

IMPROVING VEGETABLE PACKING LINE PERFORMANCE TO REDUCE WASTE AND COSTS AND INCREASE REVENUE

CASE STUDY



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Preface

As part of the Ontario Produce Marketing Association's (OPMA) food waste reduction initiative, Value Chain Management International (VCMI) worked with Gwillimdale Farms (GF) to implement effective daily management systems for their carrot, beet, parsnip, onion and potato packing lines. Effective daily management systems are typified by monitoring and reporting practices that balance the creation of a functional team with individual accountabilities, resulting in the creation of a continual improvement program.

The UK's Waste and Resource Action Programme (WRAP) estimated that adding one extra day's shelf life to perishable foods could reduce overall food waste by five per cent.¹ Means to extending shelf life include addressing supply chain constraints and delays, and increasing the effectiveness of packaging materials.

The ability to deliver consistently high quality value-added produce enables growers and packers to differentiate themselves in a competitive market, which is defined by unprecedented consumer demand for freshness, convenience, taste and value-added products.

¹ WRAP (2015). Reducing food waste by extending product life; Project code: MAR103-101. Accessible from: http://www.wrap.org.uk/sites/files/wrap/Product%20Life%20Report%20Final_0.pdf

Capturing Value

Gwillimdale Farms (GF) has two locations. Their primary operation – established south of Lake Simcoe in the outskirts of the Holland Marsh – includes 1,000 acres of carrots, potatoes, onions, beets and parsnips. GF also recently commenced vegetable production in the New Liskeard area, to meet the exponential increase in demand that has occurred in recent years. This demand culminates from GF's proven ability to consistently supply high-quality products and meet exacting customer demands on volume and format.

Since the owners, John and Cristina Hambly, first invested in on-site vegetable packing equipment in 2007, GF's packaging facilities have expanded to three production lines that wash, bag and cut – if required – an average of 250,000 pounds (five tractor trailer loads) of vegetables each day. While most of the vegetables processed are grown on their own farms, GF also purchases Canadian, US and Mexican produce from preferred partners to ensure a constant year-round supply of excellent quality products for their customers.

The capital investment required to establish and operate these extended packaging facilities has been significant. The *Growing Forward 2* funded project between GF and VCMI looked to improve the performance of packaging facilities by making minor improvements at multiple points along the packing line and associated activities, such as procurement and marketing. These adjustments would result in measurable increases in returns on investment and simultaneously reduce waste. VCMI used a methodology (the heritage of which is based on lean six sigma) to understand processes, analyze data and improve performance by addressing root causes of problems.

Identifying Improvement Opportunities

Challenges faced by Gwillimdale that can negatively impact performance include 1) the number of labels under which vegetables are packed, 2) enormous variations in order size, 3) differing pack size, and 4) late receipt and/or ongoing changes to orders. On any day, Gwillimdale fulfills multiple customer orders with a variety of products, packed in different sizes. Variations in the size, quality, consistency and timing of vegetables received directly from the field or out of storage can also impact performance.

VCMI's work with GF began by discussing the challenges faced by senior management and then walking the plant — from receipt of unwashed vegetables through to the shipment of packaged products. This enabled the VCMI team to familiarize itself with GF's cleaning, grading and packaging operations.

The process of determining opportunities to improve performance began by observing how effective equipment was being operated, and comparing that to what is possible. The more effectively equipment is being utilized, the more efficiently businesses can utilize their workforce and associated resources (incl. energy, transport, water, buildings, etc.).

A tool known as overall equipment effectiveness (OEE) was used to calculate how closely Gwillimdale's primary packing lines were operating compared to what is possible. OEE provides a normalized means to compare performance across packing lines and SKUs, identifying improvement opportunities and the root causes of current issues. It is therefore a good metric for identifying losses, benchmarking progress and improving the productivity of manufacturing equipment — resulting in the reduction of food and associated wastes.

OEE is calculated by measuring the following three factors:

$$\% \text{ planned up time} \times \% \text{ planned run rate} \times \% \text{ first time quality}$$

Up time is the number of hours that the equipment is planned to be in use. Run rate is the maximum speed which the equipment can operate effectively to produce the required output. First time quality is the actual production rate of products that meet intended quality and thus do not require rework or are not rejected. A good target OEE is 85 per cent – below 85 per cent equates to improvement opportunities; an above 85 per cent equates to operational excellence.

The OEE was completed in two rounds. The first round of OEE provided baseline data and provided GF with experience recording the data required to conduct this type of analysis. Data was recorded using an Excel template provided by VCM. First round results provided guidance on where opportunities to improve performance lay and challenges faced in accurately measuring OEE. An example of this is how to ascertain planned versus unplanned downtime and necessary versus unnecessary interruptions in production. The second round of OEE provided a more accurate assessment of the grading/packing lines' performance and confirmed a number of opportunities.

The recording and analysis of OEE identified a number of issues that impacted the performance of the packing line, particularly when packing carrots. Opportunities to improve GF's OEE for carrots by a third were identified against the targeted 85 per cent. Certain easily observable issues, such as a single washing and polishing line feeding two grading lines (each handling differently sized carrots), would require considerable investment in capital.

Other less obvious issues that the OEE identified as impacting line performance stemmed from the weighing and packing equipment. At times, this issue led to a backup of carrots that forced both lines to stop entirely. Line stoppages created waste and challenges that impact the wider business — from front line workers to senior management and dispatch.

Another issue identified by the OEE related to the management of packaging materials. The number of pack sizes, formats and designs — along with associated items, such as clips to seal bags shut — make managing the supply of packaging materials a complex process. Order-to-delivery cycle times and variations in quality add further complexities to the management of packaging materials.

Misfires

The most common issue impacting the lines' performance was identified as bagging equipment misfires. The OEE identified that misfires most commonly occurred when the weighing head incorrectly grabbed a new bag ready for filling, or carrots protruded from the top of the bag. The latter was one of the factors that led to the third most common cause: incorrectly closed bags. Bags were also tearing during their filling, closing and packing into 50lb masters.

Having identified a key constraint impacting performance, attention then shifted to establishing a plan of action for addressing the misfire issue. Presented below in Table 1 is the project charter developed during a workshop held with the GF team.

Table 1: Gwillimdale Farms Project Charter

<p>CURRENT UNDESIRABLE EFFECTS</p> <ul style="list-style-type: none"> • Loss of production and revenue • Management intervention regularly required to address issues • Issues lead to increased costs and longer production hours • "Fines" charged by trucks that are delayed in leaving 	
<p>PROBLEM STATEMENT</p> <p>Misfires by the bagging heads on both weighing machines lead to equipment downtime (loss of up-time). The most common and protracted incidents occur in the bagging of carrots.</p>	
<p>OBJECTIVE</p> <p>Significant reductions in bag head issues occurring on both weighing machines.</p>	
<p>SCOPE</p> <ul style="list-style-type: none"> • Both packing/weighing machines • Carrots • Polythene bags for 1lb, 2lb, 3lb, 4lb and 5lb packs 	
<p>PROCESS OUTPUT MEASURE (for chosen SKUs)</p> <ul style="list-style-type: none"> • OEE: Moving from current state of X% to future state of X% 	<p>POTENTIAL SAVINGS</p> <ul style="list-style-type: none"> • Potential savings & increased sales equivalent to 4% annually

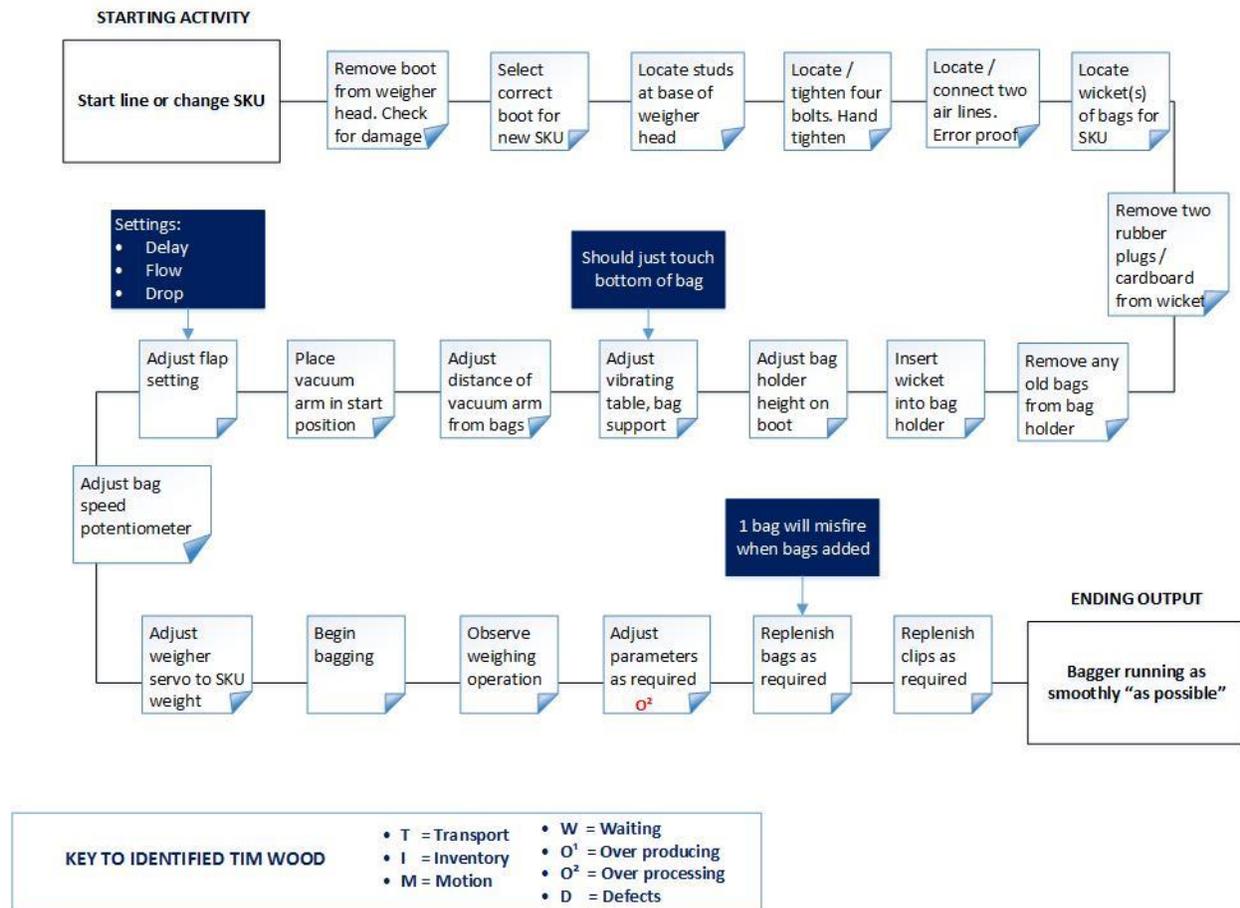
The potential opportunity that could be realized by addressing misfires on the weighing and bagging equipment was estimated conservatively to represent an additional four per cent in annual sales.

Process Map

The focus now moved to quantifying the processes associated with setting up, running, checking, adjusting and maintaining the bagging heads. With two heads each on two weighing machines, each change in pack size meant removing then installing four separate heads. Even when changing

between SKUs of the same weight and size, bagging heads may need to be adjusted to account for differences in packaging design and material. Shown below in Figure 1 is the processes followed to change each of the four bagging heads.

Figure 1: Process Map of Changing Bagger Head



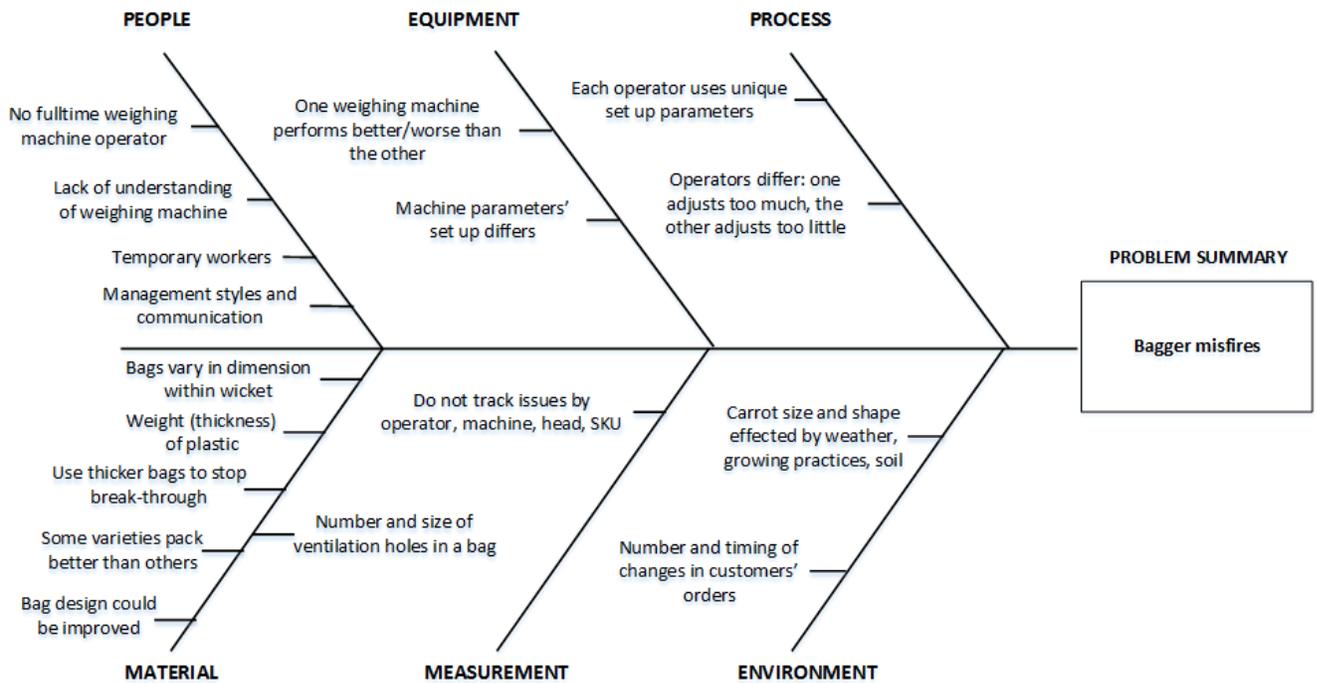
As can be seen, there are many actions and factors to be considered when changing bagging heads. The most obvious occurrence of waste as identified in the legend above entitled "Tim Wood" was in the bagging heads' adjustment – over processing. While some operators tend towards over adjusting, other operators tend towards under adjusting the heads. It should be noted that this is a subjective assessment, because the continual measurable data (CMD) required to quantify the optimum process controls required refinement.

Designing then implementing a means to record the CMD required to identify overall OEE and the performance of individual operators was a "just do it," which emerged from having mapped the head change-over process.

Cause and Effect

To further quantify potential root causes that resulted in bagger misfires, a cause and effect activity was conducted with key members of the GF team. The results are presented below in Figure 2.

Figure 2: Potential Causes That Lead to Bagger Misfires



A key insight gained from the cause and effect analysis is that the baggers operation and function varied. This was due to tribal knowledge from individual operators that was gained over time. During the year, at least three separate people operated the machine. There were no written standard operating procedures based on experience for workers to follow. Nor was there a process for monitoring performance or reporting incidences by operator, in a manner that could be directly acted upon as part of a continual improvement process. In addition, the main operators did not tend to proactively seek advice when an issue arose, which exacerbated the impact that misfires had on performance.

Reasons why the present situation of operator effectiveness had arisen was largely due to the management of staff having essentially remaining unchanged, while the scale and complexity of GF's packing line had evolved markedly. Limited year-round access to local skilled workers has also played a role in shaping the current situation. The discussions lead to the GF team determining that a sound business case existed for hiring a full time mechanically-minded person who lived locally.

Unstructured interactions between senior management also played a role in individual line workers not performing to their full potential.

Other potential causes lying behind the baggers’ underperformance included the material from which bags were constructed, bag design, and differences of ~1/8 inch (3 – 4mm) in the size of bags contained within the same wicket. Light-weight plastic has a greater tendency to tear or break loose from the bagger head. Bags with a larger number of smaller ventilation holes than traditional carrot bags were found to reduce the incidence of misfires, though the impact of these non-traditional bags on carrots’ freshness and shelf life had not been objectively evaluated.

Carrot variety and growing practices/conditions were also identified as causing misfires. Misshapen carrots can result from differences by variety and growing conditions (including weather, production practices and soil type). While for these reasons differences were anecdotally believed to impact the rate at which carrots supplied from different growers and locations could be packed, the potential impact on bagger performance of variety and source was not monitored.

Ideas Sort

Ideas that emerged from having identified potential root causes of bagger misfires were developed by the GF team. These ideas were then categorized according to their potential impact and the effort required to implement. The template on which ideas to address bagger misfires were plotted is shown below in Table 2.

Table 2: Estimated Rewards and Effort Required to Improve Bagger Performance

BIG REWARD / BIG EFFORT DO LATER	BIG REWARD / LOW EFFORT DO NOW
<ol style="list-style-type: none"> 1. Look into a different closing mechanism for securing bags (e.g. tape instead of kwik loks). 2. Explore how varieties of carrots preferred by customers / consumers due to size and taste can be grown in ways that lead to fewer issues when packing. 3. Monitor differences in the machines’ performance when packing carrots from ON, US, Mexico. 	<ol style="list-style-type: none"> 1. Hire full time machinery operator for weighing/packing equipment. 2. Establish effective standard operating procedures describing how to “set up, run, check, adjust and maintain” bagging machinery. 3. Establish structured well-functioning management hierarchy.

<p>LOW REWARD / BIG EFFORT PARK</p>	<p>SOME REWARD / LOW EFFORT DO WHEN WE CAN</p> <ol style="list-style-type: none"> 1. Contact packaging companies to enquire about plastic bags’ design. 2. Evaluate bags differing in the size of hole and the number of holes, to test their impact on carrot quality.
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Big Reward, Low Effort

Three of the ideas proposed were expected to produce big rewards with little effort. Already mentioned is the hiring of a full-time bagging equipment operator. It was identified during the idea development stage that one person could both oversee the four bagging heads and lead a continual improvement program for the entire grading/packing operations.

Establishing standard operating procedures, the effectiveness of which could be audited and continually improved upon (ultimately by the full-time person described above), was also deemed as having a big impact with little effort. This process would begin by monitoring bagger performance to identify current operators’ best practices. Simultaneously, GF would learn more about the bagger and its functions by speaking with the manufacturer and other users, and reviewing available literature.

Establishing a more structured management hierarchy would involve holding regular meetings between line operators and management. Line meetings would primarily take the form of a daily huddle before work commenced — to share the prior day’s performance and that day’s targets, and discuss any issues or problems discussed. Senior managers would meet weekly to discuss key performance indicators (KPIs) and pressing issues. More detailed monthly management meetings would involve a thorough review of KPIs, and discuss both opportunities and issues from operation and strategic perspectives.

The structure of daily management interactions would be supported by establishing: 1) detailed job descriptions that define individuals’ responsibilities, the business operations for which they are accountable, and measurable targets against which their performance is measured; and 2) an organizational chart that graphically shows to whom individuals report – along with the teams, operations and functions for which they are directly responsible and therefore supervise.

Big Reward, Big Effort

Three of the proposed ideas were categorized as having the potential to produce significant improvements in performance, though would require sizeable effort to implement. The first was exploring an alternative to kwik loks, which can malfunction — resulting in the need for rework to correctly close bags and carrots having to be discarded due to spillages.

A second longer-term option was to explore how those varieties of carrots that are preferred by fresh markets, due to their taste and appearance, can be grown in ways that lead to fewer issues when bagging. This would require different growing arrangements to be evaluated using a design of experiment (DOE) methodology. The financial implication would then need to be tested by linking data produced from field trials to the monitoring of packing line performance.²

The impact of monitoring differences that carrots sourced from different regions of Canada, US and Mexico – and different suppliers – had on bagger performance could also be significant. A process would have to be implemented for gathering the CMD required to guide purchasing and pricing decisions. This could be achieved relatively efficiently and effectively, though would take two to three years to produce reliable information that managers could depend upon.

Some Reward, Low Effort

Two ideas (both relating to packaging design) offer some rewards, while requiring a low level of effort to implement. Contacting packaging manufacturers, to enquire about the design and weight of bags based on their suitability for carrots, could lead to a reduction in misfires caused by bags tearing or breaking loose of the bagger head. The other design option was choosing bags with a higher number of smaller sized holes than traditional carrot bags. It was decided that testing the impact of different designs on carrot freshness and shelf life, and their potential impact on customer and consumer perceptions, would not be expensive and could be completed by GF.

Presented below in Table 3 is the action log developed to implement the ideas described above. Each item is described concisely, based on findings that emerged from the process map and cause and effect diagram. Listed alongside each action item is an owner — the person responsible for its completion, the date by when the activity is expected to be completed, and its current status.

² See [here](#) for an example of a DOE that encompassed production and supply chain research. The project utilized DOE methodologies to evaluate the impact of production protocols and supply chain practices on the value of Ontario grown peaches.

Table 3: Action Log

Idea #	ACTION	OWNER	BY WHEN	STATUS
1	Hire full-time bagger operator and continual improvement lead	Owner & Operations	Dec 31	In progress
2	Standard operating procedures for weighing/bagging heads	QA, Operations	Dec 15	In progress
3	Structured management hierarchy	Owners, Sales, Operations	Dec 31	In progress
4	Look at alternative closing mechanism	New Hire, QA, Operations	Feb 28	Begin Jan
5	Carrot production DOE, linked to monitoring line performance	QA, Owner, Operations, New Hire	TBC	N/A
6	Monitoring performance of carrots according to source, variety	New Hire, QA, Operations, Sales	TBC	N/A
7	Contact packaging manufacturers to evaluate bag design options	QA, New Hire, Operations, Owner	Feb 28	Begin Jan
8	Evaluate bags with more and smaller ventilation holes on carrot freshness, market acceptance	Marketing, QA, New Hire, Operations	Feb 28	In progress

The activity log is a living document, meaning that it should be updated regularly.

Conclusions

The project is enabling GF to measurably improve the performance of its packing operations, in particular the performance of its bagging equipment, and is producing results. Among the improvements achieved were opportunities identified by having observed interactions between line staff and the operation of equipment while gathering data required to complete the OEE. Where appropriate, letters from the acronym TIM WOOD are listed alongside the results achieved to date:

- Monitoring overall equipment performance (O², W, D)
- Establishing formal management processes and organizational chart (O², D)
- Improvements to the onion packing line's performance (M, O², D)
- Translation of instructions into employees' first language (T, I, M, W, O¹, O², D)

Method of Analysis

The project/work began with a visit to Gwillimdale Farms (GF) by the VCMI team, to familiarize itself with GF's operations and meet the management team. The development of an OEE monitoring template, along with subsequent visits by VCMI to GF, led to enhancements in the measurement of OEE and the identification of issues impacting performance. Data produced by the OEE was analyzed, then used to guide the workshop session. This in turn led to the development of ideas for capturing the identified opportunities. Implementation and refinement of solutions – including daily management systems – described in the case study is ongoing.

The GF team who participated in the study included

- Owners
- Sales
- Operations
- Quality Assurance
- Marketing

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