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BeeBridge State-of-the-Art Transnational Report

Elaborated by



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1. Executive summary

This Transnational State of the Art Report presents a comprehensive comparative analysis of beekeeping systems in Czech Republic, Lithuania, Poland, Estonia, Türkiye and Spain. The objective of the report is to identify structural strengths, competence gaps and systemic modernization needs relevant to the BeeBridge project.

The analysis demonstrates that all partner countries possess strong technical foundations in colony management and disease control. However, the sector across Europe remains unevenly modernised in the domains of digitalisation, entrepreneurship, climate resilience and competence-based vocational structuring.

A central finding is the imbalance between production-oriented efficiency models and competence oriented learning pathways. While biological and seasonal management practices are well developed, structured progression frameworks aligned with the European Qualifications Framework remain fragmented.

The report further highlights:

- persistent demographic ageing among beekeepers,
- underdeveloped digital decision-support competences,
- limited integration of entrepreneurship and value-chain literacy in VET,
- insufficient operationalisation of climate adaptation strategies,
- weakly structured intergenerational transfer mechanisms,
- uneven formalisation of apitherapy training.

Those findings position BeeBridge not as a replacement of national systems, but as a transnational integrator capable of strengthening competence alignment, digital transition and generational bridging within European beekeeping education.



2. Introduction

2.1 Purpose of the report

The purpose of this report is to provide a structured and comparative analysis of the current state of beekeeping practices, training systems and sectoral challenges in the six partner countries. The document serves as the analytical foundation for WP2 of BeeBridge and informs the development of competence-based training modules, mentoring methodologies and digital transition pathways.

The report goes beyond descriptive national summaries and applies a transnational analytical lens to identify converging patterns, systemic barriers and opportunities for innovation.

2.2 Scope and analytical framework

The analysis covers the following domains:

- Efficient beekeeping techniques
- Colony health and disease management
- Digitalisation of apiaries
- Marketing and diversification
- Apitherapy and wellness models
- Climate change and colony losses
- Intergenerational knowledge transfer
- Policy alignment with EU frameworks

Each domain is assessed through three dimensions:

1. Technical maturity
2. Competence structuring within VET
3. Systemic integration and innovation readiness

2.3 Methodological approach

The report is based on qualitative content analysis of six national State of the Art reports submitted within BeeBridge national reports.

The methodological process included:

- thematic coding of national findings,
- cross-country comparison,
- policy alignment analysis,
- identification of structural competence gaps,
- mapping against EU strategic priorities.

The approach combines sector analysis with vocational education system analysis, ensuring both technical and pedagogical dimensions are addressed.

3. European policy context

3.1 Common agricultural policy (CAP)

Beekeeping across partner countries is embedded within CAP support mechanisms. Financial instruments encourage equipment modernization, disease prevention measures and sustainable production models. However, CAP incentives are often production-driven rather than competence-driven.

The shift toward performance-based CAP programming highlights the need for measurable learning outcomes in agricultural sectors, including apiculture.

3.2 European green deal and farm to fork

The Green Deal and Farm to Fork strategy emphasise biodiversity protection, reduction of chemical inputs and resilience of food systems. Beekeeping plays a critical ecological role in pollination services and ecosystem health.

The analysis indicates that sustainability rhetoric is present in national documents, yet operational climate adaptation training remains limited.

3.3 Digital europe and smart agriculture

Digital transformation in agriculture is a core EU priority. Smart farming, IoT systems and data-driven decision support are increasingly central to agricultural modernization.

In beekeeping, however, digitalisation is progressing unevenly. While technologies exist, structured digital competence frameworks are rarely embedded in national VET curricula

3.4 EQF and micro-credentials in VET

The European Qualifications Framework promotes competence transparency and progression. Estonia demonstrates relatively structured qualification alignment, yet across most partner countries, explicit EQF alignment in beekeeping training is not consistently visible.

Micro-credentials represent an opportunity for modular skill recognition, particularly in digital and climate-resilience competences.

4. Structural overview of beekeeping in partner countries

4.1 Sector size and organisation

The structural configuration of the beekeeping sector varies significantly across the six partner countries, reflecting differences in agricultural models, land use patterns, and economic integration.

Spain represents the largest apicultural system within the partnership, with approximately three million beehives and a high proportion of transhumant operations. Commercial apiaries frequently exceed 150 colonies and operate within structured professional frameworks. The scale of production positions Spain as a major honey producer within the European Union.

Türkiye also demonstrates strong production-oriented characteristics, with migratory beekeeping forming a core efficiency strategy. Productivity is closely linked to seasonal mobility and nectar optimisation across diverse ecological zones.

In contrast, Czech Republic, Lithuania, Poland and Estonia exhibit predominantly small to medium-scale apiary structures. In those countries, beekeeping often operates as a supplementary agricultural activity or semi-professional enterprise. Cooperative and association-based advisory systems play a significant role in knowledge dissemination.

Despite structural variation, a shared feature across all countries is the coexistence of hobbyist, semi-professional and professional beekeepers. This heterogeneity complicates the design of unified training pathways and necessitates modular and flexible educational structures.

4.2 Demographic structure

Demographic ageing emerges as a structural concern in several partner countries. Reports from Czech Republic, Lithuania and Poland indicate an average beekeeper age exceeding 55–60 years.

The generational imbalance has multiple implications:

- slower adoption of digital tools,
- reliance on traditional methods,
- knowledge retention risks,
- weak formal mentoring mechanisms,
- uneven engagement of younger entrants.

Spain and Türkiye demonstrate relatively stronger professional cohorts, yet generational renewal remains a strategic priority in both contexts. The absence of structured intergenerational transfer frameworks represents a systemic vulnerability across the partnership.

4.3 Professional versus semi-professional models

Professional beekeeping models (Spain, Türkiye) emphasize scale, efficiency and yield optimisation. Semi-professional and hobbyist models (Central and Baltic countries) often prioritise sustainability, biodiversity and local market integration. This structural diversity influences training orientation. Professional systems tend to prioritise production metrics and disease management. Semi-professional systems emphasize seasonal management and compliance. However, neither model consistently integrates entrepreneurial literacy, digital competence or climate scenario planning in a structured manner.

5. Efficient beekeeping practices

5.1 Seasonal management paradigms

Across all partner countries, seasonal planning constitutes the backbone of efficient apiary management.

Training materials emphasize:

- spring colony stimulation,
- swarm control,
- nectar flow optimisation,
- post-harvest treatment,
- winter preparation.



In Czech Republic, rational beekeeping methodologies highlight systematic planning and hive standardisation. Poland promotes good management practices within advisory frameworks. Lithuania encourages queen replacement cycles and equipment modernization. Türkiye integrates migratory timing strategies. Spain stresses traceability and regulatory compliance.

The technical content is robust. However, the pedagogical structuring of competences—how seasonal decision making skills are developed progressively—is often implicit rather than explicitly articulated.

5.2 Productivity and sustainability balance

Productivity is generally framed in terms of honey yield per colony, queen vitality and winter survival rates. Sustainability is present but interpreted differently:

- ecological production and organic standards (Estonia, Lithuania)
- chemical reduction and IPM (all countries)
- forage cooperation with farmers (Poland, Spain)

Yet climate resilience as a structured competence is not systematically integrated into seasonal planning frameworks.

5.3 Limitations in current training approaches

The cross country comparison reveals recurring limitations:

1. Efficiency measured primarily through yield indicators rather than competence indicators.
2. Limited scenario-based training for crisis management (drought, irregular flowering, extreme winters).
3. Insufficient integration of digital data into seasonal decisions.
4. Weak alignment with formal qualification frameworks (except partial example in Estonia).

The technical foundation is strong, yet modern competence structuring remains underdeveloped.

6. Colony health and disease management

6.1 Dominant health threats

Varroa destructor remains the central health threat across all partner countries. American foulbrood and Nosema infections are also consistently addressed.

Health training typically includes:

- monitoring procedures,
- chemical and biotechnical treatment methods,
- seasonal timing strategies,
- hygiene protocols.

National veterinary frameworks provide regulatory clarity in several countries.

6.2 Integrated pest management (IPM)

IPM is widely referenced, but its practical integration varies. In Czech Republic and Spain, structured surveillance systems exist. Türkiye emphasizes preventive control within VET programmes. However, decision making frameworks—such as threshold-based treatment strategies, resistance management modelling and data-driven rotation plans—are not systematically embedded into competence frameworks.

6.3 From compliance to analytical competence

A recurring pattern emerges: health management is compliance oriented. Beekeepers are trained to follow procedures, yet less emphasis is placed on analytical interpretation and strategic adaptation.

Digital diagnostic tools and monitoring platforms are not yet deeply integrated into health decision support systems across most partner countries.

7. Digitalisation and beekeeping 4.0

7.1 Current state of digital adoption

Digitalisation in beekeeping across the partner countries is progressing, yet unevenly and often outside formal vocational structures. Technologies such as hive scales, temperature and humidity sensors, acoustic monitoring systems and mobile record keeping applications are available in several countries. However, their integration into structured training frameworks remains limited. In Estonia, broader national digital infrastructure and e-learning culture support hybrid training formats and online educational resources. Czech Republic and Spain demonstrate growing technological experimentation, particularly in commercial apiaries. Lithuania and Poland show increasing interest in monitoring devices, but systematic digital curricula are not fully embedded. Türkiye's official VET programmes do not explicitly define digital apiary management competences. The cross-country pattern indicates that digital tools are innovation-driven rather than curriculum-driven.

7.2 Digital competence gaps

The primary challenge is not hardware availability but competence structuring. Key gaps include:

- data interpretation skills,
- predictive analytics for nectar flow and colony strength,
- integration of weather data into management planning,
- cost-benefit evaluation of monitoring systems,
- digital record standardisation aligned with traceability regulations.

Older beekeeper demographics amplify adoption barriers. In Central and Baltic countries, lower. This creates a generational digital divide that directly intersects with BeeBridge's objective of generational bridging.

7.3 Alignment with EU digital strategy

The EU's Digital Europe Programme and Smart Agriculture agenda emphasise precision agriculture and data-driven decision-making. Beekeeping remains partially integrated into this transition. Without structured micro-credentials or modular digital competences, beekeeping risks lagging behind broader agricultural modernization trends. BeeBridge therefore has strong justification to introduce a structured "Digital Beekeeper Pathway" aligned with EQF descriptors.

8. Marketing, diversification and value chain development

8.1 Market Structure Overview

Honey markets across partner countries face increasing price pressure due to imports and global competition. Direct sales and local markets remain dominant in several contexts. Spain demonstrates stronger cooperative branding and e-commerce initiatives. However, most countries report insufficient training in brand positioning and customer segmentation.

8.2 Diversification Potential

Hive by-products including pollen, propolis, beeswax and royal jelly are present across all reports. Yet diversification strategies are underdeveloped.

Production techniques are described, but business modelling is not systematically addressed. Few VET programmes integrate:

- portfolio diversification planning,
- pricing strategy development,
- cost accounting frameworks,
- certification leverage for premium positioning.

This limits economic resilience and innovation capacity.

8.3 Entrepreneurship as a missing pillar

Entrepreneurship remains one of the weakest integrated competences across partner countries. Türkiye's official curricula do not explicitly structure marketing competences. Poland and Czech Republic show limited integration of business modules. The absence of structured business education reduces competitiveness, particularly for small-scale apiaries. BeeBridge can address this gap through competence-based entrepreneurship modules aligned with micro-credential principles.

9. Apitherapy and Therapeutic Apiaries

9.1 Current Landscape

Apitherapy appears across partner countries but remains fragmented. Lithuania has initiated structured training steps. Czech Republic shows growth in api-houses and wellness models. Spain presents private training initiatives without national accreditation. Türkiye regulates apitherapy within healthcare frameworks. However, harmonised competence descriptors and formal qualification levels are lacking.



9.2 Professionalisation Challenges

Challenges include:

- absence of EU-level standards,
- limited research validation integration,
- unclear safety protocols in non-medical settings,
- weak connection between apitherapy and mainstream VET.

The field shows economic and diversification potential but requires competence-based structuring.

10. Climate change and colony losses

10.1 Environmental instability

Reports from multiple countries indicate irregular flowering periods, unpredictable nectar flow and warmer winters.

Those shifts affect:

- colony build-up timing,
- feeding strategies,
- disease prevalence,
- migratory planning.

10.2 Climate Adaptation Gap

Although climate impacts are acknowledged, structured adaptation training is limited. Few materials provide scenario-based planning tools or risk modelling. This gap is critical given the EU Green Deal and biodiversity commitments. BeeBridge can introduce structured climate-resilient management competences.

11. Intergenerational knowledge transfer

11.1 Demographic imperative

Ageing beekeeper populations in several partner countries highlight urgency. Tacit knowledge accumulated over decades risks loss without structured mentoring mechanisms.

11.2 Structural weaknesses

Most knowledge transfer remains informal:

- association meetings,
- seasonal workshops,
- family-based inheritance of practice.

Few structured mentoring programmes exist within VET frameworks. Digitalisation may exacerbate generational divides if not carefully integrated.

11.3 Bridging as Systemic Innovation

BeeBridge can introduce:

- peer-to-peer mentoring models,
- structured intergenerational learning sessions,
- digital coaching systems,
- documented tacit knowledge repositories.

Intergenerational transfer should not be treated as a social add-on but as a competence system in itself.

12. Comparative cross-country analysis

12.1 Converging patterns across the partnership

The comparative review of Czech Republic, Lithuania, Poland, Estonia, Türkiye and Spain reveals a remarkable degree of convergence in core technical domains. All six countries demonstrate:

- strong emphasis on seasonal colony management,
- systematic prioritisation of Varroa control,
- reliance on association-based advisory systems,
- presence of small and medium-scale apiaries alongside professional units,
- gradual but uneven digital transition.



The shared biological and technical foundations create a solid base for transnational cooperation. However, convergence at the technical level contrasts with divergence in structural modernization, particularly in pedagogical structuring and competence articulation.

12.2 Diverging structural characteristics

Spain and Türkiye exhibit more production-intensive and commercially scaled systems. Their efficiency paradigms are strongly yield-driven and often supported by migratory beekeeping models. Czech Republic, Lithuania, Poland and Estonia operate predominantly small to medium-scale structures. Those systems demonstrate higher emphasis on community-based knowledge dissemination and semi-professional engagement. Estonia stands out for its formalised occupational standards, suggesting stronger alignment with EQF principles. Other partner countries rely more heavily on advisory publications and modular training without explicit competence level descriptors.

12.3 Digital transition gradient

The digitalisation gradient across countries can be characterised as follows:

- Advanced digital culture with partial integration: Estonia
- Technological experimentation without structured VET integration: Czech Republic, Spain
- Early stage adoption with fragmented curriculum alignment: Lithuania, Poland
- Limited formal digital competence structuring: Türkiye

This uneven landscape underscores the necessity of a transnational digital competence framework within BeeBridge.

13. Structural gaps and systemic barriers

The analysis identifies recurring structural gaps across the partnership that transcend national differences.

13.1 Absence of competence-based pathways

While practical guidance is abundant, explicit competence progression models are rare. Learning outcomes are often implied rather than formally defined. This weakens assessment transparency and mobility potential under the European Qualifications Framework.



13.2 Limited digital decision-support training

Technological tools are emerging, yet structured training on:

- data interpretation,
- predictive colony modelling,
- digital traceability systems,
- cost-effectiveness evaluation of monitoring tools

remains insufficiently developed. Without those competences, digital investments risk underutilisation.

13.3 Entrepreneurship deficit

The most consistent cross-country weakness concerns entrepreneurship and value chain literacy.

Beekeepers often receive technical training but limited exposure to:

- pricing strategies,
- market segmentation,
- digital marketing,
- product differentiation,
- certification leverage.

This gap affects sector resilience and competitiveness.

13.4 Climate adaptation incompleteness

Climate awareness is present, but structured adaptation frameworks are rare. Scenario-based training, risk modelling and long-term ecological planning are not systematically embedded. Given EU Green Deal priorities, this gap is strategically significant.

13.5 Intergenerational Vulnerability

The ageing demographic structure and informal knowledge transfer systems create vulnerability. Without structured mentoring mechanisms, tacit knowledge risks erosion. Simultaneously, digitalisation may alienate experienced beekeepers if generational mediation is not carefully facilitated.



14. Strategic implications for BeeBridge

Based on the transnational analysis, BeeBridge can act as a structural integrator and modernization catalyst.

14.1 Development of a competence-based modular framework

BeeBridge should develop clearly articulated competence units aligned with EQF descriptors. Those modules should define:

- learning outcomes,
- assessment criteria,
- progression pathways,
- micro-credential certification options.

14.2 Digital beekeeper pathway

A structured Digital Beekeeper pathway should include:

- digital record-keeping competences,
- sensor data interpretation,
- predictive decision-support methodologies,
- digital traceability compliance.

This pathway should explicitly bridge generational digital divides.

14.3 Entrepreneurship and value chain integration

BeeBridge should embed entrepreneurship within technical modules rather than treating it as an isolated topic. Competences should include:

- cost calculation and margin analysis,
- brand positioning strategies,
- diversification modelling,
- e-commerce readiness.



14.4 Climate-resilient beekeeping module

A dedicated module should address:

- climate risk assessment,
- adaptive seasonal planning,
- forage diversification strategies,
- scenario-based management planning.

14.5 Structured intergenerational mentoring model

BeeBridge should design:

- mentor-mentee pairing frameworks,
- peer learning laboratories,
- tacit knowledge documentation methodologies,
- digital inclusion coaching.

Generational bridging must become a systemic component rather than a symbolic objective.

16. Conclusions

The transnational State of the Art analysis demonstrates that beekeeping across the six partner countries stands at a structural crossroads. Technical foundations in colony management and disease control are strong and deeply rooted in tradition. However, modernization in digitalisation, entrepreneurship, climate resilience and competence-based structuring remains uneven.

The sector resilience depends not solely on biological expertise, but on its capacity to integrate:

- digital intelligence,
- economic literacy,
- climate foresight,
- structured intergenerational collaboration.

BeeBridge is strategically positioned to fill those gaps through transnational integration, modular competence design and generational bridging methodologies. Rather than replacing national systems, the project can reinforce coherence, support modernization and enhance alignment with European policy priorities including the Common Agricultural Policy, the Green Deal, Digital Europe and the European Qualifications Framework. By doing so, BeeBridge contributes not only to vocational innovation, but to the long-term sustainability and competitiveness of European apiculture.