# USING STATISTICS TO MODEL A SOCIAL ENTERPRISE'S PATH TO SCALE

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# Using Statistics to Model a Social Enterprise's Path to Scale

*For Stanford Social Innovation Review*

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I didn't start my career in the social sector. In fact, I was working for a hedge fund the day I met Tofique — the young man who was the catalyst for change in my life's path. Tofique was from Bangladesh. When we first met at the home of a mutual friend, he was trying to analyze the most complicated data I had ever seen.

But it wasn't just any data. Tofique was attempting to understand how to help women on small dairy farms in his country improve milk production. The complexity of this data — and the varied and vital questions it could help answer if cracked — opened my eyes to the need for rigorous data science in the social sector. I was an instant convert.

Within two days, I quit my hedge fund job and founded Datassist. Working together with Tofique and Kevin McKague, at the time with York University's Schulich School of Business, we took that complex data and spent three years developing a detailed model to track specific trends and drivers in the productivity and profitability of rural farmers in Bangladesh.

More than a decade on, my team and I have worked with the likes of the Bill and Melinda Gates Foundation, CARE USA, the Ontario Secretariat for Syrian Refugees, and a raft of other nonprofit and government agencies. We've also partnered with data journalists like FiveThirtyEight and Orb to help shine a light on issues relating to poverty, inequality, education, and the environment around the world.

Data mining, collection, and analysis have been standard practice in the corporate sector for years. Large enterprises were quick to see the value of modeling every aspect of business. I cut my statistical teeth in this field. I spent years using advanced weighting techniques and building nuanced statistical models that combined semi-parametric and mixed-effects models to accurately describe phenomena in the real world while accounting for different units of analysis and contextual effects.

But data science becomes a vastly different beast when one transitions from the corporate to the social sector. The work we do at Datassist is incredibly rewarding, but not without challenges. Resources are stretched, frontline staff and volunteers aren't as ready to put their faith in numbers, and — most importantly — real lives can be at stake. The scientific nature of data becomes maddenly elusive when, instead of dealing with profits or production lines, you are measuring living, breathing human beings desperately trying to wrodk their way towards a better life. We've had to adapt data collection, analysis, and visualization methods to ensure we weren't inadvertently hurting those who most needed our help.

Even with all the difficulties and roadblocks that can arise, a growing number of nonprofits and social sector organizations are embracing the value that advanced data analysis and statistical modelling can add. This case study is about how we worked with one pioneering social enterprise to use statistics to help the understand the key strategic challenges and opportunities on their path toward financial sustainabiltiy and scale.

Farm Shop: A Social Enterprise in Search of Scale

Farm Shop had been initially established as a non-profit Trust in Kenya in 2011 by cofounders Farouk Jiwa and Madison Ayer to provide smallholder farmers with quality agricultural inputs at affordable prices through a social franchise model of shops owned by local entrepreneurs. The social franchise model was designed to incorporate localized agricultural knowledge and smallholder farmer needs with standardized management and marketing processes, technology and aggregated purchasing of input supplies. The founders saw that the success of smallholder farmers in Africa depends on the ability of agricultural input supply shops to consistently provide farmers with information and quality inputs at an affordable price. To do this, they knew that the entire industry of agro dealers had to be modernized and transformed into well-run businesses to better serve farmers, especially smallholders.

Farm Shop's social franchise model works with local entrepreneurs to convert or set up small shops in rural areas and sell agricultural and veterinary inputs (e.g., seeds, fertilizers, animal feed, medicines) and sell or provide referrals to services (e.g., soil testing, spraying, home delivery, artificial insemination, animal health care) that can enhance smallholder farmer productivity and incomes.

When I was first introduced to Farm Shop in 2014, they had ambitious plans for scale. They had already established a network of 25 shops and had been doubling the number of shops in their franchise network each year since their founding in 2011. They had an ambitious vision of establishing 500 shops in Kenya by 2020 and expanding to East Africa and beyond to a network of 10,000 shops, benefitting 25 million individuals. They had secured some seed funding and in 2015, the Canadian International Development Research Centre and Global Affairs Canada offered Farm Shop and their research partner Kevin McKague and his team a major grant to work toward achieving their target of reaching break-even and scale.

**African Food Security Challenge**

As a social enterprise, Farm Shop was creating a business model to help address the global food security challenge which was especially pressing in Africa. Globally, 795 million

people are food insecure1 with 70 per cent of the world's extreme poor live in rural areas2 and over one billion people are employed by the agriculture sector.3 In essence, the world's poor are highly dependent on agriculture as a source of income and if supported correctly, growth in this sector can be a highly effective tool in alleviating poverty and improving the lives of smallholder farmers.4,5 As the World Development Report: Agriculture for Development emphasized, "Improving the productivity, profitability, and sustainability of smallholder farming is the main pathway out of poverty in using agriculture for development."6 However, agriculture-led growth that can contribute to sustainable development and poverty reduction requires a revolution in productivity in smallholder farming.7

Since the early 1960s, the productivity per acre of various grains (such as maize, wheat, and rice) has more than doubled in the US, China, and India, while Africa has shown very little relative improvement.8 This stagnation in African agricultural productivity is due to many factors, including the lack of access to productivity enhancing inputs and knowledge in rural areas because of high transaction costs, risks, and lack of economies of scale.9 Government extension services, where they exist, are often limited and not designed for smallholder farmers; instead, agricultural extension services and agricultural companies target their products, information, and marketing to larger and better-off farmers. Further, as men from rural areas increasingly seek off-farm employment, women undertake more of the agricultural work, and access to knowledge and inputs tailored for women farmers has not adequately responded to this change.10

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[1] FAO, 2015
[2] International Fund for Agricultural Development, 2011
[3] International Labour Organization, 2014
[4] Curtis, 2010. Agricultural growth is at least twice as effective in reducing poverty as growth originating in other sectors. See Mondiale, B. (2008). *World Development report: agriculture for development.* Washington DC: The World Bank, page 6.
[5] Mondiale, B. (2008). *World Development report: agriculture for development.* Washington DC: The World Bank, page 10.
[6] Mondiale, B. (2008). *World Development report: agriculture for development.* Washington DC: The World Bank, page 10.
[7] Mondiale, B. (2008). *World Development report: agriculture for development.* Washington DC: The World Bank.
[8] BMGF cite.
[9] Mondiale, B. (2008). *World Development report: agriculture for development.* Washington DC: The World Bank, page 12.
[10] Cite my book chapter on gender.

Perceiving these challenges, various donors have developed projects to support agricultural input shops;11 however, these initiatives have not been financially sustainable or successful in achieving scale. In this context, Farm Shop introduced its social franchise business model as a way to sustainably improve the food security and prosperity of smallholder farmers through increased productivity and incomes as a result of access to quality agricultural inputs, knowledge, and services.

**Using Statistics to Model a Path to Scale**

Given that Farm Shop was in startup mode with ambitious plans to scale, one of the most essential things they needed was a financial model that the cofounders and senior managemetn team could use to inform their strategy and ensure they were on the right path. Our team worked with them during this process to create a model of strengths, vulnerabilities, and potential decisions.

The obvious first step to modelling a social enterprise's path to scale is to actually build the model — identify key variables and measures and beginning to amass data. We developed the Farm Shop Scale Model over two years (2016 and 2017). Although modelling has its roots in the traditional elements of a break-even scale model, it draws on statistics and also includes several unique elements to accommodate the social nature of the business.

Our first round of basic building blocks to create the model included:

- Total fixed costs for the system (not dependent on the number of shops)
- Fixed costs per additional shop
- Sales volume by product category (feed, minerals, seeds, agro-chemicals, fertilizer, veterinary products, equipment)
- Contribution margin per product category (profit margin)
- Annual increase of sales volume from headquarters to shops

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11 See, for example, "The ADAPT Project in Zambia: Successes and Lessons in Building a Scalable Network of Rural Agro-Dealers to Serve Smallholders" (2010). Atlanta: CARE USA. Farm Shop board members Farouk Jiwa and Christian Pennotti served as advisors to this initiative.

As we refined and further developed the model as Farm Shop's busienss model evolved, we added several new measures to accommodate changes in Farm Shop's strategy. Additions to the model in 2017 included:

- Proportion of shops owned/operated by Farm Shop (Farm Shop began opening a few company-owned shops in addition to the majority of franchisee-owned shops)
- Product category contribution margin by shop type (company owned or franchisee)
- Differentiation between business and nonprofit expenses

Using these basic building blocks, we generated an equation to understand the relationship between cost, volume, and profit of the Farm Shop franchise:

| Target Number of Shops to Break Even = | Total Fixed Costs + Target Profit |
|---|---|
| | Weighted Average Product Category Contribution Margin |

This equation lets Farm Shop test how strategic management decisions will affect scale.

An influence diagram is a graphic representation of a decision situation. It closely resembles a flow chart or decision tree, but unlike those, it displays the dependencies between variables. This enables us to visualize relationships between decisions, other factors, uncertainties, and results. The strategic decisions involved in scaling up a social enterprise are complex processes that can alter the regular operations of a system in meaningful ways.

We combined Farm Shop's data with information gleaned from interviews with their management team to model current relationships within the system to create a basic influence diagram. As relationships became more apparent over time and with testing, we added additional levels of complexity.

Farm Shop is generating both effective demand and supply. Franchises supply products to meet market demand but also offer training and education. This, in turn, increases demand, which can then be met by the franchises. The success of a single shop generates positive effects for the entire community or region, which then increases demand for more shops. Our influence diagram had to reflect these dynamics.

Our Farm Shop influence diagram had to incorporate a range of factors:

- Quantitative (scaling the number of beneficiaries)
- Organizational (scaling the capacity, staff, management system, knowledge base)
- Geographical (expanding with the region and to new regions)
- Depth (scaling impact in existing shops)
- Replication (incubating new entrepreneurs to replicate the business model)

Impact is one of the most vital relationships to consider when making decisions in a social enterprise. Scaling Farm Shop had to be about growing impact, not just expanding the business model. The following influence diagram highlights areas of social impact (in yellow).
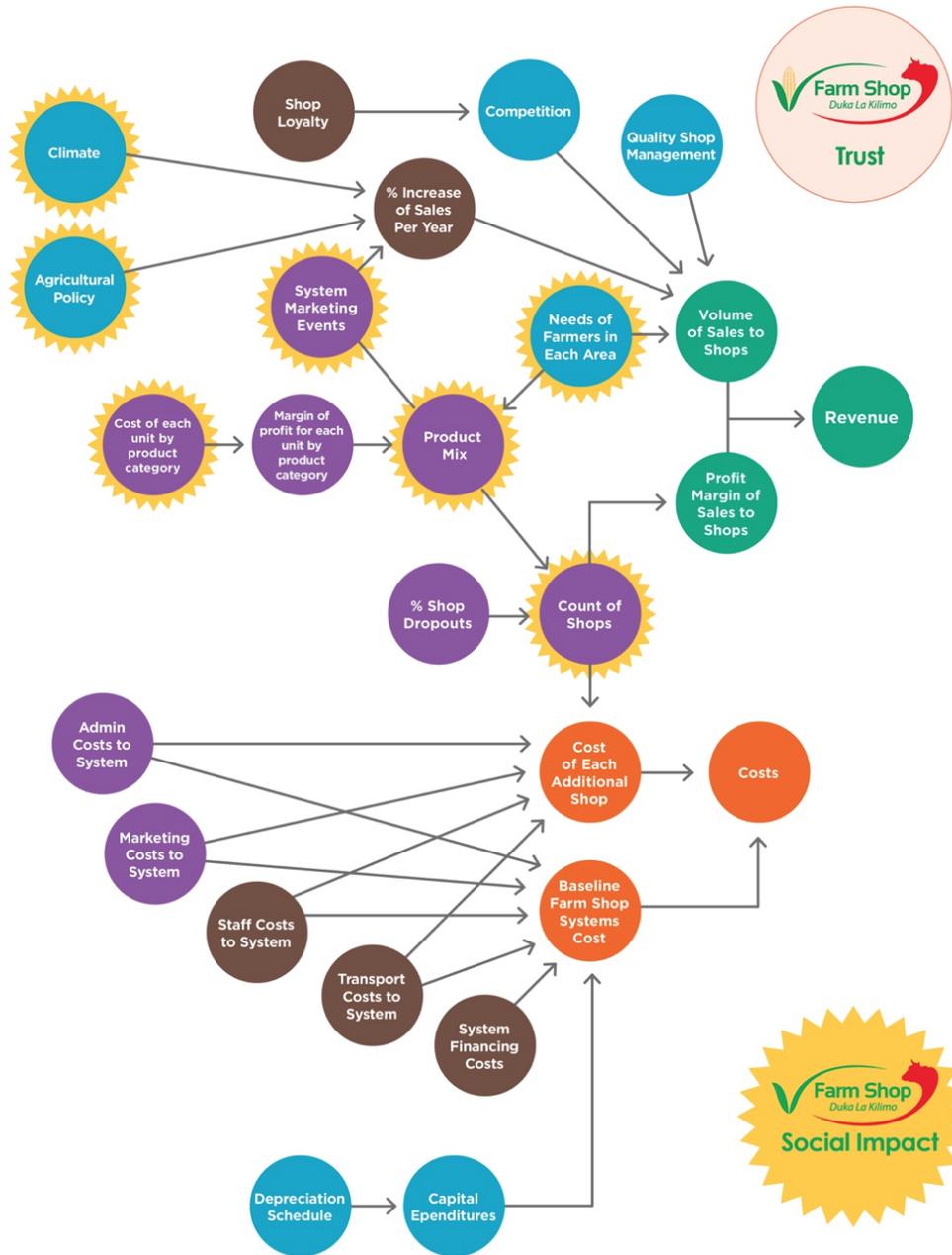
**Modelling the Current State**

To make informed decisions about the future of a social enterprise, we must understand how the various aspects are working as a system. But given the web of complexities and interactions involved, we must think in terms of dynamic scale model — not a static analysis. It's also crucial to remember that, for a social enterprise, the bottom line is not the

only consideration. The balance of revenue and costs is mediated by the social impact on which the enterprise is based.

As Farm Shop scales, they must understand where the break-even point (no profits, no losses) is, as well as identify the margin of safety needed to maintain their system as a freestanding enterprise. To achieve this, we had to balance profit margins, profit mixes, staffing needs, marketing plans, and other strategic decisions against both profit margins and social impact.

Traditional scale analysis is based on a relatively standard selection of indicators: fixed costs, price, volume, and so on. For established corporate sector organizations, these models make sense. But for social enterprises — particularly those in emerging sectors with developing economies — they are wholly inadequate. We need a model that incorporates dynamic product mixes and treats the traditional variables as random. (Which is, in fact, what they are.) This way, we can include uncertainty in scale models.

There are two basic ways to handle uncertainty: by conducting a sensitivity analysis (which I'll get to in a bit), or by statistically computing expected values with confidence intervals using probability distributions. For Farm Shop's dynamic model, we built an interactive web application to test theories and strategic choices based on the underlying assumption of their business model. Below, we use this tool to examine multiple potential scenarios for Farm Shop's current state and scaling process over the next year. In each one, the red dashed line represents the most likely trends in expenses and the blue dashed line represent the most likely trends in revenue. When these two lines cross, we have a break-even situation. The dotted lines shows confidence bands to incorporate risk and probability.
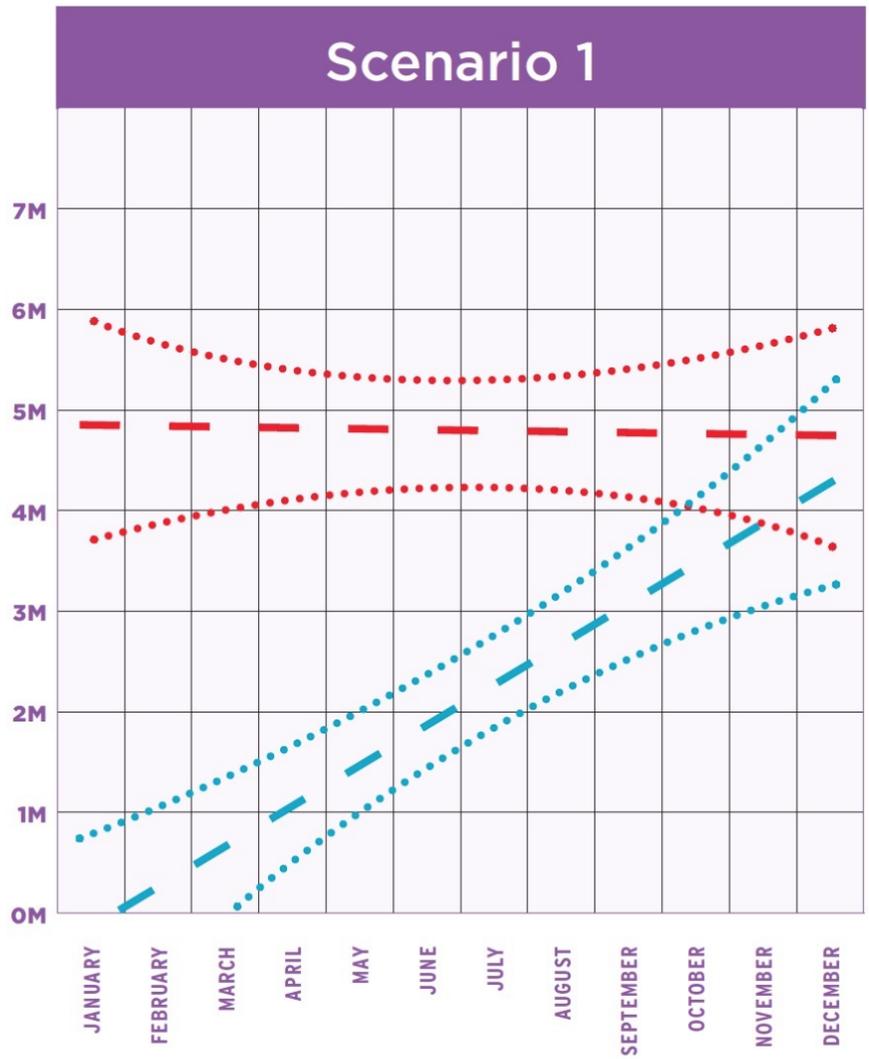
Caption: Scenario one includes a high rate of sales increases to the shops, a preferred product mix, and a low cost to the system per additional shop.
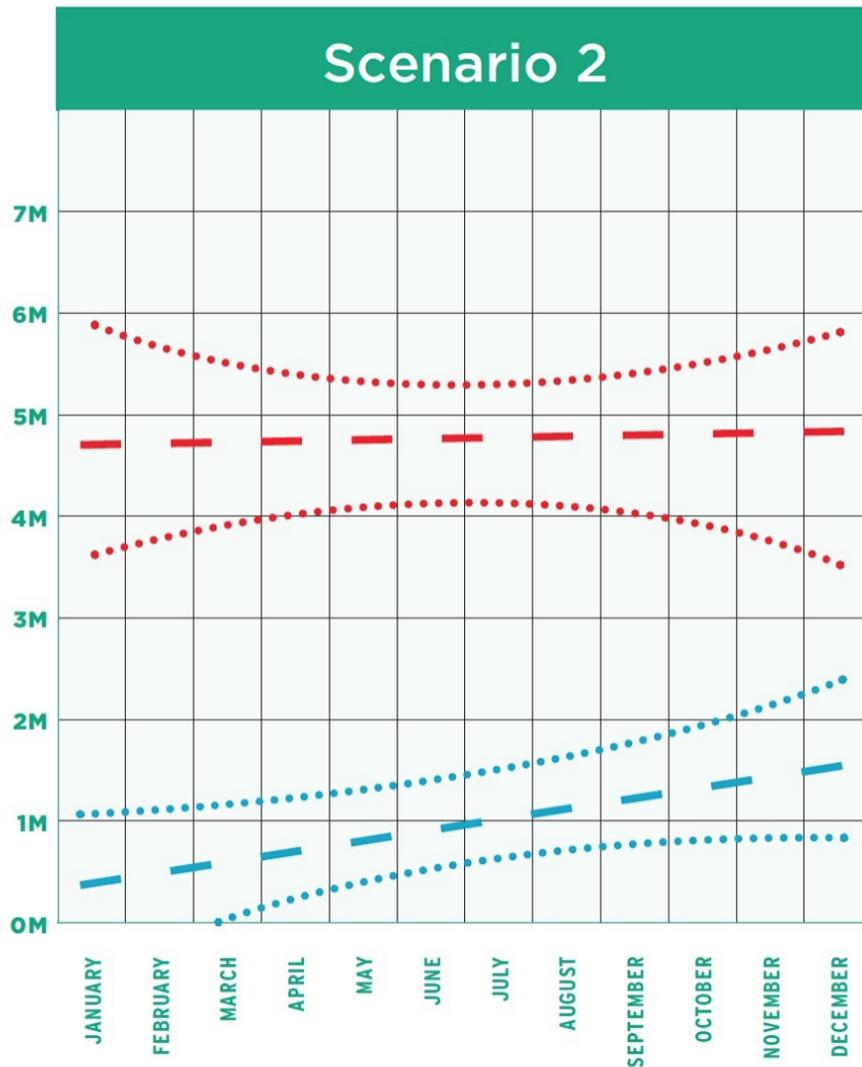
Caption: In scenario two, we've slowed down the predicted rate of sales increase from the warehouse to the shops.

**Conducting a Sensitivity Analysis**

With a basic quantitative working model of the Farm Shop system's current state, the next step is to quantify the system's stability and risk sensitivity — both internal and external. Sensitivity analysis is a "what if" technique used to examine how results will change if the original predicted data is inaccurate or if the underlying assumptions change.

To do this, we consider a large number of scenarios across the range of likely outcomes of the baseline assumptions — we perform a series of calculations in parallel according to the rules of probability. Instead of treating each random variable as a point estimate, we treat uncertain assumptions as probability distributions. This provides additional insight into possible occurrences. We assign a probability to the various potential events and apply the probability to selected outcomes within the model.

Once we've done this, we can test which indicators (price fluctuations, changes in the number of shops, etc.) have the largest potential impact on the Farm Shop system. Having a working idea of the relative impact of each decision point enables the management team to make decisions more effectively and provides some guideposts in emerging situations.

For Farm Shop, costs are highly related to events as laid out in the influence diagram — some of these are within management's control and some are not. (For example, Farm Shop has no control over changes in the climate, but such changes could have immediate and volatile effects on the system. The sensitivity analysis demonstrates the need for a plan to address this.)
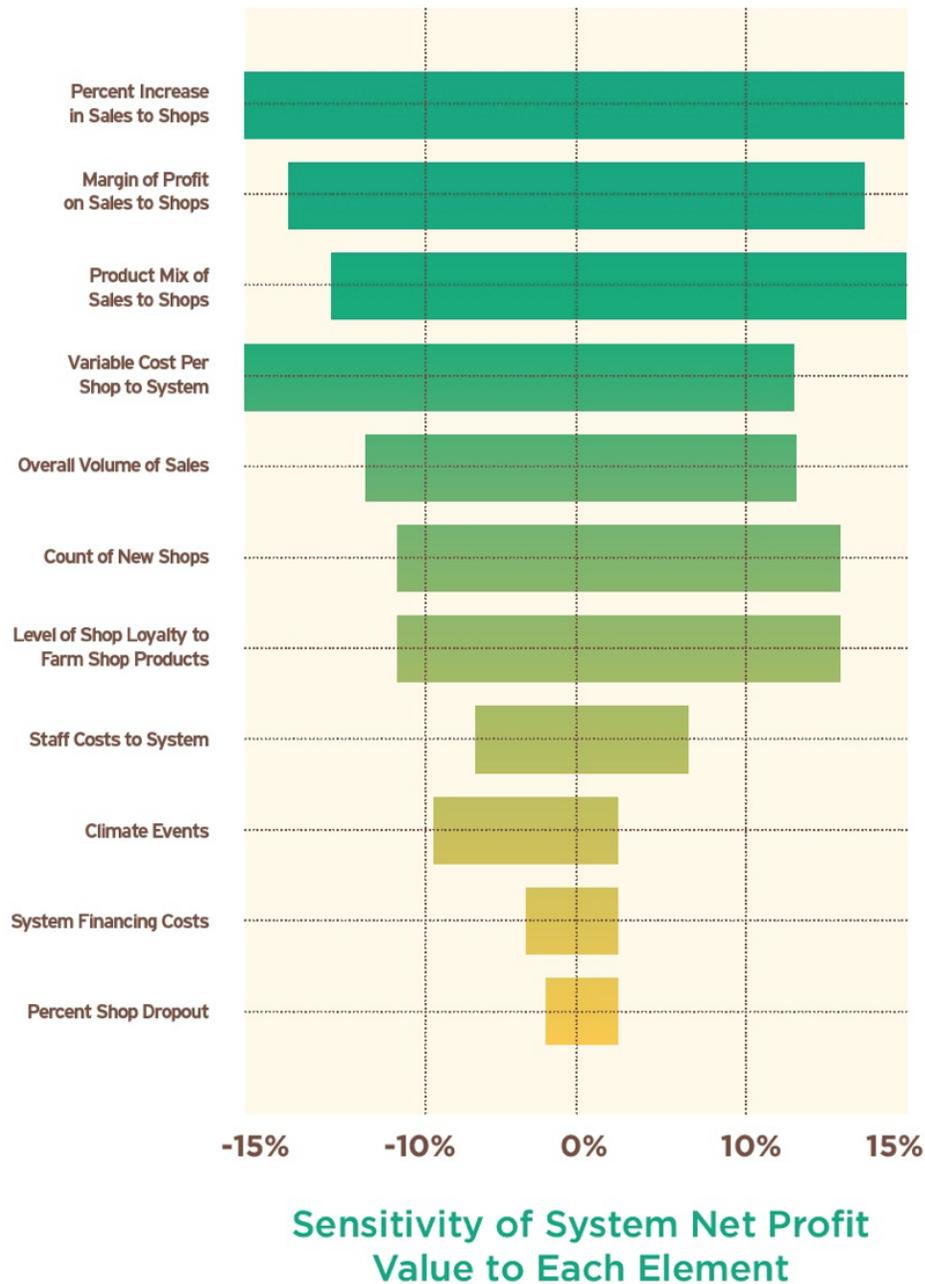
Caption: The sensitivity analysis shows which events are most likely to affect the Farm Shop system.

## Testing and Reiterating

The first model a social enterprise builds will never be perfect. Once the initial model is complete, you must continue to collect relevant data to fine-tune your model.

For the Farm Shop model, we continued to collect data each month on sales, costs, product mix trends, and sensitivity indicators. We tested several approaches to scale, including:

- Establishing some shops managed by Farm Shop itself
- Separating cash flow needed to run the business from cash flow needed to support solely nonprofit aspects of the system
- Adjusting product mixes to optimize the connection between local farmers' needs and Farm Shop's financial sustainability

The most significant change that came about during the implementation of this project was one that I think every social enterprise would benefit from — a move to collecting more granular and accurate data.

Once the Farm Shop team recognized the value of the financial models, they were highly motivated to collect more detailed data. They designed and implemented a point of sale data collection system, which helped them predict more accurately what products and services the people they served needed.