ABSTRACT

The percentage share of Gross Value added (GVA) of agriculture and allied sectors to the economy of India is around 20.2% in 2021. Among the allied sectors, beekeeping exhibits great potential to contribute to income generation and poverty alleviation. Beekeeping is a sustainable livelihood option owing to the favourable environmental conditions and diversity of bee species in the country. Honey being the major byproduct of beekeeping is of immense importance in terms of production and export value. Other products include bee pollen, propolis, bee wax, etc., The consumption of honey has gone up globally in times of COVID 19 pandemic due to its immunity-boosting properties. However, like several food products in India, it is susceptible to instances of food fraud. There is no mechanism to monitor the value chain of honey. Therefore, this study takes into account the value chain analysis of honey as the first step followed by exploring the factors responsible for the implementation of e-traceability using a suitable technology like blockchain. The study also forecasts the production of honey on the basis of climatic factors.

This research conducts a honey value chain analysis. As part of the study, it maps the value chain of honey in parts of Maharashtra. This area was selected primarily because it falls in the Western Ghat region. Western Ghats are the hotspot region in India and known for best source of natural honey in India. The value chain participants include producers i.e., the beekeepers or farmers, aggregators or collectors, processors, traders, and consumers. Honey production is found to be a profitable business in the area with a cost-benefit ratio of 1.57. The factors responsible for determining the production of honey are family size, experience in beekeeping, access to the market, and access to training. Further, the challenges in production are pests and diseases, pesticide application, deforestation, and lack of suitable equipments. On

the marketing front, the challenges are adulteration, variation in prices, unregistered beekeepers, and unlicensed traders.

The value chain study is further extended to the integration of e-traceability in agri-food supply chains. This required exploring the critical factors in the implementation of e-traceability. This was done through the methodology of Fuzzy-ISM and Fuzzy-MICMAC. The hierarchical model created revealed that appropriate technology for e-traceability, competitive advantage, coordination, and transparency are the driving forces in e-traceability implementation.

The production of honey is the outcome of environmental, economic, and social factors. On the environmental front, honey production largely depends on climatic factors and the flora of the place. With limited data on floral diversity, this research makes a forecasting model for honey production on the basis of climatic factors using the machine learning technique of ANFIS with a hybrid optimization method. The results indicate that temperature and relative humidity are important parameters in forecasting honey production. Overall, all the zones exhibited low RMSE values indicating the model can be effectively used for forecasting honey production according to Indian climatic conditions. The low value of RMSE of 4.88 % shows that the ANFIS based honey forecasting model is robust for predicting honey production.

The literature reveals that blockchain with its decentralized database is appropriate for implementing e-traceability technology. Thus, the study explores the basics of technology and constructs an architecture for blockchain-based traceability using the case of honey supply chain. The factors required for the adoption of Blockchain are explored using Partial least squares-Structural Equation Modelling (PLS-SEM). According to the results, performance-driven factors like food safety, food quality, time and cost efficiency, consumer confidence, minimization of intermediaries, and data transparency are driving forces for the adoption of blockchain in the agri-food sector. Also, organizational factors like competitive advantage,

communication between stakeholders, and proper regulations in place are also critical factors responsible for the adoption of blockchain by food firms. Furthermore, a suitable platform for implementing the technology is explored. Hyperledger Fabric (HLF) with the highest weightage is considered for applying blockchain. Further, the performance of HLF is analyzed using the Hyperledger caliper tool with parameters, throughput, latency, and scalability. The throughput varied from 707 to 955 successful transactions per second and latency is as less as 150 milliseconds. The use of the Fabric platform can support up to 6 organizations.