Application of Lean techniques to dairy farming

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Abstract: *The combined contributions of people and efficient processes is central to the long term success of livestock farms. Lean production is business philosophy focusing on organisational effectiveness through waste reduction and improving productivity. Although widely used in other industries, there is limited research on the effectivenss of Lean principles to increase labour efficiency on dairy farms. Therefore the obective this case study was to apply Lean principles to Irish dairy farms to remove waste and increase labour efficiency. Two studies were used to evaluate the applicability of Lean principles to dairy farming. The Dairygold Co-Operative pilot programme involved 15 farmers completing a self-assessment of kilometres walked and typical working day length before and after the programme. Initial training on Lean techniques and tools was provided. The core tools used were visualisation, standardisation, 5S, problem solving and identification of wastes (TIMWOODS). Data from a subset of 76 farmers invovled in a separate time-use research study was also used to determine if implementing Lean practices saved farmers time compared to similar farms which had not undertaken the programme. Over the 6 month period of the pilot prgramme, there was a saving of 18 work days and a €1,440 reduction in costs across the 15 farms. Farmers also walked 116 km less as a result of having more efficient practices. Similar to the Dairygold pilot study, Lean was also proven to be effective at reducing the time needed to complete tasks in the time-use study with 'Lean' farmers working fewer hours (7.6 h/ day) compared with 'not Lean' farmers (9.7 h/day; P<0.001). 'Lean' farmers spent significantly less time on milking, administration and repairs and maintenance (P<0.001). The results of this study demonatrate that Lean principles can be effective in improving labour efficiency on Irish dairy farms. The application of Lean principles on-farm can reduce working hours and physical workload as well as delivering improvements in safety while having a significant positive impact on farmers' quality of life and mental wellbeing.*

Keywords: *lean management, workload, dairy farming, labour efficiency*

Introduction

Farm structure in the developed world is undergoing a major structural shift as herd size increases, changing from traditional family farms to small business structures with an increased requirement for skilled labour (Hadley *et al.*, 2002; O'Donovan *et al.*, 2008; Deming *et al.*, 2018). Labour input is one of the four main resources employed in any business. The contributions of people are central to the success of livestock farms and the efficient use of people time is of paramount importance. Increasing efficiency in the most time consuming business tasks will positively impact on overall business efficiency. There are two ways of increasing work efficiency; by increasing output or removing waste and working smarter. Often increasing output is associated with an increase in labour usage and given that labour is limiting on many farms, reducing the workload whilst maintaining or improving productivity is the preferred option. However, the challenge is to reduce labour input on dairy farms without negatively impacting on productivity or product quality.

Seasonal pastured-based milk production systems are characterised by the compact calving pattern designed to maximise the utilisation of grazed grass (Roche *et al.*, 2017). High utilisation rates of this cheap feed source (Finneran *et al.*, 2012) make this system highly profitable (Dillon *et al.*, 2005; Peyraud *et al.*, 2010), but it creates an unbalanced workload for farmers. Deming *et al.* (2018) reported that up to 57% of the annual workload occurs during spring and summer. This unbalanced workload means farmers often have a higher demand for seasonal workers than full-time employees. However, it can be challenging for farmers to recruit seasonal staff for short periods of intense work often with long working days and unsociable hours (Ní Laoire, 2002) and farms are often reliant on unpaid help (Hostiou and

Dedieu, 2012). In addition, inadequate work practices on many farms may inflate the requirements for labour input. Therefore improving work practices and efficiency during the busy spring period may reduce the requirement for labour input on farms.

The original Lean concept dates back to around 1910 and was later popularised by Toyota (Womack *et al.*, 1990). Lean production is a Japanese approach to management that focuses on eliminating waste which are any elements of activity that add time, effort or cost but which do not add value whilst ensuring quality. Lean was previously seen as a collection of tools and techniques, but it is now widely recognised as a fundamental business philosophy. It has been modified and applied to several industries, such as construction, healthcare and software. There are some examples of the practical application of Lean to farming in the UK (AHDB, 2014), in New Zealand (FarmTune®) and elsewhere. The application of Lean principles to dairy farming could improve work practices thereby increasing overall labour efficiency and maintaining or even improving farm performance (AHDB, 2014). Therefore the objective of this case study was to apply Lean principles to Irish dairy farms to remove waste and increase labour efficiency.

Method

Two studies were used to demonstrate the applicability of Lean to dairy farming. The Dairygold pilot study was a small scale study where Dairygold Co-Operative offered a short training programme on Lean to 15 dairy farmers to determine the benefits of implementing Lean principles on their farms. A separate time-use research study was completed in 2019 by Teagasc, the national agricultural research agency, to determine if implementing Lean practices saved farmers time compared to similar farms which had not undertaken the programme.

Dairygold pilot study

Dairygold Co-Operative society is located in Munster, Ireland with approximately 3,000 milk suppliers. In 2017, following the success of a five year Lean programme at factory level, a decision was made to extend this to Co-Operatives dairy farm suppliers. The ultimate goal was to establish a self-sustaining lean programme. To understand how Lean would apply on a dairy farm, how it could be deployed to a large number of farms and what benefits may result, a Lean farm pilot programme was established with 15 farmers. The average Dairygold supplier delivers 5600 litres of milk per year. Any surplus calves that are not required as replacements for the dairy enterprise or the beef enterprise (if present on the farm) are sold to neighbours/ mart. To comply with Department of Agriculture guidelines, calves are not sold before they are 10 day old. The pilot farmers average herd size was 120 cows and ranged from 90 to 179 cows. Before and after the programme, the farmers completed a self-assessment of kilometres walked using a health app on their smart phone. Farmers also completed a self-assessment of their typical working day length by completing a timesheet indicating their typical start, finish a break times. Initial training on Lean techniques and tools were provided. The farmers were then guided and supported by Dairygold Lean coaching staff and Milk Advisors to implement Lean practices. The core tools used were visualisation, standardisation, 5S, problem solving and identification of wastes (TIMWOODS). Visualisation is about making key information about the business available to those who work on the farm ensuring that they are clear in respect of what the business needs to achieve on any one day. Standardisation documents the one best way for carrying out a task. A documented/structured approach ensures consistency and drives efficiency. 5S refers to organisation and ensures there is a place for everything and everything is in its place. This leads to a safer work place with less time searching for things. Problem solves is a structured way to ask questions to identify improvements that deal with the

causes and of underperformance and not its symptoms. It allows for a permanent solution to be put in place based on facts. TIMWOODS is a process to identify, reduce or eliminate activities that are not adding value to the farm. At the end of the programme the pilot farmers met as a group to review the results and to discuss the successes, failures and challenges of implementing Lean on their farms. To evaluate their experiences of the pilot programme, the farmers completed a questionnaire after the programme finished. Descriptive statistics were performed using JMP (SAS, 2016) to determine the benefits observed from applying Lean practices.

Time use study

A separate study involving 82 Irish farmers recording their time-use in real-time was conducted in spring 2019 (Hogan *et al.*, 2020). The objective was to benchmark labour efficiency on Irish spring calving herds. Herd sizes ranged from 49 to 382 cows. For a more detailed description of the time-use study, refer to the paper by Hogan *et al.*, published in the proceedings of this conference. A smartphone app was developed to allow farmers to record labour data in real-time by starting and stopping the app's stopwatch recording for designated tasks on-farm on one day per week on alternating days (Monday to Saturday). There were 10 tasks ('administration/ business', 'breaks', 'calf care', 'cow care', 'feeding', 'grassland management', 'heifer care', 'milking', 'other enterprises' and 'repairs & maintenance') listed in alphabetical order in the app that the farmers could choose from at any one time (Hogan *et al.*, 2020). For this analysis, a subset of 76 of those farmers and any farm staff that recorded their time-use on the app between 21st January and 31st March (11 recording days) were selected. Any farmers missing data for the January to March period were excluded therefore 76 farmers were retained for analysis. Farmers were categorised as 'Lean' (n=5) or 'not Lean' (n=71) based on information supplied. Average herd size for the 'Lean' farmers was 171 cows (ranging from 84 to 290 cows) and 139 cows for the 'not Lean' farmers. Standard *T*-tests were performed to determine if the differences between 'Lean' and 'not Lean' farmers for hours worked per day and task duration using JMP (SAS, 2016). Statistical differences were considered significant using a 0.05 significance level.

Results

Dairygold pilot study

	Before Lean pilot programme				After Lean pilot programme			
	Mean	Standard deviation	Max	Min	Mean	Standard deviation	Max	Min
Length of the working day (Hours / day)	11.7	1.27	13.8	8	11.3	1.23	13.3	7.8
Distance walked (km)	11.6	1.59	14.3	9.1	11.3	1.54	13.9	8.7

Table 1. Self-assessment of the length of the working day and kilometres walked per day by the 15 farmers participating in the pilot Lean programme.

Table 1 presents the length of the working day (h/ day) and the distance (km) walked by the pilot farmers before and after participating in the programme. On average the length of the working day was 11.7 h/ day and farmers walked 11.6 km/ day before the programme. As a result of participating in the programme, farmers worked 24 minutes/ day less and walked 283 metres/ day less, on average. Over the 6 month period, there was a saving of 18 work days and 116 km of walking as a result of having

more efficient practices which corresponded to a reduction in costs of €1,440 per farm across the 15 farms. In the pilot study, 93% of farmers saw improvements in safety and all would recommend the programme to other farmers.

Time-use study

'Lean' farmers worked 7.6 h/ day on average with an average task duration of 50.2 minutes compared with 9.7 h/ day with an average task duration of 59.5 minutes for the 'not Lean' farmers (P<0.001). 'Lean' farmers spent significantly less time on 'milking', 'administration/business' and 'repairs and maintenance' (P<0.001; Figure 1). There were no significant differences between farmers for 'calf care', 'cow care', 'feeding', 'grassland management', 'heifer care', and 'other enterprises' (Figure 1).

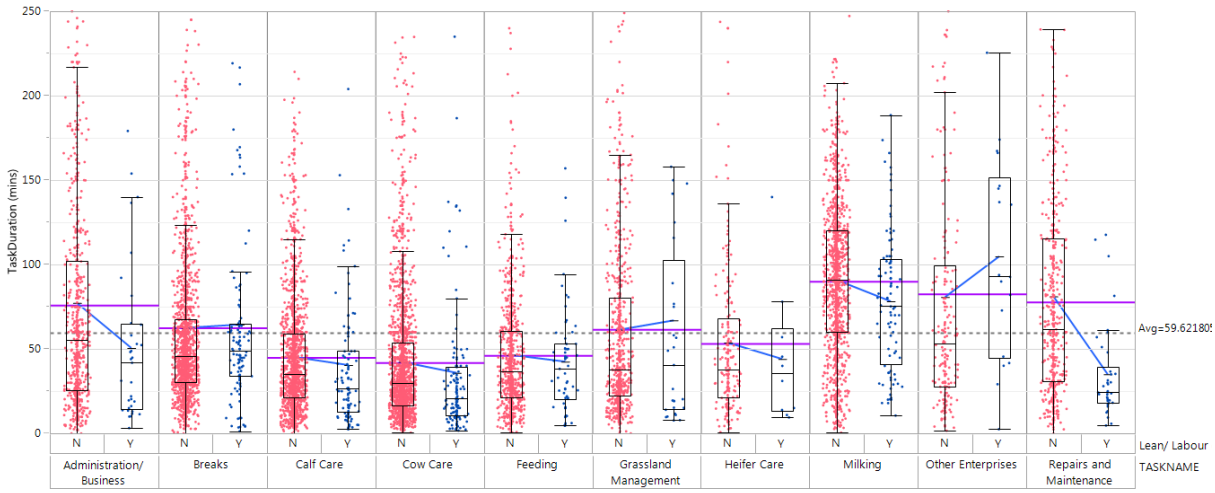

Figure 1. Time (minutes) spent at various tasks by farmers categorised as either 'Lean/ labour efficient' (Y) or 'not Lean' (N) on days when farmers recording their time-use in February and March 2019.

Discussion

The dairy industry is often perceived as an unattractive career because of poor working conditions including long working hours (Porter *et al.*, 1993; Beecher *et al.*, 2019). The challenge for dairy farmers is to reduce working hours and labour input without negatively affecting output or product quality. In this regard, Lean principles may be useful as the Lean philosophy promotes a vision of continuous improvements which aims to achieve a better and sustainable future (Liker, 2009). This study provides insights into the application of Lean principles to improve labour efficiency on Irish dairy farms.

Similar to the Dairygold pilot study, Lean was proven to be effective at reducing the time needed to complete tasks in the time-use study. A limitation of the Dairygold pilot study was that farmers completed a self-assessment of their hours worked. On pastured-based dairy farms, milking is the most time consuming task accounting for between 33% and 57% of the overall workload (Taylor *et al.*, 2009; Deming *et al.* 2018). Deming *et al.* (2018) reported that efficient dairy farmers spent 7.2 h/ cow per year on 'milking' tasks, however there was a difference of 4.12 h/ cow per year between the 25% most efficient and 25% least efficient farmers. In the present study, 'Lean' farmers spent significantly less time at 'milking' which included herding, milking and wash-up than 'not Lean' farmers. Having adequate

capacity in the milking parlour, a sufficient number of milking units and a good milking routine contribute to having an efficient milking process (O'Brien *et al.*, 2012). Increasing efficiency in the most time consuming area of the business will positively impact overall business efficiency as seen in the time-use study as 'Lean' farmers worked fewer hours compared with 'not Lean' farmers. Although some the daily savings were small in the pilot programme, these savings accrued to 18 days of work for the full 6 month study period.

Dairy farm systems are complex businesses which require significant management time on office work and administration (Deming *et al.*, 2018). In the present study, 'Lean' farmers spent significantly less time at 'administration/ business' tasks compared with 'not Lean' farmers suggesting that they may have more efficient processes. In a time-use study of labour efficient dairy farmers, they spent 2.1 h/ cow per year on management tasks which included office/ business work, advisory tasks and trading stock (Deming *et al.*, 2018) while farmers in the current study spent 62 minutes on average at 'administration/ business' tasks. One possible way to improve the efficiency of office and administration tasks is to use technology. Rose *et al.* (2016) identified that recent developments in smartphone technology and access to mobile internet and cloud services have led to an increase in the number of smartphone apps supporting farmers' decision making.

There are a limited number of studies which report the time farmers spend at 'repairs and maintenance' tasks. Taylor *et al.* (2009) reported that farmers spent 11% (354 hours) of their total annual workload on 'repairs and maintenance' compared with 5% in a study by Deming *et al.* (2018). However, Deming et al (2018) did not include repairs in their definition of 'maintenance' tasks and studied only efficient farmers which may account for some of the differences between the two studies. In the present study, 'Lean' farmers spent less time on 'repairs and maintenance' tasks compared with 'not Lean' farmers in February and March. One of the key principles of Lean management is the identification and removal of wastes; defects are one of the eight wastes. A defect can include the failure to maintain equipment, machines and fixtures allowing breakdowns to occur. Farmers adjust their workloads according to the availability of workers and season (Hostiou and Dedieu, 2012). Therefore it is possible that 'Lean' farmers spend less time on 'repairs and maintenance' during the busy spring period when routine work accounts for most of the day. Instead farmers may have had more control regarding when 'repairs and maintenance' needed to be done and could potentially concentrate on 'repairs and maintenance' work during less intense work periods.

There was large variation in the amount of time spent at each task between farms, with more variation for 'not Lean' farmers compared with the 'Lean' farmers possibly due to the smaller number of 'Lean' farmers. Time-use studies have also demonstrated that large variation exists between farmers regarding work task durations (Deming *et al.*, 2018, Hostiou *et al.* 2015). The large variation demonstrates that labour efficiency is a complex topic. There are many factors that contribute to the complexity including farm facilities, practices and work organisation that are often specific to the farm. However, the large variation also indicates that there is scope for many farmers to reduce the amount of time spent at tasks. It is worth noting that many of the 'not Lean' farmers were as efficient as the 'Lean' farmers. Lean provides a systematic structure for the identification and removal of wastes (Veres *et al.*, 2018) as well as a focus on a better organised work pattern. However, it is possible that many of the 'not Lean' farmers already had good works organisation habits in place and may have already been implementing some Lean management practices without realising it. On that basis, Lean management might be most suited to farmers who require a more structured approach to reducing their labour input.

The pilot farmer group identified 5S, Visualisation and Standard Work as being the most initially beneficial Lean tools. 5S represents Japanese words that describe the steps of a workplace organisation process. Visualisation aims to make the situation easily understood merely by looking at it while Standard Work (standard operating procedures) establishes the best and most reliable methods and sequences for a process. Before the pilot study, no farms used standard operating procedures whereas all farms used standard operating procedures after the pilot study. Having standard operating procedures ensured fewer mistakes or missed steps during a process because step by step instructions are provided which act as guidelines to the user (Amare, 2012), meaning tasks are performed to a high standard consistently (Stup *et al.* 2006). 5S gave structure and tidiness to the farms as a result of clearing out the unnecessary items, and creating places for the relevant items. Similarly previous research found that 5S increased productivity and because the workplace was cleaner, it created a safer work environment (Veres *et al.*, 2018).

Kilpatrick and Jones (2003) describe successful training programmes as ones where training is combined with discussions with experts and/or fellow farmers and followed up with contact with individuals as the change was actually put in place in the farm business. This was the model used in the pilot programme and could be a reason for the high level of endorsement of the programme by the farmers. The language used by the trainers is important as farmers prefer simple and easy to understand terminology (Kilpatrick *et al.*, 1999). Modifying the Lean terminology used in 'factory settings' to terms more commonly used on the farm and to use farmers as coaches were two important factors identified by the pilot group as key aspects to develop a sustainable large scale farmer led Lean programme.

Conclusion

In an increasingly competitive environment and with increasing on-farm workload during expansion, it is necessary to manage the farm's processes more efficiently. The application of Lean principles on-farm can reduce working hours, physical workload and costs while simultaneously delivering improvements in safety and having a positive impact on farmers' quality of life and mental wellbeing.

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