Improving returns in food production through smarter information use

Words by Dr Rodolfo García-Flores

Whilst it is expected that food consumption will continue to grow for at least the next 40 years,[1] driven by a growing population and rising incomes, this increase will also face constraints from scarcity of resources, more attention to food security, and changing dietary habits. Variable climate patterns, economic uncertainty and changing regulatory policies will demand adaptation and more efficient and better integrated supply chain operations. Automated data analytics are already facilitating the use of decision support models and opening the door to important efficiency increases and enabling widespread agricultural supply chain optimisation and risk analysis. In this article, we provide an overview of data analytics in food supply chains with emphasis on risk management.

Data analytics enable organisations to make better decisions by obtaining valuable insights from their data. Analytical models can be grouped into *descriptive* (they provide a summary of the data), *predictive* (they produce an estimate of the future) and *prescriptive* (they advise on outcomes of decisions). Prescriptive models are the most valuable for commercial operations, as they not only build upon descriptive and predictive models, but also incorporate and formalise the knowledge from experts and operators to model and assess the decisions that can make or break a business. This knowledge is represented as rules, preferences, constraints and scenarios. Prescriptive models are based on simulation and optimisation, which are methodologies that analyse the availability of resources and explore all the possible actions. The discipline of applying advanced analytical methods to help take better decisions is known as Operational Research (OR).

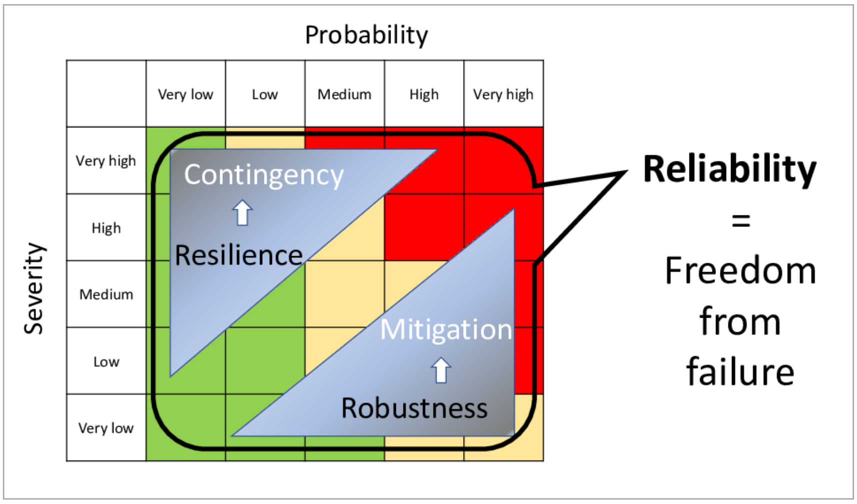

Figure 1. The risk space framework[3]

Developing prescriptive models for food supply chains is challenging because of the inherent complexity derived from the biological nature of agricultural systems. This complexity is reflected in high variability, the difficulty to quantify issues related to sustainability, and the importance of timing to process and market (perishability). These risks can be assessed and quantified using stochastic optimisation, which is a methodology that helps understand how to achieve the best outcome by minimising the impact of identified risks. This is done through weighting a number of plausible scenarios and their probabilities of occurring, and which could be seen as the calculation of expected values for the solution. Thus, no matter what scenario unfolds, the optimal solution of a stochastic model is robust in the sense that it is less likely to deviate from the expected optimal solution value than a solution that assumes the certainty of a single scenario that may not occur; the latter is called a deterministic model. As the chance of having a more precise estimate of the uncertain scenarios increases, so does the chance of the model suggesting a solution that is closer to the true optimal, and therefore of making the best decision.

Optimisation, both deterministic and stochastic, has been used in the food industry to model inventory management, transportation and logistics, production scheduling, infrastructure investment, time to market and reduction of food loss. Increasingly, these models rely on real-time data collected from sensors on the field, distributed computer networks, commercial databases, climate and economic forecasting models, warehouses and point-of-sale, opening up possibilities for reactive optimisation, which is the real-time calculation and correction of operational plans using the latest information collected on the ground. This is part of the promise of Industry 4.0.

In addition to optimisation, risk managers use the concepts of resilience, which is "the potential to recover quickly from disruption", and robustness, which is "an ability to withstand disruption with an acceptable loss of performance".[2]

Thus, a robust food supply chain is fit to handle business-as-usual risks, whereas a resilient supply chain is better able to manage the risks of disruption. Resilience and robustness together ensure that a system is reliable, that is, it is free from failure and can consistently perform well.

A useful framework to unify some of these concepts is the risk matrix. Resilience stands out as a promising research topic to address in data analytics - stochastic optimisation is helpful to weight disruptive scenarios, but the response to the disruption should also touch on the cultural aspects of continuous improvement. These challenges are harder to attain for networks of companies than for individual players, as more coordination and a broader view of the system are necessary. The fact that cognitive, political and ideological agreement is needed in addition to quantitative modelling makes the design of a truly resilient supply chain a very difficult endeavour.

There is a gap in research on food supply chain resilience. True resilience only comes from continuously asking the right questions proactively, building networks and partnerships, and ensuring a variety of creative strategies as part of a broader entrepreneurial culture.

References

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