Eight tools relevant to risk ranking of biological hazards in food were identified and assessed using two case studies. Differences in their performance were observed, related to the risk metrics, data requirements, ranking approach, model type, model variables and data integration. Quantitative stochastic models are the most reliable for risk ranking. However, this approach needs good characterisation of input parameters. The use of deterministic models that ignore variability may result in risk ranking errors. The ordinal scoring approaches in semi-quantitative models provide ranking with more errors than the deterministic approaches. FDA (Food and Drug Administration)-iRISK was identified as the most appropriate tool for risk ranking of microbiological hazards. The Burden of Communicable Diseases in Europe (BCoDE) toolkit can be used in combination with the outputs from FDA-iRISK or as a top-down tool to rank pathogens. Uncertainty needs to be addressed and communicated to decision makers and stakeholders as one of the outcomes of the risk ranking process. Uncertainty and variability can be represented by means of probability distributions. Techniques such as the NUSAP (numeral, unit, spread, assessment and pedigree) approach can also be used to prioritise factors for sensitivity and scenario analysis or stochastic modelling. Quantitative risk ranking models are preferred over semi-quantitative models. When data and time constraints do not allow quantitative risk ranking, semi-quantitative models could be used, but the limitations of these approaches linked to the selection and integration of the ordinal scores should be made explicit. Decision trees should be used only to show how decisions are made about classifying food–pathogen combinations into broad categories. BCoDE and FDA-iRISK, in combination with a network of available predictive microbiology tools, databases and information sources, can form a risk ranking toolbox and be applied based on a “fit for purpose” approach supporting timely and transparent risk ranking.