

Applying Lean Thinking to the Horticultural Value Chain in New Zealand

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Abstract

A perennial global issue is providing for a rapidly growing world population, without equivalent increase in resources. This problem has led to a growth in interest in lean thinking in many industrial sectors. In New Zealand (NZ), the pipfruit industry set an ambitious target of NZ\$1 billion in exports by 2022. To help enable such a goal, one key government action has been to encourage lean thinking to improve production performance. However, the pipfruit industry has not widely taken up this challenge, possibly because it is not known whether the lean paradigm will suit this seasonal industry, which has a large manual labour component and relies on pushing product into market, contrary to lean principles. Although lean has been successfully implemented in a number of industries, there is little information about implementation in a horticultural context. The aim of this study was therefore to research the concept of lean and its practical applicability in a horticultural setting, specifically the NZ pipfruit industry. The literature review examined transferability of common lean practices to other industries. Consultants were interviewed to assess their views on the suitability of lean to the pipfruit sector, while an industry-wide survey determined the current state of knowledge and lean deployment, using a unique 'single-question-per-day' approach. Case studies, including 'action research' studies, provided rich data from organisations that had started with lean implementation in recent times. This review presents a model for lean in horticulture, and presents pictorial examples of lean practices applied to the value chain.

Keywords: pipfruit, lean, productivity, horticulture, action research

Introduction

A major contemporary issue is the ability to provide goods and services to meet the needs of a rapidly growing world population, with no equivalent increase in natural resources. In the mid twentieth century, Japan (a relatively small country) faced a similar problem in relation to exporting goods to post-war global markets, including the US. Japan's answer was to relentlessly pursue efficiencies in their production system, leading the country to gain a reputation for quality and excellence within a relatively short time frame. One result of this was the Toyota Production System, which served as the progenitor of contemporary lean thinking. In food and agribusiness, most research focuses upon technical and scientific developments relating to products and methods of production. However, given this need for greater efficiencies in the value chain, it is also important to examine production systems and seek improvements in these systems.

In New Zealand, the primary industries, including pipfruit (apples and pears), are gaining in relevance both from the monetary perspective (to increase NZ's export trade) and from the global perspective to provide food for the world's population. Ballard [1] describes NZ as the land of milk and honey with its abundant natural resources, and NZ primary industries account for 72% of New Zealand's total exports at \$30 billion per year [2]. Although a nation of 4.5 million people, New Zealand grows sufficient primary product to feed 40 million people.

With a world population rising from the current 7bn, to 8bn by 2025 and over 9bn by 2050 [3], the sustainable and (by inference) 'lean' use of land and water, and production of food will become increasingly important in the growing global environment. The NZ government and industry bodies have therefore set ambitious strategic performance targets that need re-thinking of 'the way we do things' [4,5].

In its Business Growth Agenda, the NZ Government has set an export growth target of 40 % by 2025. In order to achieve such growth, the government is investing a further

\$100 million per year over the four years starting 2013 as part of its Internationally Focused Growth Package. The government is already investing in business development with a number of programmes.

New Zealand Trade and Enterprise (NZTE), as the NZ government's national economic development agency, introduced several business improvement programmes including its '*Beachheads*', '*Better by Capital*', '*Better by Design*', '*Better by Strategy*' and '*Better by Lean*' programmes, as well as a number of other initiatives. Each programme targets specific business concerns, ranging from raising capital or arranging networks to improving performance.

Starting in 2005, NZTE initiated several programmes specifically based on the lean paradigm, including its *Aichi, Lean Direct* [6] and the current '*Better by Lean*' programmes. The expectation was that adoption of the lean paradigm potentially offers advantages that will create a better fit for industries in the global drive for improved performance, eliminate inefficient processes and activities, and satisfy the customer in both production volume and quality. Beginning in 2005, NZTE has been supporting the founding and coordination of regional lean clusters—clusters of companies who implemented lean and seek exchange of information to help them progress lean. This strategy for encouraging collaboration and innovation is proving effective in many countries and sectors [7].

'Lean production' has been claimed to be the driving factor behind the growth of the Toyota Motor company. In the classic book identifying lean production, 'The machine that changed the world' [8], the authors state that the principles of lean production can be applied equally in other industries across the globe:

"In this process we've become convinced that the principles of lean production can be applied equally in every industry across the globe and that the conversion to lean production will have a profound effect on human society – it will truly change the world" [8].

The aim of this study was to research the concept of lean, its theoretical 'fit', and practical applicability in a horticultural setting, specifically the New Zealand (NZ) pipfruit industry. The study's objectives were:

1. Identify common theoretical themes for the lean philosophy, methods and tools, that are not industry or contextually bound and that may be transferable to the pipfruit industry.
2. Identify and analyse the current lean deployment within the NZ pipfruit industry.
3. Analyse the applicability and any implementation approaches of the lean philosophy, methods and tools within the NZ pipfruit industry.
4. Develop a conceptual lean model for the NZ pipfruit industry and consider if the model is applicable to the wider horticultural sector.

Literature Review

Lean Manufacturing

The concept of lean manufacturing was arguably introduced to the world in a key article [9] and the aforementioned book, which became ‘a management classic’ and one of the most cited references in operations management [10]. Forty years of lean articles followed, with lean being gradually tested outside the world of manufacturing. Stone [11] refers to the emergence of lean as the final part of the discovery stage, the first of five stages deduced from research in lean over a period of forty years of literature. In his view, lean was next disseminated; implemented at strategic levels; expanded to other industries; and finally measured—a gradual evolution of the new paradigm. Stone’s review shows that lean - as a paradigm – has stood the test of time, and is now relevant in many more ways than it was intentionally designed for.

Various models have been developed to explain or conceptualise lean, and to help others apply it. One of the most pervasive, and simple models equates to the 5 lean principles originally promulgated by Womack and colleagues [8]. These are as follows:

1. Value: Understand value as the customer defines it.
2. Value stream: Understand and map the value stream
3. Flow: Make the value ‘flow’ (e.g. by eliminating unnecessary waste)
4. Pull: Produce only what is ‘pulled’ by customer / market demand.

5. Perfection: Continually apply the above 4 tenets towards achieving perfection in the process.

The horticultural and pipfruit sector

A review of writings on the pipfruit industry in NZ and horticultural sector in general, revealed a number of sectoral idiosyncrasies. The industry, and to some extent horticultural industries in general, can be summarised as shown in table 1.

Table 1: Key characteristics of the NZ pipfruit industry

Customer / consumer
<ul style="list-style-type: none"> • <u>Customers</u>: Customers include category managers, supermarket chains and floor traders • <u>Consumers</u>: End-consumers are people of all gender, ages and economic and social levels • <u>Taste</u>: Consumer taste is substantially culturally bound
Product
<ul style="list-style-type: none"> • <u>Product development</u>: Development of a new variety can take between 12 and 15 years • <u>Commercialisation</u>: Growing sufficient supply involves producing enough to cope with customer demand and can take a minimum of 10 years to build up • <u>Volume/cost relation</u>: Pipfruit is a high-volume, low-cost product, satisfying basic human needs • <u>All year every-day supply</u>: Customers and thus consumers expect to be able to supply and demand the product every single day of the year; note a northern and southern hemisphere aspect to be present • <u>Shelf life</u>: Pipfruit has a forced customer life cycle of close to one year, with an effective cool-chain • <u>Variety</u>: There are hundreds of existing varieties, mostly with subtle differences • <u>Variability</u>: Seasonal and natural circumstances create variability in the product
Processes
<ul style="list-style-type: none"> • <u>Main process</u>: The growing process cannot be stopped once in progress • <u>Product change-over</u>: Growing a new product takes a minimum of around eight years • <u>Seasonal processes</u>: Processes are substantially determined by seasonal conditions • <u>Decision making</u>: Many decisions are based on complex growing process and weather pattern combinations and thus challenging to standardise • <u>Assembly and disassembly</u>: Product is grown, converged into a bin, disassembled and reassembled in a packhouse • <u>Just-In-Time</u>: Does not apply to growing fruit but can be implemented at subsequent steps
Resources
<ul style="list-style-type: none"> • <u>Infrastructure</u>: Growing land and coolstores and packhouses • <u>Manual labour</u>: Large temporary workforce, mostly unskilled • <u>Equipment</u>: Variety of orchard, packhouse and coolstore equipment
Logistics
<ul style="list-style-type: none"> • <u>Distance to market</u>: Distance to market is substantial; all transport includes ships, costing time • <u>Push/pull</u>: Supply and demand is both push and pull with relative predictability • <u>Inventory</u>: Inventory building from ISO week 6 to ISO week 20-24, then gradually subsiding • <u>Market access</u>: Regulatory restrictions determine where fruit can be shipped
Seasonal influences
<ul style="list-style-type: none"> • <u>Forced actions</u>: Seasonal component forces actions • <u>Activity periods</u>: Different activity periods in different segments of the industry • <u>Weather</u>: Weather has a significant impact on required actions, quality and quantity of fruit

Many of these characteristics impact adversely on the applicability of lean as defined earlier. For example, fruit ripens at one time in the year, and so product cannot easily

be ‘pulled’ by market demand. Product development lead times are very long, and keeping inventories is a necessity. Consistency is hard to achieve (weather is a big factor). Distance to market implies that transportation lead times are long, and labour is highly seasonal, with unskilled labour being flown into NZ to help with harvest.

Materials and methods

To investigate the applicability of lean in pipfruit, the following major stages and methods were adopted in this study, as has been more fully described in [12].

1. Literature review: The literature review was used (as is usual) to determine whether existing models of lean could be applied to the pipfruit sector without modification, or whether a new conceptual model needed to be developed. The latter was the case and a conceptual model was developed.
2. Key informant interviews with, and a survey of, lean consultants in NZ: A search found 26 consultants actively engaged in helping organisations with lean. It was considered useful to interview all of them, using a questionnaire that could be mailed to those who could not be interviewed.
3. A survey of industry players: This survey included all major entities from the value chain, and was developed based on Kobayashi’s ‘20 keys’ set of criteria for effective lean implementation [13], and 20 key lean methods and tools. From a population of approximately 555 organisations (approx. 400 growers, 65 pack house/coolstores, and 90 exporters) the stratified sample shown in table 2 was selected. The survey was mailed using an innovative approach of mailing one question per day, allowing a response within one minute. Pipfruit industry managers being busy people, this meant they would be more likely to respond, than receiving all questions at one time of a survey questionnaire. Survey fatigue is a major issue in management research, and New Zealanders are often suspicious of overly ‘academic’-looking models and questionnaires.

Case studies: To elicit rich, qualitative data on lean implementation, it was considered necessary to augment the quantitative survey data with more in-depth case studies. Since lean was beginning to be implemented by some organisations in the industry, a

good approach would be to study the process of implementation longitudinally and temporally (over time). The second author/principal researcher, himself a consultant to the NZ pipfruit industry, had a role in advising these organisations on how lean could or should be implemented in a sustainable way. Since he was effectively influencing the system and the outcome, action research (AR) was deemed the appropriate methodology to use in these cases. AR involves a cycle of intervention, observation and reflection / reflexivity [14]. The resulting cases are as summarised in table 3.

Table 2: Distribution of sample by industry activity

Membership position	Number
Grower (dedicated)	71
Packhouse/coolstore	2
Grower/packhouse/coolstore	24
Packhouse/coolstore/exporter	3
Grower/packhouse/coolstore/exporter	14
Exporter (dedicated)	18
First tier supplier	5
First tier customer	3
Total	140

Table 3 Qualitative data collection

Method	Organisation	
Standard case study	Pack house	Pack house
Action research case study	Orchard	Pack house

Results and discussion

Twenty-one (21) consultants agreed to answer questions, giving roughly an 80% response rate. It emerged that only two have actually direct experience of the pipfruit sector. The consultants believed that philosophy of lean was more important than tools, and that standardization, training and visual management could be readily applied to the

horticultural sector. They felt that only around 1% of the sector could be considered 'seriously lean', and many felt that engaging management was a major problem.

Of the industry-wide respondent survey, the response rate was just over 25%. The average industry response in relation to the degree of application of 20 key lean tools is shown as the lower, blue line in figure 1. This shows a low level of lean understanding / application within the sector as a whole, at the start of the study (2012).

In relation to action research case organisations, improvement was reported and observed during the course of the lean implementation. One example from the data is shown below (figure 1), where the green and red dots indicate the relative shift in adoption of lean principles over the course of the implementation as at 2013 (red dots) and 2014 (green dots). Similar changes were observed in the use of 20 key lean tools.

General findings from the entire study are now summarised below, arranged according to the five tenets of lean thinking as were outlined earlier:

Value definition: The pipfruit value chain involves picking the fruit from a tree, sorting and grading, packaging, cool-storing and transporting to the point of retail. A major aspect of value in a horticultural value chain is prevention of the destruction of value, i.e. ensuring the fruit is processed and transported without undue deterioration. The supply chain is configured so as to allow for some further ripening to take place post-harvest, i.e. some value is added after the fruit is removed from the tree, besides the obvious value addition of moving the fruit to the point of consumption. Fruit delivered in ideal condition to the intended market represents one aspect of value, while damaged or unfit fruit used for other purposes (downgraded, used in sauces or animal feed) is another market.

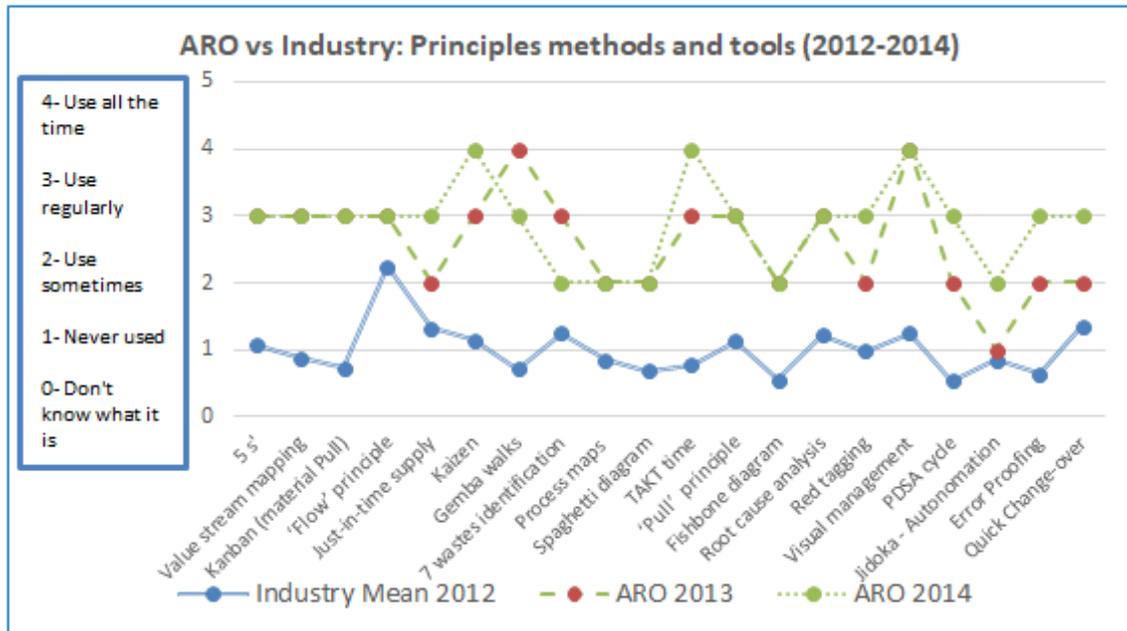


Fig. 1: Action Research orchard (ARO) scores vs industry mean scores

Value Stream mapping: A major issue identified was a lack of integration in the supply chain. The flow of information in the chain was not fully effective, with market information not always being delivered back to the growers and other elements. A major requirement of JIT based systems has always been the provision of accurate and timely market data, which enables demand to be met with minimal waste. It was found that exporters were not as willing to be involved in the research as the more 'physical' entities, perhaps seeing less relevance to their operations. Yet exporters provided a critical point of contact between markets and industry actors.

Flow: Promoting flow relates to adopting lean tools and methods to enable value to be maximized in the value stream, and waste removed as a consequence of this. A number of lean thinking approaches were identified. In the orchard operation, the tree can be viewed as the 'machine' producing the product. Lean thinking advocates total productive maintenance (TPM) of such vital equipment. In pipfruit, this was found to represent effective and standardised pruning. Pruning trees prior to the growing season is essential to optimize the yield, prevent rot and ensure correct fruit size. In the packhouses and cool stores, lean was applied in more standard ways, though visual management, 5S exercises, continuous improvement team meetings, consideration of layout and product flow and so on.

Pull: It has been mentioned that horticultural industries such as pipfruit produce product in batches (since ripening takes place at one time of the year). This is the greatest challenge when thinking about lean in such sectors. Another challenge was the significant lead time involved in developing new products. For example, if a new variety of apple is requested by an overseas market, it may take some years to develop the desired characteristics, and then seven to eight years for the trees to mature sufficiently to produce fruit. Thus, achieving real-time ‘demand-pull’, or one-piece flow, is not practical. However, with a well-integrated supply chain the time to market can still be continually improved, as all international competitors face the same lead time challenges.

Perfection: In relation to the on-going improvement of the system, a self-assessment ‘questionnaire’ was developed that growing organisations in the sector could use to chart their progress against lean. This instrument and its development were described in [15]. The instrument allows organisations to monitor and improve their progress against key lean principles, tools and methods.

Conceptual model: Finally, the findings revealed that lean theory has sufficient fluidity and adaptability for lean methods to be applicable to the horticultural sector. Some adaptation is required to the specific methods and tools, but the underlying 5 principles can be applied. The conceptual model developed from literature was adapted through the findings to produce the model shown in figure 2, which was fully discussed in [16]. On the left is the customer, whose value proposition pulls the product from the production system (arrow facing towards product). However, there is also by-product, which is ‘pushed’ into the market and accepted by other customers (e.g. fruit that does not need the exact standards of the primary customer). Right hand side of the model shows that pipfruit consists of process and labour that are both ‘stable’ (year-round), and seasonal (periodic). The ‘belief system’ of lean involves engaging the workforce (people) in lean practice, towards the on-going improvement of the system (hence the thick ‘arrow in the ‘belief system’ circle).

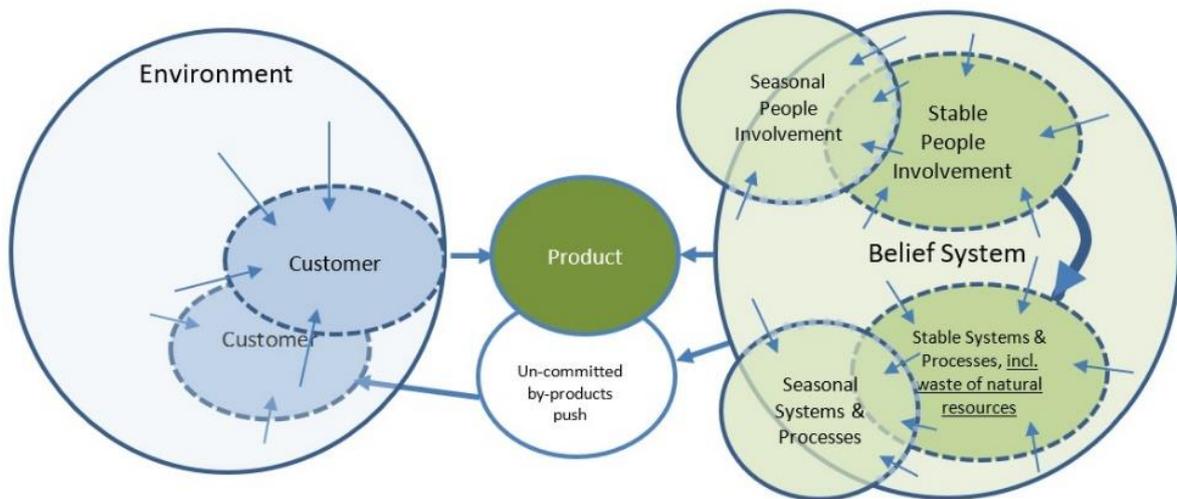


Fig. 2. Pipfruit Industry Lean Model

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