mortality of bees Researchers are talking about nosemosis, a fungus that causes a disease that affects the digestive tract.

5.5.4 Evolution of the marketing and consumption of honey in Algeria

Although the production of honey has undergone a remarkable evolution in recent years, the absence of official production and consumption figures remains unexplained. The quantity placed on the market is insufficient to meet the local demand for honey. Organized distribution circuits hardly exist, which results in very variable prices even for honeys of the same type. Direct sales from the producer to end consumers are very common. Nevertheless, the consumption of honey remains low in Algeria, since that of the Algerian citizen does not exceed 180 g/year. For its part, the FAO considers that the high prices of honey are the consequence of the absence of a honey futures market, and therefore the absence of benchmarks for understanding and setting prices. Generally, the price is around 6000 DA/kg (40 €/kg) for retail. Moreover, national production is under the pressure of very strong competition from imported honeys. The success of the marketing of honey necessarily passes through the identification, organization and development of the marketing circuits of the Algerian beekeeping sector. To do this, it is desirable to carry out media campaigns to publicize the local types of honey and encourage its consumption. In addition, the labeling - which would make it possible to differentiate real honey from fake honey - of local honeys, their characterization and the scientific confirmation of their therapeutic virtues can only increase consumer confidence in the product. It is important to underline that despite being a very individualistic sector, there is a growing tendency towards the formation of groupings, whether cooperatives (which have grown considerably) or other legal forms.

5.5.5 Import of honey

The study shows that the beekeeping sector is among the Algerian sectors most threatened by this opening to different markets. With the abolition of customs duties and all forms of production support. The beekeeping sector will find itself in a bad position vis-à-vis the external market, insofar as there are countries which have production surpluses and very competitive production prices and which may be interested in the Algerian market. This poses a long-term threat to the local industry. However, some economic specialists believe that in the context of Algeria's accession to the Euro-Mediterranean free trade area and, with the abolition of customs duties, the Algerian beekeeping sector could have setbacks will succumb to the products import.

5.5.6 Sustainable Beekeeping Strategy

It is necessary to set up a national program for sustainable beekeeping in line with the National Strategy for Sustainable Development launched in recent years by the Algerian government. Beekeeping should be better harmonized to take into account their respective needs. We must take more account of the way of life of bees and their preservation. As such, sustainable beekeeping will be based on the principle that the bee acts as a sentinel and gives the alert for damage to the environment and biodiversity.

5.5.7 FILAHA STRATEGY: OBJECTIVES 2015-2019

- Improvement of beekeeping production to 10,000 tons of honey

- The valorization of beekeeping products by the characterization of Algerian honeys in particular the labeling: project of creation of the "honey" consortium by the profession, framed by public institutions (ALGERAC, ALGEX, and ITELV) in view of promoting beekeeping products to the export.

- characterization of honey (sign of quality) within the framework of the twinning project with the European Union.

- Establishment of regulations governing beekeeping and strengthening the protection of bees from diseases and phytosanitary products.

5.5.8 GEOGRAPHICAL INDICATION

The promotion of quality linked to geographical origin through geographical indications (GIs) contributes to the promotion of products and the protection of producers as well as the assurance of quality to consumers.
"We have excellent quality honeys, it is up to us to know how to place them while respecting international standards", he added the president of the National Federation of Beekeepers (FNAP) during a day of study on beekeeping in Algeria, "challenges and export prospects", organized by the National Agency for the Promotion of Foreign Trade (ALGEX).
Controlled designations of origin (AOC) represent a strategy for organizing differentiated quality linked to the terroir. However, for labeling to be possible, certification is mandatory and modernization and regularization of quality are necessary. Some "good practices" such as quality control are to be implemented. Algeria is far behind since out of the 148 beekeepers surveyed, 112 declare that they do not carry out any quality control of their production. While waiting for the creation of specialized laboratories, Algerian beekeepers are trying to find other export niches to the Middle East where tens of tons are currently exported. La Mitidja alone participates with an area of more than 25,000 Ha of citrus fruits. The production of orange honey from this region occupies an important place in the overall production of Algerian honey, hence the need for the establishment of a geographical indication which characterizes this product. This also applies to honey from the mountains of Kabylia. The application of this strategy facilitates entry into demanding markets such as the European Union, the United States, Canada or Australia.

5.5.9 Strengths, weaknesses, opportunities and threats

Strengths:

In Algeria, the temperature is excessive for a good part of the year, exceeding 30°C. This is well suited to honey extraction operations. Thus, the diversity of melliferous plants favors the existence of several varieties of honey.

- Possibilities to continue to increase national production: Algeria presents a growing trend in the development of beekeeping activity. It is necessary to have a strategy that allows to place and position the honey on the international market.

- Possibility of exporting for the next few years, in particular differentiated products and other hive products :Algeria has significant comparative advantages which could become competitive if accompanied by a development and marketing strategy. Mechanisms can be implemented that include denominations of origin, honeys differentiated by botanical origin and organic honey, among other possibilities.

- Increase in the use of honey by different industries: As in other regions of the world, in Algeria, honey and other hive products have started to be used in various industries such as food, pharmacy and cosmetics. This growing trend can promote the development of the sector.

Weaknesses

- Inaccurate statistical data and lack of reliable registers of producers and Algerian production: In Algeria, the statistical data are inaccurate. Producers are still unaware of the importance of statistics in making strategic decisions. Thus, it is difficult to establish certain lines of action due to the lack of reliable information on the sector.
- Lack of information on market developments :Given that it is a highly exportable product, it is strategic to know the orientations of international policies, their evolution, agreements, tariff preferences, etc., as well as the evolution of purchases and sales of major competitors.
- Increased barriers to international trade :In recent years, barriers to trade have increased, particularly due to health and quality issues. For the entry of honey from another country, it is necessary to have a health certificate which must be issued by an accredited certification body.

- There is still a lack of training for producers and business people in the implementation of quality assurance systems such as BPM, HACCP or ISO 9000 standards. Added to these threats is the possibility that some countries are beginning to require honey companies to have HACCP systems in place.

- The marginality of the beekeeping sector in the agricultural world and the low level of investment.
- Underdeveloped domestic market : The domestic market is underdeveloped and there is no tradition of consumption. Honey in Algeria is mainly associated with medicine to treat colds and sore throats, which is why its consumption is sporadic. In any case, demand is greater due to changes in consumer habits.

Unlike other foods, its main place of sale is not supermarkets. In this case, the consumer prefers to buy the product in traditional stores. This is given by the association that is made between the natural product of the field and the personalized point of sale which contains information on the history of the food.
-Problems of adulterated honey in the domestic market : Due to the low price of adulterated products and the consumer's ignorance of what pure honey is, there is a high degree of adulterated honey in the market. In addition, the lack of control on the part of the State. This situation generates unfair competition which makes it difficult to formalize producers who work in compliance with the regulations.

- Strong problems of tax evasion: In the specific case of the beekeeping sector, the highest level of evasion is among small and medium producers, since this path generates competitive disadvantages for those who comply with the regulations.
- Little development of high value-added products
  The development of differentiated honeys and other bee products such as propolis, pollen, among others, is a bit premature. International demand exists and is not satisfied and Algeria has assets.
- Low technological progress in the development of living material, genetic improvement and disease control

It is necessary to intensify the research in the technological development to obtain better performances in the hives. Few surveys are conducted based on the real needs of producers. It is necessary to agree on policies for technological development in order to make effective use of the few resources available for research.

- Significant shortcomings related to aspects of product quality and standardization and the frequent lack of certification hampering export
- The vagaries of the weather and the lack of water around the hives

- Low yield of hives, due to lack of mastery of modern techniques

- The health status of the bees and the bad behavior of man towards these bees

- The anarchic use of pesticides, results in high mortalities within the bee herd

- The limited number of beekeepers and hives in relation to honey potential.
- Difficulties of access to bee sites
- The lack of organization of the actors, and the non-existence of a financing system for this type of activity

Opportunities

In recent years, Algeria has engaged in a series of free trade negotiations. These negotiations could open new markets for Algerian honey. This is the case of the countries of the European Union, African countries and the Middle East. African and Middle Eastern countries are interesting markets from the point of view of honey consumption and the low local production that exists due, in some cases, to climatic restrictions. In recent years there has been an increase in the demand for natural products and this has motivated the development of organic production with a significant boom in the European Union. Algeria is able to supply the European market with honey and other bee products from organic farming.
Among the opportunities are:

- State support system,
- Training, research…,
- Job creation (promoting niche). Economic with the integration of Algerian women in beekeeping
- Export product
- Local market with great potential,
- Added value of other products and services (royal jelly, pollination).
- Opening of new markets linked to international agreements
- Higher Quality Requirements : This is the biggest threat of all. There is a trend towards requirements in terms of quality, linked not only to hygiene and sanitation conditions, but also to commercial issues or consumer requirements. Some countries have even started to require honey free of genetically modified organisms, without residues of antibiotics or contaminants, among others. Algeria has significant assets, particularly with regard to GMOs, but it has some problems with residues from the misuse of veterinary products used by producers to treat bee diseases.

Threats

- The different segments of the sector are not visible to organize the interprofessional
- Beekeepers' organizations (cooperatives and associations) encounter governance problems
- Huge loss of livestock due to pesticide poisoning,
- Loss of melliferous species and species (deforestation, diseases, concrete, etc.)
- Certain diseases threaten the existence of important bee species (jujube, eucalyptus, etc.)
- No monitoring and evaluation of the sector.
- Absence of standards and quality label.
- Lack of legislation governing beekeeping in Algeria.
- Uncontrolled introduction of queens and risk of loss of adaptation Genetic.
- The difficult sale of local honeys.
- Low quality, cheap, unfair trade import honey.
- Sanitary regulations little applied.
- Reduced food controls (fraud).
- Lack of promotion of national products at the local level.
- Theft and ransacking of hives by strangers.
- High price (or absence) of sanitary treatments.
- Difficult fight against fraud (lack of laboratory).

Constraints for the development of the beekeeping sector in Algeria

bee breeders are faced with obstacles often due to the lack of an ideal framework, namely the development of hive breeding areas in regions with great potential. They do not have land for this breeding, despite their enthusiasm for developing their local production. In addition, during transhumance, beekeepers face several risks that cause them to lose a large part of their hives, or even all of them, such as fires, looting and especially the use of pesticides by the owners of the sites.

Beekeepers denounce the disregard for the alerts they issue. All that is needed is for the chemicals placed on the market to be better controlled and their use regulated more rigorously. The agricultural officials who have been trying for years to encourage the development of beekeeping by allocating annual budgets, should not watch helplessly as so much effort and money is wasted. The beekeeping sector is still very fragile in Algeria and really does not need any additional obstacles. However, the bee industry is very profitable. It is enough to visit the fairs that are held in our cities to realize that honey, whose curative virtues are innumerable, is in great demand and consumed.

But with the absence of the beekeeping theme in veterinary and agronomic training, the absence of a complete and validated guide to good beekeeping practices and the lack of agreements related to the teaching of beekeeping between the different Ministries, the beekeeping sector remains one of the Algerian sectors most exposed to threats.

According to the previous analysis carried out, the Algerian beekeeping sector is in a phase of repositioning. Algeria occupies a prominent place in the Maghreb and African context, but it still has to resolve very significant internal deficiencies that would allow it to move forward on threats and transform them into opportunities for better integration into the market. The strategy should aim to offer more honey and better quality.

5.5.8 Recommendations and perspectives

- Faced with these worrying facts, the strategy of the beekeeping sector must make Algeria a major beekeeping country in the Maghreb Union by modernizing beekeeping operations, guaranteeing the quality of honey, developing the production of beehive, by providing the sector with a capacity for forward-looking reflection via the creation of an interprofessional organization. Finally, we must make the beekeeper an actor in rural development, in particular by training and installing new beekeepers. All of these issues are part of the sustainable development plan for beekeeping, implemented by the Algerian government.
- Establishment of a public prophylaxis policy at the level of an entire territory with the full collaboration and assistance of beekeepers and their guides (specialized veterinarians, technical centres, beekeeping associations, beekeeping cooperatives, etc.). Furthermore, the link between beekeepers and farmers through socio-professional organizations would undoubtedly make it possible to discuss the problems relating to the anarchic use of pesticides and the interest of bee pollination in the agricultural field.
- Provide high-level training for beekeepers to master beekeeping techniques
- The awareness of beekeepers for the quality control of their honeys, as well as the use of innovative labeling and packaging.
- Elaboration of a honey map for all regions, as well as a pollen repository helping the characterization and conformity of the botanical origin of Algerian honeys.
- Installation of qualified and specialized laboratories.
- Ensure the traceability of honeys and improve their visibility on the market.

- Harmonize and update national legislation on honeys for the production of quality honey that meets the standards required by importing countries.
- Define the different segments of the sector, to ensure the traceability of the products and lead to the organization of the inter profession.
- Implementation of a participatory approach for the qualification of honey "Geographical indication: GI".
- Support the development of organic beekeeping (technical and financial support) in the frame work of the NADP.

5.6 The Moroccan Beekeeping and Honey Sector

Authors Content and Text: Case Study Leader Hafida Hanine et al. USMS
Limited Formatting due to pdf. File and quality of document delivered: Thomas Wassermann, CREDA

5.4.1 Introduction

Beekeeping is an agricultural sector that has a special character in Morocco. It is virtually present in different regions. The apiarian potentialities in Morocco are important and remain under exploited. Honey production is stagnating because of many difficulties concerning repopulating colonies despite governmental efforts to modernize the sector. This review is to present a synthesis about the sector of beekeeping and honey production in Morocco. It will allow describing the situations, to understand the challenges faced by the Moroccan beekeeping by focusing on: bee farming, honey production, professional organization, marketing and regulatory issues. The main issues of this work package is increasing honey production and productivity of the hives, the application of good hygiene practices, enhancing honey quality, regulatory revision, adjusting the current model of professional organization, structuring of honey marketing channels and finally conclude with recommendations and prospects.

Info: CREDA clearly communicated the agenda of Techoney´s Work package 1. Moroccan partners agenda is slightly seen in a different way and was only delivered in pdf. Original text see: https://doi.org/10.1155/2021/9039726 Formatting possibilities for CREDA were limited.

Due to its important floristic, faunal and landscape diversity, Morocco is endowed with an important and unique beekeeping potential, resulting one of the most valuable territories for honey production in the Mediterranean area [26]. Here, beekeeping is a well-rooted tradition and one of the most profitable businesses, thanks to the conspicuous production not only of honey, but also of pollen, propolis, beeswax, and royal jelly. A market overview showed that the Moroccan honey production increased from 4.7 tons to almost 8 tons between 2010 and 2020, with a turnover of around 101 million [27]. Moreover, a vibrant modernization of the sector has started in the last decade, thanks to the leverage effect of the Green Morocco Plan (GMP), the National Initiative for Human Development (NIHD) and, not least, the Moroccan Ministry of Agriculture, setting a referential catalog for high-quality terroir products, including honey, with the final aim to label them under Geographical Indications, Designations of Origin or Agricultural Labels, thus, promoting their consumption [28]. The Béni Mellal-Khénifra region, placed between the High and Middle Atlas mountain ranges and the Tadla Plain, is well known for its rich and varied botanical diversity allowing for significant honey production [29]. Particularly, the region boasts the monofloral Euphorbia honey of Tadla-Azilal, labeled with Protected Geographical Origin (PGI) and produced from Euphorbia resinifera, an endemic Moroccan species mainly distributed in Azilal and Béni Mellal areas.

In Morocco, there are two well-recognised honey bee (Apis mellifera L.) subspecies: A. m. intermissa in the north and A. m. sahariensis in the south-east. The latter subspecies is found in the arid and semiarid climates of the Sahara Desert. In this study, we used honey bees from four areas of south-eastern Morocco which are, to some degree, isolated by arid zones. We analysed the shape and size of the forewings, using the method of geometric morphometrics. The bees from the four areas of south-eastern Morocco differed significantly in terms of wing shape. Moreover, bees from traditional hives were smaller than those from modern hives. The bees from south-eastern Morocco were clearly different from the reference samples obtained from the Morphometric Bee Data Bank in Oberursel, Germany, representing most of the global variation in honey bees. Surprisingly, the bees were also different from A. m. sahariensis, which should occur in the study area, according to earlier studies. This difference could have been caused by introgression with non-native subspecies imported by beekeepers. The distinct honey bees from south-eastern Morocco deserve to be protected. We provide a method for identifying them, which can help protect them.

Despite all the advances highlighted in relation to the development and labeling of Honeys as terroirs product several persistent difficulties linked in particular:

A. TO MOROCCAN CONSUMERS:

I. Ignorance of the special value of labeled honeys,
ii. Perception of the good sanitary quality of the honey circulating in the informal circuit compared to those conditioned and sold in organized tours;
iii. Limited purchasing power for demand for differentiated products.

B. TO PRODUCERS:

I. Honey producers not completely convinced and motivated as to the differentiation strategy (in comparison with the germination of the argan sector);
ii. Insufficiently organized and structured following a certain mistrust of organized structures marking a preference for harvesting and self-consumption traditions.

vs. To institutions: the national strategy for the development and promotion of local products must be multisectoral. It is no longer the business of one ministry (in this case agriculture) but of several. The ministry of culture has a major role as much as the ministries of tourism, crafts or communication.

C. MARKETING: at this level it is essential to set up an effective public-private partnership playing favor of producers. Indeed, the large-scale distribution sector can play a strategic leadership role in the marketing of local products and therefore participate in a part to educate and inform the Moroccan consumer and on the other hand to promote the internationalization of these products.

In the analysis of a supply chain, marketing deserves special attention. For Moroccan beekeeping, marketing is the link that presents the most constraints, we can count everything: first the seasonality of demand which remains linked to the month of Ramadan and religious holidays, then a opaque organization of this link comprising a multitude of intermediaries and channels and finally, a little local market developed. The production of Moroccan honey is marketed according to several unorganized or organized circuits depending on the case. [Figure 1]:

a-Traditional circuit that can also be qualified as "informal circuit" or "unorganized". This circuit is used by traditional beekeepers and a good part of modern beekeepers. It is characterized by relationships merchants based primarily on trust. Several places of sale in

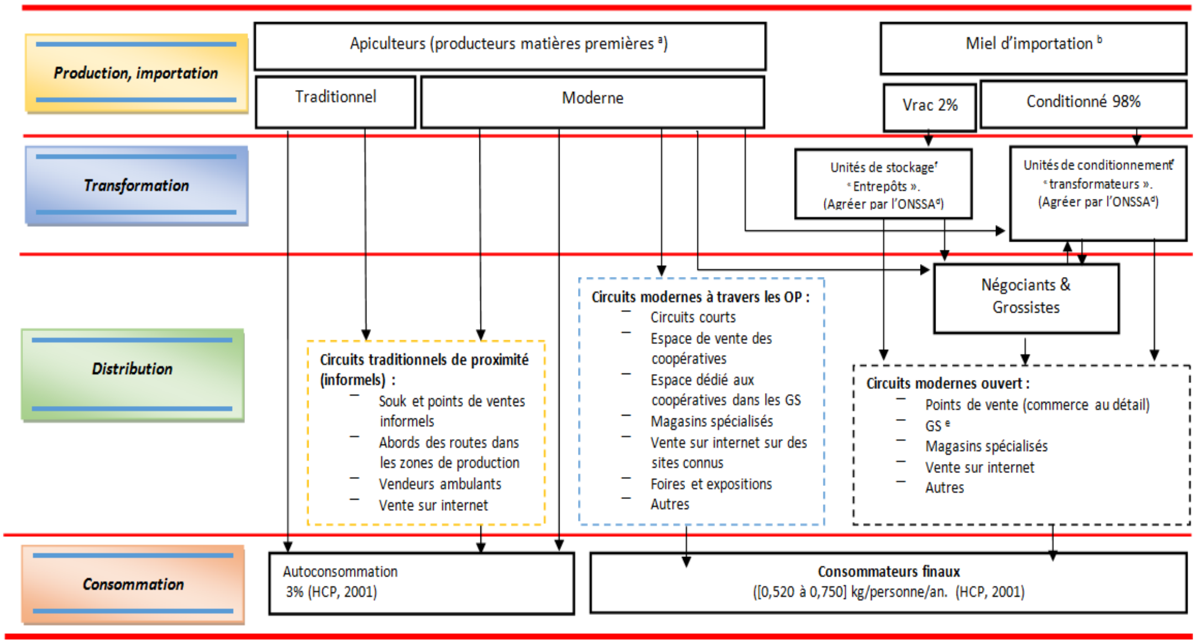


Figure 28: The production of Moroccan honey is marketed according to several unorganized or organized circuits

This circuit are possible: the souks located in production areas, local sales outlets, urban markets, roadsides in production areas and street vendors. informal internet (web site) sales can be classified under this category although they do not carry the traditional character. In addition to this, you need to know more about it.

Modern (organized) route taken by more or less professional and structured producers or traders (individuals and associations of producers). They market the honey through distributors located in the centers urban areas of certain hotels and tourist camps at the level of the administrative centers of the cooperatives (sales area). The circuit also passes through supermarkets, honey conditioning and processing centers, sales areas during local and national events of local products, but also at the store level electronic. Only 50% of the quantity of honey produced, from modern beehives, is sold according to identified circuits known as circuit modern organized. The remaining 50% of national production is to a small extent for own consumption, otherwise sold in traditional circuits at prices ranging from 70 DH to 350 MAD [2].

This inventory shows the significant weight of traditional circuits, more than 250,000 beehives (including units informal) and more than 22,000 beekeepers, in the honey marketing link in Morocco. These parallel circuits and unstructured so-called "informal" strongly penalize the

organized sector [3]. In the modern circuit (unit of packaging, cooperatives, wholesalers and traders), the kilogram of honey costs 50 to 300 MAD depending, well of course, the season, the quality and the label.
There are currently 14 honey packaging units in Morocco, approved by ONSSA.
These establishments are the only ones authorized to process imported honeys in bulk, which contributes to the control of traceability of foreign honeys in relation to local honeys [4]. However, the traceability in question must be strengthened more so by the evolution of current regulatory texts relating to honey in order to integrate the obligation to define, in the labeling, the mention of a mixture of honey from different origins. The diversity of melliferous plants and to recognize the state of beekeeping in the Fez-Meknes region in Morocco. We conducted a questionnaire for beekeepers that set up their hives in the prefectures and provinces of the region, and we have studied the pharmacological evidence of the most preferred plants by beekeepers to assess its medicinal values. The results indicate that honey, bee pollen, bee bread, royal jelly, propolis, bee wax, bee venom, and bee queens are produced in this region with different percentages, and 102 plants belonging to 32 families were obtained in the inventory of melliferous plants; the most represented families were Asteraceae and Lamiaceae (13.73% each) followed by Rosaceae (8.82%). Among these 102 plants identified, 79 plants provide nectar and pollen for bees, 16 plants provide only pollen, 3 plants provide only nectar, 35 plants are resinous, and 6 plants provide honeydew for bees. The outcome of this study will contribute to the valuation of melliferous plants and help to establish a practical guide for the development of the beekeeping sector as an agricultural economic approach.

5.4.2 Statistical data of honey sector

For example in Morocco, According to Green Strategic, the Agricultural Development Fund (FDA) aims to promote private investment in the agricultural sector and to orient it, through targeted subsidies and premiums, towards activities allowing better exploitation of the national agricultural potential. Beekeeping also benefits from this aid since the state subsidizes the equipment necessary for the production of bee products with a subsidy rate of 30% on materials such as the honey filter, the wax waffle iron or the units of wax making. This sector also benefits from flat-rate subsidies as follows: (a) Aggregation project for beekeeping around a unit for extracting and packaging honey (honey production): 750 Euros/ tonnes and (b) Production of selected breeding queen bees: individual breeders 25Euros/ hive and 300 dh / hive for groups of breeders. (Table1,2,3,4,5)

Table 21: Production Population of Natural Honey (number)

Year	France	Italy	Spain	Morocco	Tunisia	Turkey
2015	800.834	477.447	2.730.000	379.666	622.711	7.748.287
2016	803.766	436.750	2.834.514	385.539	664.717	7.900.364

2017	859.462	409.538	2.904.971	392.073	673.731	7.991.072
2018	868.365		2.965.557	396.951	693.480	8.108.424
2019				401.828	713.229	8.128.360

Source: FAO Database, 2021. http://www.fao.org/faostat/en/#data/QL Note: FAO data based on imputation methodology

Table 22: Yield of Natural Honey (hg)

Year	France	Italy	Spain	Morocco	Tunisia	Turkey
2015	199	202	122	103	53	140
2016	140	222	109	125	53	134
2017	168	232	101	153	53	143
2018	224		123	187	52	133
2019	185			198	52	135

Source: FAO Database, 2021. http://www.fao.org/faostat/en/#data/QL Note: Calculated data by FAO

Table 23: Natural Honey Production (tonnes)

Year	France	Italy	Spain	Morocco	Tunisia	Turkey
2016	11.235	9.705	31.018	4.800	3.529	105.727
2017	14.448	9.500	29.393	6.000	3.550	114.471
2018	19.469		36.394	7.430	3.579	107.920
2019	15.755			7.960	3.690	109.330

Source: FAO Database, 2021. http://www.fao.org/faostat/en/#data/QL Note: Official data

Table 24: Natural Honey Import (quantity: tonnes, value: 1000 US$)

Element	Year	France	Italy	Spain	Morocco	Tunisia	Turkey
Import Quantity	2015	32.762	23.549	30.654	1.524	160	-
	2016	35.572	22.568	27.973	2.670	140	1
	2017	35.547	23.602	32.251	2.075	252	-
	2018	32.279	27.875	27.923	3.311	234	22
	2019	32.777	24.650	26.550	2.425	367	45
Import Value	2015	127.272	84.566	73.265	3.203	763	2
	2016	126.775	72.459	65.682	5.079	707	6
	2017	130.679	82.148	77.400	4.375	1.056	3
	2018	129.803	100.859	68.530	7.052	895	76
	2019	117.082	80.432	57.395	5.122	1.421	221

Source: FAO Database, 2021. http://www.fao.org/faostat/en/#data/TP Note: Official data

Table 25: Natural Honey Export (quantity: tonnes, value: 1000 US$)

Element	Year	France	Italy	Spain	Morocco	Tunisia	Turkey
Export Quantity	2015	5.064	8.883	30.590	49	1	7.192
	2016	5.077	7.815	27.422	132	7	3.623
	2017	5.050	6.765	25.332	4	1	6.431
	2018	4.400	5.335	23.590	60	1	6.386
	2019	4.433	5.049	23.064	8	1	5.499
Export Value	2015	32.225	43.846	103.027	200	22	25.072
	2016	34.345	38.225	110.679	315	49	14.926
	2017	36.250	36.783	112.831	123	12	23.320
	2018	31.868	31.657	107.719	274	23	25.563
	2019	29.567	27.045	89.807	274	15	24.581

Source: FAO Database, 2021. http://www.fao.org/faostat/en/#data/TP Note: Official data

5.4.3 Area of the Study

The region of Fez-Meknes and BMK region are located in the northern and southern center of Morocco (34° 02′00 ″north, 500′00″ west), integrating part of the Saïss plain alongside the mountain ranges of the Rif and the Middle Atlas, and it stretches over an area of 40.075 km2 representing 5.7% of the national territory. It is geographically limited by the Tangier-Tetouan-Al Hoceima region in the north, the Rabat-Sale-Kenitra region in the west, the Oriental region in the east, the Beni Mellal-Khenifra region in the southwest, and the region of Drâa-Tafilalet in the South .

The Fez-Meknes region and Khneifra Beni Mellal region includes nine prefectures for the first one and 5 provinces for the second one: the prefecture of Fez, the prefecture of Meknes, the province of Boulemane, the province of Sefrou, the province of Moulay Yacoub, the province of Taounate, the province of Taza, the province of El Hajeb, and the province of Ifrane and Beni Mellal Khenifra (Table 6,7 and Figure1,2,3 and 4).

The Beekeeping State and Inventory of Mellifero-Medicinal Plants in the North-Central and Sud West of Morocco

Table 26: Climatic and geographical information of the Fez-Meknes region.

Locality name	Latitude (N)	Longitude (W)	Altitude (m)	Pluviometry (mm)	Temperature (°C)
Fez	33°52′22.86″	5°32′26.63″	410	1–78	9.9 to 27.2
Meknes	33°52′22.86″	5°32′26.63″	546	2–93	9.8 to 25.9
Boulemane	33°21′46.3″	4°43′48.3″	1752	9–60	3.2 to 22.1

Sefrou	33°49′49.89″	4°50′7.14″	823	2.4–62.7	9.2 to 26.3
Moulay Yacoub	34°5′14.81″	5°10′42.25″	238	1–85	6 to 36
Taounate	34°32′12.9″	4°38′23.53″	600	1–101	9.1 to 26.5
Taza	34°12′38.02″	3°59′52.97″	550	2–91	9.5 to 28.2
El-Hajeb	33°41′8.65″	5°22′4.02″	1000	4–106	7 to 24.5
Ifrane	33°31′22.1″	5°6′39.44″	1664	8–122	2.7 to 21.8

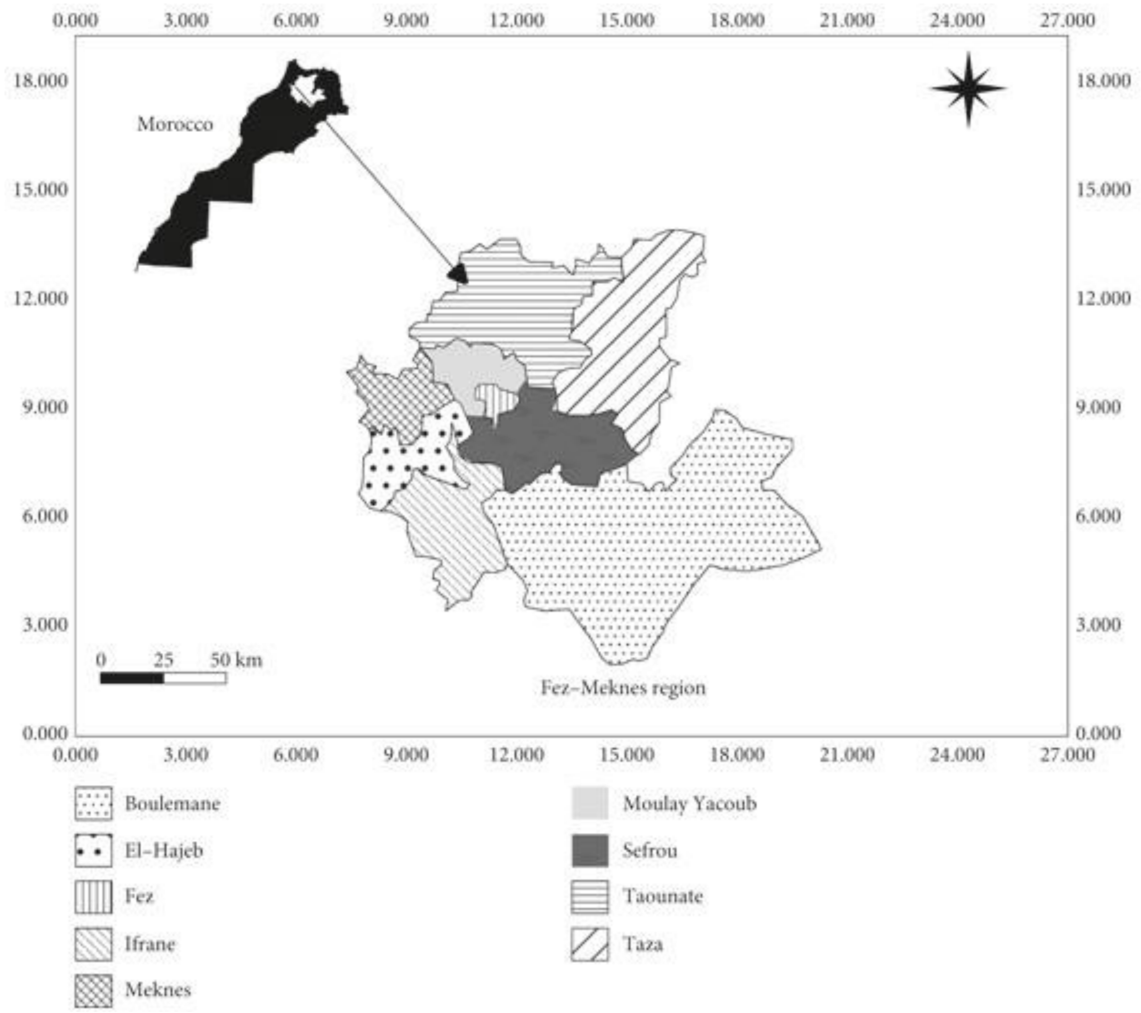


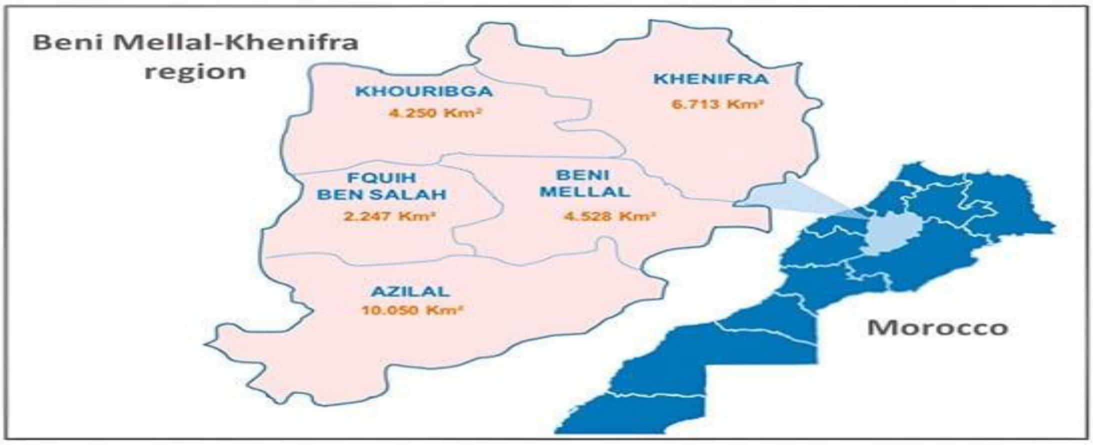
Figure 29: Mapping :Botanical and geographical origins of beekeeping requested

Table 27: Climatic and geographical information of the Beni Mellal Khenifra region.

Mapping :Botanical and geographical origins of beekeeping requested

Honey type	Locality	Area
Carallumaeuropaea	-Morocco	- Tiznit

Eucalyptusspp	- Morocco - Morocco	- El Jadida -Casablanca
Thymusspp	- Morocco - Morocco	-Azilal - Tinghir
Citrus x sinensis	- Morocco - Morocco	- BeniMellal - BeniMellal
Ceratoniasiliqua	- Morocco - Morocco - Morocco	- Khenifra - Beni Mellal - Beni Mellal
Ziziphus lotus	- Morocco	- FkihBensalah
Euphorbia	- Morocco	- Beni Mellal
	- Morocco - Morocco	- Azilal - Beni Mellal
multifloralhoney	- Morocco - Morocco	-FkihBensaleh - FkihBensalah



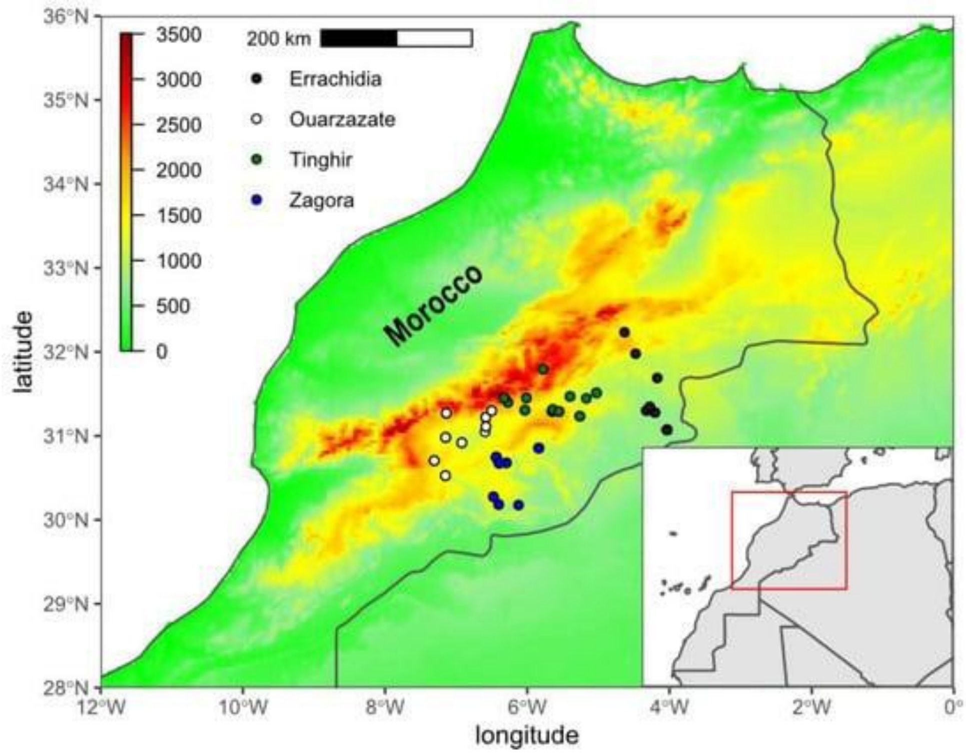


Figure 30: A map of Morocco with the Darâa-Tafilalet region where the sampling took place. The markers indicate the locations from which the samples were collected. Colour of the markers indi- cates four areas covered by this study.

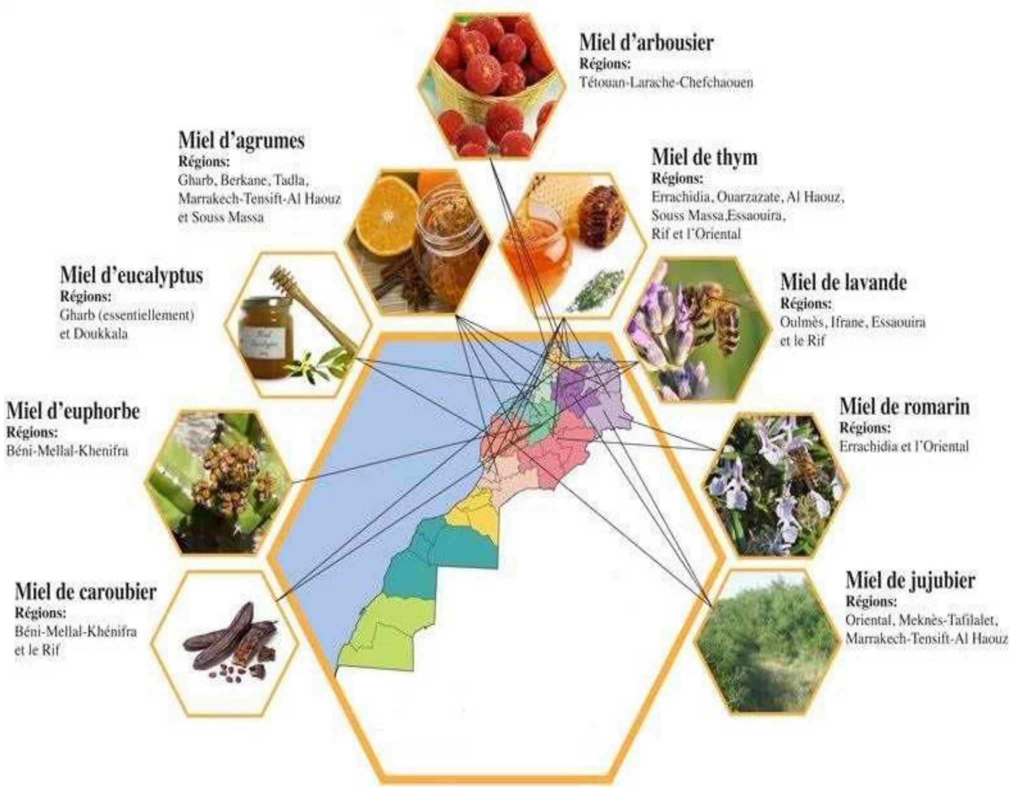


Figure 31: A map of Morocco with the Fes Meknes, Beni Mellal Khenifra region where the sampling took place. The markers indicate the locations from which the samples were collected. Colour of the markers indi-cates four areas covered by this study.

Based on the information given by the beekeepers and the data described (Figure4), the predominant vegetation in Fez is Olea europaea L var. sativa (cultivated), Ceratonia siliqua L (cultivated), Capparis spinosa L (cultivated), Myrtus communis L (native), and Silybum marianum (L.) Gaertn (native); the predominant vegetation in Meknes is Olea europaea L var. sativa (cultivated), Capparis spinosa L (cultivated), Silybum marianum (L.) Gaertn (native), Mentha spp. (cultivated), and Ammi visnaga (L.) Lam (native); the predominant vegetation in Boulemane is Bupleurum spinosum Gouan (native), Peganum harmala L (native), Thymus vulgaris L (native), and Rosmarinus officinalis L (native); the predominant vegetation in Sefrou is Prunus cerasus L (cultivated), Prunus domestica L (cultivated), Ceratonia siliqua L (cultivated), Olea europaea L var. sativa (cultivated), Ruta graveolens L (native), and Quercus ilex L (native); the predominant vegetation in Moulay Yacoub is Capparis spinosa L (cultivated), Olea europaea L var. sativa (cultivated), Myrtus communis L (native), Ammi visnaga (L.) Lam (native), Silybum marianum (L.) Gaertn (native), and Agave sisalana Perrine (cultivated); the predominant vegetation in Taounate is Olea europaea L var. sativa (cultivated), Crataegus monogyna Jacq (native), Ficus carica L (cultivated), Ceratonia siliqua L (cultivated), Matricaria chamomilla L (native), Origanum vulgare L (native), and Prunus domestica L (cultivated); the predominant vegetation in Taza is Olea europaea L var. sativa (cultivated), Ceratonia siliqua L (cultivated), Arbutus unedo L (native), Tetraclinis articulata (Vahl) Mast (native), Quercus ilex L (native), Pinus halepensis Mill (native), Quercus suber L (native), Cedrus atlantica (Manetti ex Endl) (native), Rosmarinus officinalis L (native), Globularia alypum L (native), Ziziphus lotus (L.) Lam (native), and Dittrichia viscosa (L.) Greuter (native); the predominant vegetation in El-Hajeb is Ammi visnaga (L.) Lam (native), Myrtus communis L (native), Silybum marianum (L.) Gaertn (native), Thymus vulgaris L (native), and Crataegus monogyna Jacq (native); and the predominant vegetation in Ifrane is Thymus vulgaris L (native), Origanum vulgare L (native), Lavandula angustifolia Mill (native), Cedrus atlantica (Manetti ex Endl) (native), and Pinus halepensis Mill (native).

5.4.3 Data Collection

In order to facilitate data collection for this study, 132 beekeepers were interviewed using a questionnaire focused on information about the beekeeper: gender, education level, age group, and duration of experience; information on the apiary: the number of hives, the amount of honey produced annually/hive, and other apicultural products provided by each beekeeper, as well as the prefecture or the province in the region Fez-Meknes preferred by the beekeeper for installing their apiary; and information on the honey plants that exist in each prefecture and province of the Fez-Meknes region: we asked beekeepers to give us a list of melliferous plants. Thus, we collected data on the information about the apicultural importance of each plant listed. The vernacular name of the plants was given by the beekeepers, and the scientific name was identified.

Registration of all plant species observed by beekeepers was carried out throughout the year in the nine prefectures and provinces represented by the Fez-Meknes region. Each source has been identified by its vernacular name, scientific name, and botanical family. The average date of the flowering period of each plant and the apicultural value as a source of nectar and/or pollen, resin, and honeydew were recorded.

5.4.4 -Characterization of the Beekeeping Sector

Information on Beekeepers and Their Apiaries

Beekeeping in Morocco has experienced a very important development in recent years, thanks to the contribution of the Morocco Green Plan. Therefore, many people approach this activity with different motivations and interests. The results of this survey illustrated in Figure 2 show that all interviewees are professional beekeepers and beekeeping is their main source of economic income. The bee hive products especially honey is marketed through traditional circuits (localized souks in production areas and others local outlets, urban markets, and roadsides in the production areas) and modern circuits (supermarkets, hotels and tourist camps, and electronic services). In addition, the household income of the surveyed beekeepers increases positively during the International Exhibition of Agriculture organized annually in Meknes, which gives a valuable opportunity for the marketing of their products. Concerning the beekeepers gender, 98.48% is male and 1.52% is female, thus confirming a male predominance, and 90.9% of surveyed beekeepers in the pre-Rif region (Morocco) was male and only 9.1% was female, and this is because the beekeeping as a profession is relatively hard for women . According to the opinion of the surveyed women in our study, the difficulty of beekeeping profession manifests mainly in the transhumance activity, which is done only at night and requires a high physical effort. The age range of the beekeepers questioned is the following: 50% of beekeepers are between 40 and 60 years old, 39.39% between 20 and 40 years, and 10.61% older than 60 years (Figure 32).

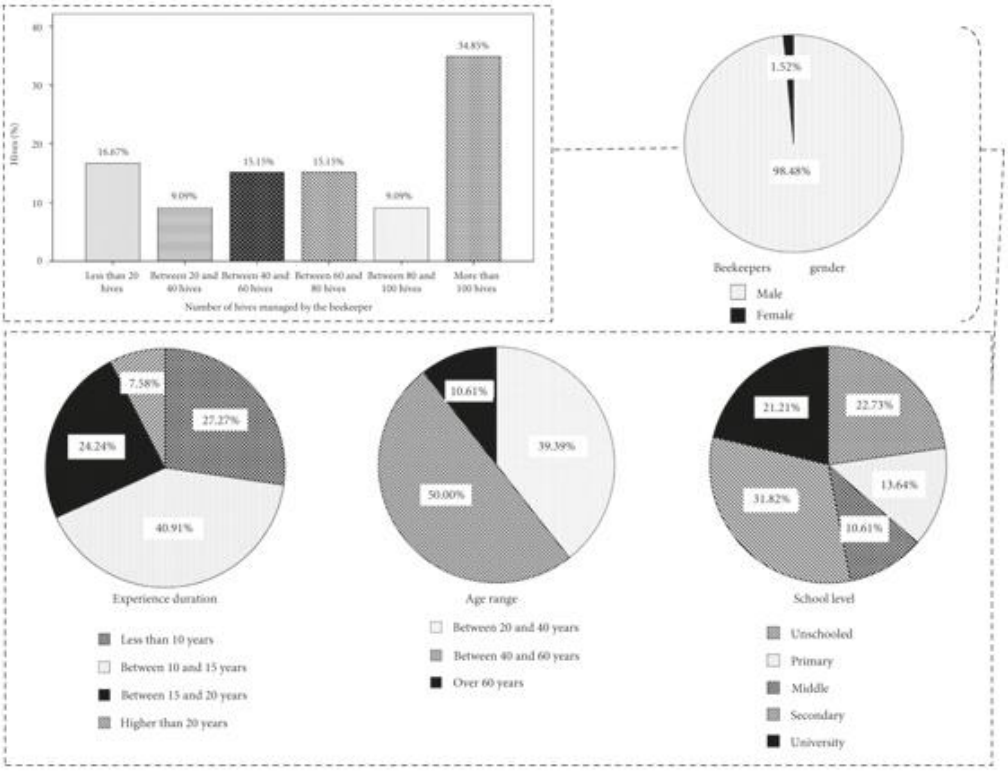


Figure 32 : General information on beekeepers and their apiaries.

The school-level of the beekeepers surveyed is as follows: 31.82% have a secondary education level followed by 22.73% who are unschooled, 21.21% have a university education, 13.64% have a primary education, and 10.61% have a level of college education. These results affirm the importance of the academic and intellectual level in the apicultural practice, which requires a fundamental knowledge of melliferous flora and their relationship with environmental factors. Concerning the years of experience in beekeeping, 40.91% of the beekeepers questioned have an experience between 10 and 15 years, 27.27% have an experience of less than 10 years, 24.24% of beekeepers have an experience between 15 and 20 years, and 7.58% of beekeepers have an experience more than 20 years. Concerning the number of hives in apiaries, 34.85% of the beekeepers surveyed manage apiaries made up of more than 100 hives, 16.67% have apiaries with fewer than 20 hives, 15.15% of beekeepers have apiaries made up of 40–60 hives, 15.15% of beekeepers have apiaries made up of 60–80 hives, 9.09% have between 80 and 100 hives, and 9.09% have an apiary made up of 20–40 hives. These results illustrate the region’s studied potential and its contribution to the national honey production.

The Preferred Locations by Beekeepers in the Fez-Meknes Region to Put Their Beehives

Regarding the location preferred by the beekeeper for the installation of hives in the Fez-Meknes region (Figure 5), 21.21% of beekeepers prefers Sefrou, 18.18% prefers Taza 12.12% prefers Taounate, 12.12% prefers Boulemane, 12.12% prefers Meknes, 9.09% prefers Ifrane, 6.06% prefers El-Hajeb, 4.55% prefers Moulay Yacoub, and 4.55% prefers Fez. The choice of the installation area was based on the climatic characteristics, the type of vegetation, and the increased market demand for certain types of monofloral honey such as carob (Ceratonia siliqua L), arbutus (Arbutus unedo L), oregano (Origanum vulgare L), and jujubier (Ziziphus lotus (L.) Lam) honeys (Figure6).

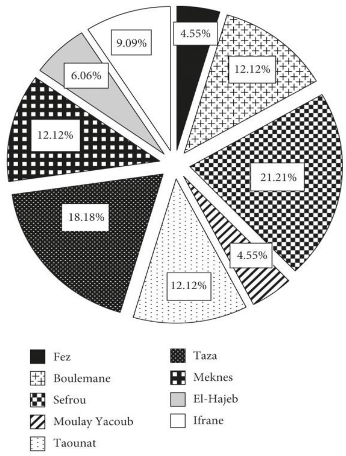


Figure 33 : Distribution of beehive installation locations in the Fez-Meknes region.

5.4.5. Types of Bee Products Supplied by Beekeepers

Concerning bee products supplied by beekeepers (Figure 6) and (Table 8), 10.77% of beekeepers produced and marketed only honey, while 89.23% produced and marketed honey and other bee products by the following percentages: 83.30% bee wax, 63.60% fresh bee pollen, 43.90% propolis, 22.70% dry bee pollen, 15.20% bee queens production, 7.60% royal jelly, 4.50% bee venom, 3% fresh bee bread, and 0% dry bee bread. The percentages of honey.

and others bee hive production ranged between 10.77% (Only honey) and 89.23% honey and other beet products. The Beekeeping State and Inventory of Mellifero-Medicinal Plants in the North-Central of Morocco

Table 28: Types and percentages of bee hive production

	Honey (%)	Fresh bee pollen (%)	Dry bee pollen (%)	Fresh bee bread (%)	Dry bee bread (%)	Royal jelly (%)	Propolis (%)	Bee wax (%)	Bee venom (%)	Production of bee queens (%)
Percentage of production	100	63.60	22.70	3	0	7.60	43.90	83.30	4.50	15.20

Among the famously used hive products, honey is the one that leads the list; hence, it is known that the beekeeping sector is essentially interested in the production and marketing of honey, in the second position is the bee wax, a very high percentage of beekeepers who have been surveyed (83.30%) produce bee wax, and the majority of the production is for hive recycling purposes, in the third place, we find the fresh bee pollen, followed by propolis in fourth. Since the surveyed population has a relatively high educational level, we observed that they are very well aware of the nutritional and therapeutic values of the other hive products such as bee pollen and especially fresh bee pollen, propolis, royal jelly, bee bread, and bee venom, but these last three products are poorly produced in the Fez-Meknes region and even throughout the Moroccan territory due to the difficulties encountered in the production and harvesting of these products. For instance, the royal jelly implies the breeding of the queens and requires precise techniques to keep its therapeutic value, which is very sensitive to temperatures above 4°C; similarly, for bee venom, that requires specific devices introduced to the entrance of the hive that cause a weak electric field and stimulates the bees to release the venom on the device . Furthermore, the fresh bee bread is rarely produced in the region; the percentage of production is only 3%, and this is because most beekeepers do not master correctly its harvesting technique without destroying a part of the hive while doing so.

Moreover, the pharmacological benefits of this product are recently discovered, and it is still unknown to the public (Figure 34) .

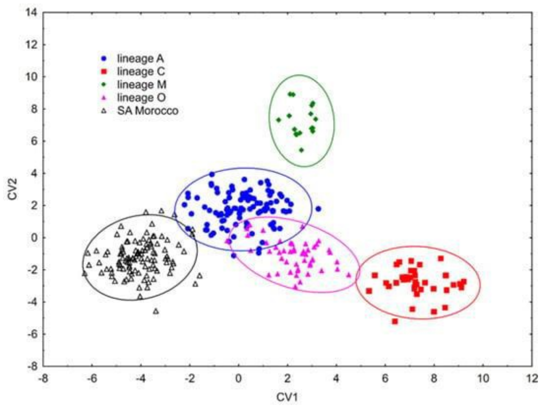


Figure 34: The first two canonical variates illustrating variation of wing shape of honey bees in Norther and south-eastern Morocco in comparison to reference samples of four main lineages; A, C, M, O. Each marker represents the mean scores of each colony. The ellipses represent 95% confidence intervals around the centroid of each data cluster.

The evaluation of the morphometric variability of honey bee samples from the four populations of south-eastern Morocco has clearly indicated distinguishable differences between them in terms of wing shape and size. Similar results were also presented in earlier research. Given the fragmented distribution of the study area (oases separated by arid zones), constituting a sufficient obstacle for natural genetic exchange, some divergence between these populations could be expected. In view of the mostly similar environmental conditions, these incongruities are more likely the result of reduced gene flow between these four populations and the presence of genetic drift.

Locally adapted subspecies have proved to survive better in their original environment than imported ones. Thus, prioritising the conservation of native honey bee subspecies presents an urgent step in preventing losses in genetic variation. To do so, the first stage in the process of conservation remains the identification of the morphometric diversity among such

locally adapted subspecies. In this study, we provide data based on wing measurements that can be used to assess and identify the current populations' status, which may prove helpful for the conservation of the region's native bees. Even if they are to some degree hybridised, they represent the natural range of the Saharan honey bee which is a distinct subspecies and deserves to be protected from further hybridisation. Moreover, the investigated bees most probably inherited some traits from A. m. sahariensis and survived for a few recent generations in a harsh local environment.

5.4.5 Annual Honey Production per Hive

Annual honey production per hive in Fez-Meknes is presented in Figure 5; the results indicate that 89.39% of apiaries produce less than 20 kg of honey per hive, 7.58% of apiaries produce between 20 kg and 40 kg of honey per hive, and 3.03% of apiaries produce between 40 kg and 60 kg of honey per hive. These findings show low honey production in the region; this may be due to Varroa mites' infection and bee poisoning by insecticides and climatic changes (Figure 35).

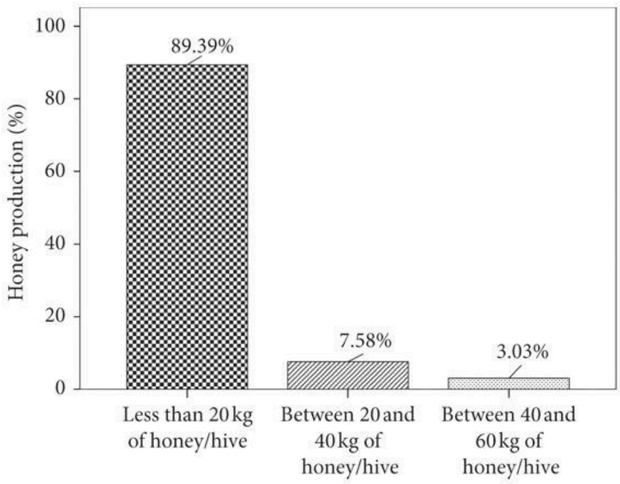


Figure.35 : Annual honey production per hive

5.4.6 Taxonomic Diversity of Melliferous Plants in the Fez-Meknes Region

The information obtained by the beekeepers from the bee's foraging observations around the apiary made it possible to identify 102 melliferous plants belonging to 32 families (Figure 6). The most represented families in the established list of melliferous plants is the Asteraceae family with a percentage of 13.73% and Lamiaceae 13.73%, Rosaceae 8.82%, Apiaceae 7.84%, Rutaceae 6.86%, Fabaceae 5.88%, Cupressaceae 4.90%, Boraginaceae 4.90%, Cistaceae 2.94%, Fagaceae 2.94%, Moraceae 2.94%, Geraniaceae 1.96%, Papaveraceae 1.96%, and Pinaceae 1.96%. In a study published by Ennabili et al. (2000), the inventory of honey plants from the Mokrisset region (NW of Morocco) showed the presence of 78 species belonging to 35 families, and 48.7% of them corresponded to five families: Labiatae, Compositae, Rosaceae, Leguminosae, and Ericaceae [25]. In another study carried out in the central Rif region of Morocco, the most important taxa used by honeybees for nectar and/or pollen were Ammi visnaga (L.) Lam, Mentha spp., Eucalyptus camaldulensis Dehnh., Rubus ulmifolius Schott, Cannabis sativa L, various grasses, and Cistus spp (Figure 36).

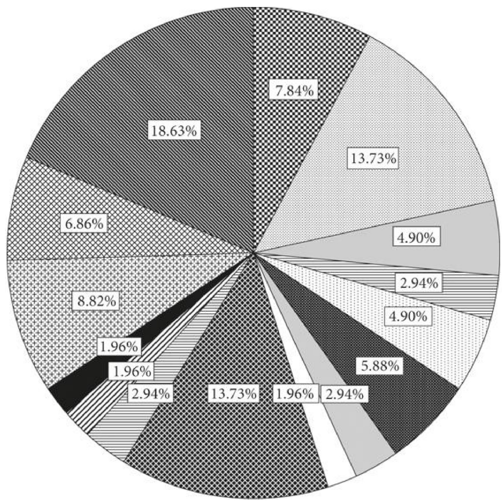


Figure 36: The most representative families of melliferous plants

Among the plants listed, we found 28 trees, 26 shrubs and undershrubs, 46 herbaceous plants, and 2 bulbs. 79 of these plants are classified as nectariferous and polliniferous; hence, they supply bees with pollen and nectar. 16 are polliniferous and they supply bees with pollen only, 3 are nectariferous and they supply bees with nectar only, 35 are resinous and they supply bees with resin, and 6 are honeydew plants and they supply bees with honeydew .

Sedentary beekeeping is the kind of beekeeping practiced by a traditional beekeeper or agri-beekeeper who leaves his hives in the same place and does not move them throughout the year. The bee's harvest radius in this type of beekeeping does not exceed 2-3 kilometers. This limits the production of the apiary. On the other hand, pastoral or transhumant beekeeping aims to move hives from site to site from 50 km to 500 km depending on the rate of flowering in melliferous regions . The flowering period of the plants mentioned in the list (Table 4) varies according to the species; it spreads over the whole year from January until December. All beekeepers interviewees in this study are professional, and these conditions favor transhumance practices for them.

Regarding the type of melliferous plants preferred by beekeepers for the installation of hives (Table 4), 100% of beekeepers prefer to install their hives near nectariferous plants because they know the importance of this type of plants for honey production. In addition to nectariferous plants, 83.30% of beekeepers also prefer polliniferous plants, while 25.80% prefer resinous plants, and only 6% of beekeepers prefer honeydew plants. From these results, we can see that the beekeepers of Fez-Meknes know the importance of polliniferous and resinous plants to bees, considering the role of pollen and propolis for hives and bees' health, as well as for the marketing of these products in the region that are recently studied and consequently revealed to be rich in bioactive molecules with protective and therapeutic interest.

Regarding the opinion of beekeepers on the best vegetation that produce a good quality of propolis, most of them mentioned the following plants: Pistacia lentiscus, Ferula communis, Populus alba, Pinus halepensis, Cedrus atlantica, Eucalyptus globulus, Ficus carica, Juniperus thurifera, and Tetraclinis articulata. For the best nectariferous plants, the interviewed beekeepers cited the following plants: Capparis spinosa, Calendula officinalis, Arbutus unedo, Ceratonia siliqua, Citrus genus, Bupleurum spinosum, Lavandula angustifolia, Lavandula multifida, Rosmarinus officinalis, Salvia officinalis, and Thymus vulgaris. While for the good plants that provide the best pollen to bees, they have listed the following plants: Capparis spinosa, Calendula officinalis, Prunus dulcis, Opuntia ficus- indica, Silybum marianum, Carthamus tinctorius, Centaurium erythraea, and Pelargonium odoratissimum. According to several studies, as shown in Table 5, the most preferred melliferous plants by beekeepers have a potent and large biological activities including antioxidant, antidiabetic, anticancer, antifungal, anti-inflammatory, and diuretic effects. It has been previously reported that the medicinal properties of bee products are highly dependent on many factors, including their botanical origins ; in fact, the diversity of their botanical sources gives them a wide range of pharmacological activities that can provide consumers a functional food product with therapeutic benefits.

5.4.7. Conclusion

According to the National Union of Professional Beekeepers, the production of honey in Morocco recorded during the year 2022 a significant drop of around 70% compared to 2021, due to the collapse of bee colonies. It should be borne in mind that this phenomenon is mainly caused by the numerous episodes of drought which have considerably reduced honey resources and therefore national production.

In addition, the price of citrus honey per kilogram recorded this year a remarkable increase of more than 25% compared to its usual price. The price this season has fluctuated between 50 and 62 dirhams per kilogram. This increase will inevitably have an obvious impact on the purchasing power of consumers accustomed to buying this type of honey, said the union in a press release sent to MoroccoLatestNews.

It should be noted that the process of harvesting citrus honey started a few days ago in different regions of the Kingdom. However, the survey carried out by the National Syndicate specifies that beekeepers have observed a clear gap in production between the regions usually known for their abundant production of this type of honey.

The regions of BMK, Fez Meknes and Gharb and Souss Massa recorded average or good productions while beekeepers in the regions of Berkane and Beni Mellal complained of a significant drop in production this year and which, according to them, is dependent on climate change. and water stress.

On the other hand, the National Union of Professional Beekeepers points out that a number of producers, faced with fierce competition between the imported product and local honey, have resorted to promoting their local production on the Internet, by offering free delivery services.

The consensus of melliferous plants in the Fez-Meknes and Beni Mellal Khenifra regions made it possible to draw up an inventory of these plants and classify them according to the ingredients that they provide to the bee (nectar, pollen, resin, and honeydew) and the realization of a beekeeping calendar according to the flowering rhythms of each plant. The Fez-Meknes region offers great beekeeping potential, mainly due to the diversity of melliferous plants, allowing transhumance practices. An accompanying beekeeping policy is necessary to allow the optimal use of natural resources and a revitalization of this sector in order to improve the standards of living of the local population. This study contributes to the promotion of the field of beekeeping and to the valorization of the melliferous plants in the Fez-Meknes and Beni Mellal Khenifra region.

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