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General discussion and conclusion

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This book contains the contributions of the speakers in a workshop on 'Bayesian approaches for quality modelling in the agro-food production chain' organized in 2003 by Frontis – Wageningen International Nucleus for Strategic Expertise, a part of Wageningen University and Research Centre. The overall purpose of the workshop was to discuss the possibilities and limitations of Bayesian approaches in quality modelling and risk analysis in the agro-food chain. The first objective was to introduce the subject to participants who were newcomers to this field by presenting an overview of the state of the art. The second objective was to define research areas in the agro-food chain where a Bayesian approach could be applied. Participants with expertise in various disciplines came from Wageningen UR and similar institutions in Europe and the USA to participate in the workshop and to contribute chapters for this book.

Introductions were presented on the food industry in general, emphasizing that the underlying philosophy of the agro-food-chain has changed in recent years from a producer-driven to a consumer-driven chain. This shift has increased the uncertainty about the production and marketing goals throughout the chain, since quality concepts and preferences of consumers are highly subjective. Moreover, the increasing variety in products (including conventional and organic products) and the complexity of the associated food chains add to the difficulties in planning and managing these chains. Modelling of food quality and safety aspects throughout the chains becomes imperative to enable better management of the chains. Bayesian statistical and modelling approaches seem very appropriate for this task, because prior beliefs (including those of consumers) are essential components of these models.

The application of a Bayesian approach was reported in several papers. It showed promise not only for risk analysis and decision models, but also for model calibration and stochastic sensitivity analysis. Bayesian models were proposed at different levels in the food production chain, including primary production, quality control of primary products, food processing, food safety control and marketing. In particular, Bayesian network analysis holds promise for understanding relationships among components of a food production system and for predicting quantitatively the probabilities of a certain performance of such a system. An additional advantage of such a network analysis is that relationships among components can be studied in both directions (backwards and forwards).

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Workshop participants agreed that a Bayesian approach is, in principle at least, applicable to a wide range of problems in the agro-food production chain. However, it is also clear that this is only the beginning: much needs to be done in this area. The question remains whether the approach gives indeed a suitable answer to problems; this needs to be investigated in the near future. Basic questions arise like: when do you start building a model?; when is a model ready?; how are models and data interrelated? In any case, the Bayesian approach allows us to include expert opinion to structure data and to include uncertainty in the models and their outcomes. The focus should perhaps be more on modelling the domain of interest rather than working towards a specific answer to a problem. It is more about querying than about predicting: it helps to ask the right questions for a particular problem, it is a search for the questions that really matter.

A Bayesian approach holds the promise to couple all related disciplines in the food chain, i.e. mathematics and statistics, economy, primary production, post-harvest technology, food science and technology, operations research and logistics. In a way, it could couple 'people, planet, profit' by integrating data as well as expert opinions from various sources, and it could lead to a methodology for the necessary integration of natural and social sciences. An inventory should be made of quantitative tools to make disciplines work together, starting in a simple way, identifying solvable problems and learning by doing. A goal could be to develop decision-support systems to control such things as food safety, by taking into account quality control, monitoring, sampling and process control as well as economic factors and consumer attitudes. A practical problem is still the availability of software. Currently two programmes are at one's disposal, namely Winbugs and Hugin.

In conclusion, all participants agreed that a Bayesian approach to quality modelling in the agro-food production chain has proven to be useful and holds a big promise for the future. Limitations of Bayesian approaches were less obvious. However, it became clear that expertise is limited yet among specialists in food production systems. A desire was expressed to collaborate on exchanging knowledge and expertise among food production specialists and Bayesian statisticians in order to solve the important problems that are typical for agro-food production chains. This workshop provided opportunities for future development and implementation of decision models for these chains. We express the hope that the readers of this book will gain ideas and motivation to contribute to providing sufficient food of the quality desired by consumers.