Feedstuffs

How to optimize your food supply chain, without an army of data scientists

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Over the last decade the food and agriculture industry has seen a virtual explosion of information and data from sensors and IoT devices. There are satellite images of fields, real-time GPS information from carriers, the latest seed data, reams of historical harvest and commodities trading feeds, plus sensors relaying information at (almost) every stop along the supply chain path, from growers to consumer insights at retail shelves. This wealth of information provides better supply transparency and the ability to develop new business insights. While the good news is that we have an abundance of data like never before, the bad news is that we can't hope to process it in a meaningful fashion. In theory, this wealth of data should result in better decisions, but for many organizations the data can be overwhelming, and the decision complexity is increasing. The classic paralysis through analysis.

Data overload is a relatively old problem. Unfortunately, many standard technology solutions – such as data warehouses, are necessary but insufficient. As a result, organizations have turned to a more traditional solution: people. Defining a problem, making a decision, and formulating a solution that is impactful and makes use of the firehose of information, has become the realm of the data scientist. The new problem for many enterprise companies has been the cost and challenge of finding, hiring, and keeping qualified data scientists with the combined technical and industry knowledge. As their success in an organization grows, these specialist resources can become overloaded and turn into a massive bottleneck for innovation and growth. That's the best case. Most food and agriculture companies simply can't acquire the data scientists they need. Many companies have fallen back to hiring AI consultancies or buying and adopting standardized package solutions that embed such approaches.

Because of this, organizations do the best they can to make sense of the data – using existing technology, and people at hand. Most firms can only focus on getting near-term answers rather than true insights and optimization. For example:

Preliminary focus: When should I harvest a field crop?
True Insight: What seeds should I plant & where, to maximize the value of my acreage?

Preliminary focus: Which trucks are under-utilized?
True Insight: What is the best load-plan to fully utilize all my trucks?

Preliminary focus: How do I store my raw materials to maintain ingredient integrity?
True Insight: What sequence and quantity of materials should I maintain to optimize results?

Preliminary insights can be incredibly valuable, and are critical to business success, but they don't offer full solutions – most frequently they are used to highlight a problem that needs fixing. The operational staff then have the task of finding a solution in the face of huge complexity, and resort to a common human response – they simplify the task. Too often, decision makers on key operational tasks choose what is easiest to manage versus what is best for the business. This makes it manageable. As data and complexity increase, it is better to find a practical solution than wasting time trying to find the true insight.

"For every complex problem there is an answer that is clear, simple, and wrong"

H.R. Mencken

The food and agriculture supply chain – special, complex, and difficult

The problem is not just the volume, variety, and velocity of data (or even the veracity, if we want to add the fourth 'V'). It's the nature in which the data needs to be combined. Supply chain professionals are familiar with the travelling salesman problem, bullwhips, and a variety of issues caused by the way decisions cascade and network through a system. Our supply chain problems are often combinatorial, which is a kind way of saying they become unmanageable much faster than exponential problems. Supply chain challenges are resistant to even the latest high-powered analytics systems because there are too many options to analyze in any reasonable timeframe. That means we must take a different approach, and use a data scientist, with AI and Machine Learning skills. But we've already determined that those skills are hard to obtain. So our problem is threefold:

1. Effective data management is hard
2. Combinatorial supply chain issues cannot be easily solved with analytics
3. A lack of accessible & affordable data science skills

What's even worse is that executive leadership believe the data initiatives they have generously funded are providing advantages, while the truth can be that the more data that arrives, the harder it becomes for operational staff to make the 'best' decision:

The Case of the Dairy Plant

Imagine you run a dairy production facility that receives several tankers of milk per day, and you must determine into which vat the tanker should empty its contents. Each vat may be connected to one of several production lines for whey products, butter, cheese, etc. Last year you may have directed the drivers to the emptiest vat and told them to fill it up. Following a recent initiative by your management, though, you now have a new application that shows you which cows, on which diet, from which farm, contributed to the milk in each compartment of the tanker – and there may be up to six compartments. Suddenly, your decision on where to put the milk delivery has become much harder, much more complex. You may operate on a rule-of-thumb. Tankers with most of the milk from farms in district 3 will go to vat 5, and those from district 4 will go to vat 8, and so on.

Previously, the best decision was easy – fill the empty tank. Now, you may be mixing the wrong milk together, missing a great opportunity to improve product quality and value.

There is a data iceberg at play here, and when it rips into your organization, you will make simplified decisions and miss opportunities to improve the business performance. The damage is below the waterline, and remains hidden, because the business continues to function 'normally' as the new data is flowing, nobody realizes they are potentially losing millions of dollars – until a competitor finds a way to take advantage of similar data and technology, to offer a better service, price, or product. This scenario doesn't cause any red lights to flash on the management dashboard, as

costs hold steady, but your process is weakening compared to the competition, or to the potential savings. So we can add a fourth point to our previous list

4. If we don't do anything, we get further behind.

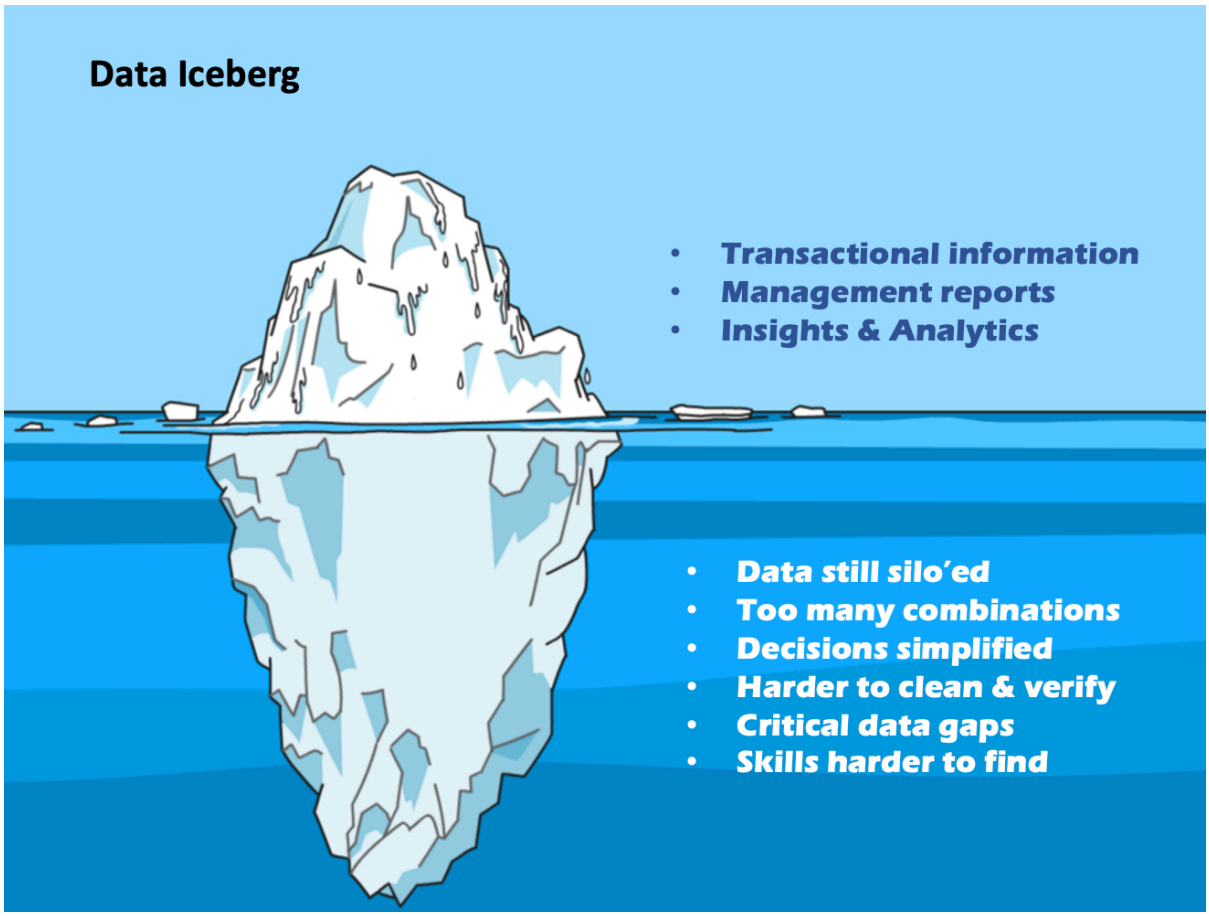

Figure 1: The Data Iceberg

Revisiting the Dairy Plant

To provide true insights into the tank loading problem, the dairy manager needs to be able to allocate each incoming batch to the appropriate tank in a way that will keep the ingredient integrity, but also optimize the cost and value generated by the resulting production processes. It is a combinatorial problem that requires insights into the objectives, constraints, tradeoffs, and results of various decisions. An optimization model is needed, but one that can be used effectively in day-to-day operations.

Think like a data scientist

You may already have an instinct for where your organization potentially spends too much money, but how can you rapidly define the issue and find a cost-effective solution, without months of expense and effort? We know that throwing more data at the problem is not going to help, although having the right data will almost certainly be critical to the eventual solution. Consider what questions you can ask to take control:

1. **Which processes offer the best opportunity or costs you the most money?**
    a. Would improving this process have the biggest financial impact?
    b. Can you see this in the financial results?
2. **What metrics are you measuring for this process?**
    a. Are they accurate?
    b. Valid?
3. **What levers (weight, flow, temperature, sequence, etc.) affect the metrics?**
    a. Which of those levers can you control?
    b. Which levers could you influence, if not control?
4. **What are the key decisions made on a frequent basis to adjust/set the levers?**
    a. Who makes those decisions?
    b. What data do they use?
    c. Is there any data missing?
    d. How do they make the decision?
    e. What assumptions and constraints are involved?
    f. What is the cost of a wrong decision?

If you can answer the questions above, you are far along on the journey of defining the problem and finding the true insights needed. You may also want to capture some historical results, and a clear goal for your solution, such as *'We must deliver a 15% saving on total cost per lb. compared to the 2020 benchmark'.* At that point, you are ready to start the search for a practical solution.

But all we have done is define the problem, identified some of the constraints and the nature of the data needed. The challenge of finding a data scientist who can model the issue and rescue us from this sea of data has not disappeared.

Build/Buy or try something different

Let's be honest, there is no magic solution. A clear problem definition is a critically important step, but now you will have to face the time-honored build/buy scenario. A larger firm may be able to use a data science team, or an AI consultancy – if they have the bandwidth and/or budget. A smaller team may need to buy a packaged solution. There are, however, some new approaches emerging, especially in the 'no-code' arena. The 'no-code development platform' (NCDP) is where business users can fashion their own solutions, without developing any software. Much in the same way users can develop web sites using simplified words and diagrams, the 'no code'

systems allow business users to create their own algorithms and code to solve business problems. Some of these solutions are more like the old 'buy' – they are applications that are customizable by the users, but ultimately you are adopting someone else's best practice for that process. Which can be a good place to start if your process is significantly broken.

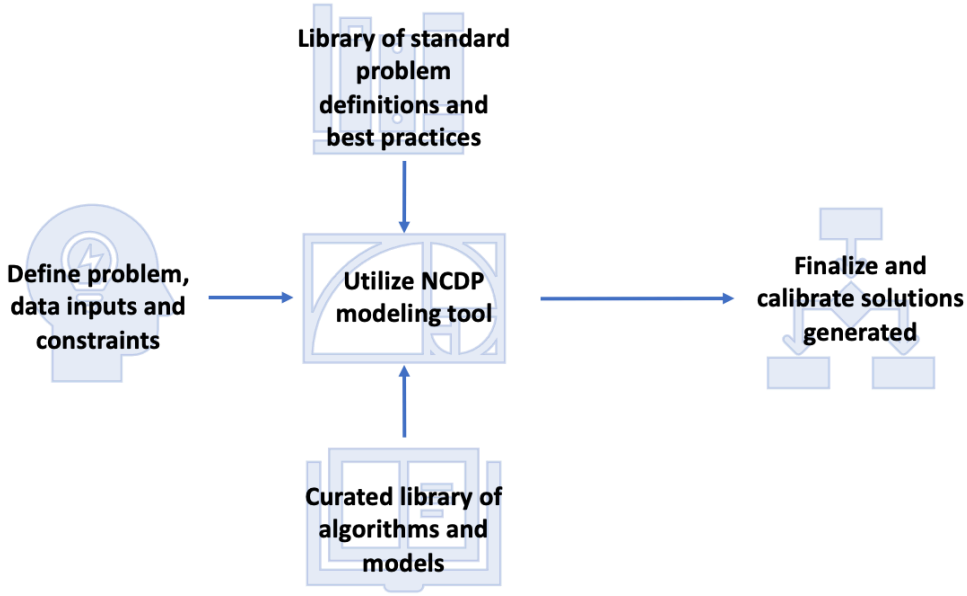

Figure 2: Supply Chain Optimization – NCPD Approach

There are some intriguing NCDP options which are closer to a build approach but promise faster time to deploy at much lower cost. These tools have the advantage of letting you adapt and evolve your own process, specific to your operations. There are a growing number of such tools in the market, such as SWARM Engineering, the first such platform to specifically target solutions for the food supply chain. I may do a deeper dive on their technology in a subsequent article, but for now, the approach is that they:

- Provide a **problem modeling tool** for business users to define their challenge, in business terms (and they claim this can be done in a couple of hours)
- Use a library of 'standard' **problem definitions for common supply chain issues**, such as inbound logistics or load planning which are fully editable by the business user
- Match a solution to the problem definition from a **curated library of algorithms**
- Instantly deploy the solution in a **Software-as-a-Service platform**

This is an intriguing approach, and if proven could have a huge impact on efficiency in food supply chain processes and provide valuable insights into complex and previously unsolvable problems.

Full disclosure – I am an investor in Swarm Engineering, and I believe their approach will have a dramatic impact on the food and agriculture supply chains. Their NCDP algorithms and software are uniquely tailored for food and agriculture systems and their applications have already proven themselves with many clients.

Further information

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