Work organisation in dairy farms: work durations, changes of practices and precision livestock farming.

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Moorepark Dairy Levy Research Update

International Agricultural Workforce Conference

Radisson Blue Hotel, Cork

Tuesday 10th July, 2018

Series 36

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Foreword

The dairy industry is the most strategically important indigenous sector of the Irish economy. Driven by increased production and higher dairy market returns, Irish dairy exports increased to €4.02 billion in 2017 about one third of total Agri export value and over half of the national beef output is from the dairy industry. However, the industry faces a big human capital challenge as increased scale has been the major driver of increased output with nearly half of all dairy cows are now milked in herds of >100 cows which has been a significant structural change for the industry. Teagasc has identified farm labour as one of the major limitations to the further growth of the dairy industry. However, many dairy industries globally have faced this challenge previously and for that reason, we have organised this conference with international experts, to identify solutions and strategies to overcome the challenges faced by the Irish dairy industry as it continues to grow and deliver real value for the Irish rural economy.

ICOS is delighted to sponsor this important conference, which will help family farm businesses become better and more efficient places to work. At farm level, we have seen great advances in terms of productivity, efficiency and milk quality in recent years. Globally, the environmental metrics of Irish agriculture and the economic value of the dairy industry to Ireland are unrivalled. That said there are a number of challenges we need to address including encouraging new entrants into dairy farming and becoming active members of their co-operative businesses. For a farm to be truly sustainable, the farming enterprise must have a viable future that includes protecting the human capital on which it relies.

Focus needs to be placed on providing a good work environment for all personnel and a good work:life balance, while at the same time optimising profitability and sustainability of dairy farm systems. All of these topics will be discussed at the International Agricultural Workforce Conference.

Teagasc and ICOS welcome you to this conference.

Agenda

08:30 Registration and refreshments

09:15 – 9:40 Opening and introduction
— *Prof. G. Boyle (Teagasc)*

Session 1: Putting in context International and Irish farm labour situations

Chaired by TJ Flanagan, ICOS

09:40 – 10:05 International trends in farm labour demand and availability
— *A/Prof. Ruth Nettle, University of Melbourne, Australia*

10:05 – 10:25 Irish studies on farm labour issues
— *Dr. Bernadette O'Brien, Teagasc*

10:25 – 10:45 Irish dairying – rapid expansion, structural change and future plans
— *Mr. Paidi Kelly, Teagasc*

10:45 – 11:15 Discussion

11:15 – 11:45 Break and refreshments

Session 2: Labour efficiency

Chaired by Prof. Jim Kinsella, UCD

11:45 – 12:05 Work organization and productivity
— *Dr. Priscila Malanski*

12:05 – 12:20 Using LEAN principles to improve labour efficiency on dairy farms
— *Mr. Pat Ryan and Mr. Patrick Shine*

12:20 – 12:45 Panel discussion with Dr. Hostiou (*INRA*), Dr. Marion Beecher (*Teagasc*), Mr. Joe Ahearne (*Leading Edge*), Mr. John Paul Murphy (*Dairygold*), Mr. Pat Ryan and Mr. Patrick Shine

12:45 – 14:00 Lunch

Session 3: Milking technology and process efficiency

Chaired by Mr. Eddie O'Donnell, Co. Tipperary

14:00 – 14:30 Factors impacting on milking efficiency
— *Dr. John Upton, Teagasc*

14:30 – 14:50 A herringbone or rotary milking parlour? – A farmer's perspective
— *Mr. Pat Hickey*

14:50 – 15:20 Discussion

15:20 – 15:35 Break and refreshments

Session 4:	People management on dairy farms *Chaired by Dr. Tom O'Dwyer, Teagasc*
15:35 – 16:05	Lessons from a rapidly expanded industry in New Zealand — *Dr. Callum Eastwood, Dairy NZ, New Zealand*
16:05 – 16:25	Study of dairy human resource management practices — *A/Prof. Ruth Nettle, University of Melbourne, Australia*
16:25 – 16:40	Effective management of staff time and well-being – A farmer's perspective — *Mr. Mark Cassidy*
16:40 – 17:00	Discussion
17:00 – 17:15	Conference close and take home messages

International trends in farm labour demand and availability (and what it means for farmers, advisers, industry and government)

Ruth Nettle

Rural Innovation Research Group, University of Melbourne, Australia

Summary

- The ability of agricultural industries to attract the people they need to sustain themselves is a concern shared in most industrialised nations.
- The dynamics of farm labour organisation and demand need to be considered.
- Agricultural sectors need to be proactive when it comes to farm skills and the future workforce.
- Farmers around the world need to develop their own workforce strategies, and these will intersect with the decisions of family members; the farm's innovation strategy (e.g. investment in new technology/ labour saving technology) and will require a broadening of the farms 'traditional labour pools' to attract and develop the new skills sought.

Introduction

This paper outlines the main trends and forecasts in farm labour demand and supply in some industrialised nations. The paper concludes with considerations for farmers, agricultural industries, farming communities and government in responding to what are fundamental shifts in the future of work more generally.

What's changing?

The ability of agricultural industries to attract the people they need to sustain themselves is a concern shared in most industrialised nations. However, the underlying reasons for this are a result of a confluence of factors whereby farm workforce changes intersect with wider economic and social processes locally and globally:

- Changing career trajectories and lifestyle expectations of young people.
- Changing work patterns both amongst women and in the structure of the farm workforce more generally.
- Large growth in the 'services' workforce in the economy (consider farm advisers, contractors).
- An ageing farm workforce and low rates of recruitment of young people into farm careers as well as urbanisation and overall structural ageing in many countries.
- Structural change in agriculture leading to an on-going decline in the number of farm businesses.
- A weakening of the tradition of family succession and higher entry costs into farming (e.g. from higher land values/larger farms).

- The relative attractiveness of agriculture in comparison to other careers.

(adapted from: Santhanam-Martin and Nettle, 2015)

In many countries, this has resulted in reduction in the family workforce as a proportion of the total farm workforce, more reliance on hired farm labour and an increase in casual (temporary), contract and seasonal workforces, including from overseas (Nettle, 2015; Nye, 2018). The substitution of capital for labour (i.e. labour-saving technologies), and the need for flexibility, given the dynamic nature of agricultural production/seasons and markets, also relate to changes in farm workforce organisation. On top of these trends, large-scale regional or local labour market trends can impact farm workforce structures. For instance, in Australia, the impact of the mining boom (2006-2015) on regional workforces created a crisis in agricultural workforce supply in some sectors, which generated the more rapid introduction of labour replacing technologies and introduction of short-term/seasonal and skilled migration policies (Nettle *et al.,* 2018).

What are the labour market trends?

The decline in the total agricultural workforce over the last 2 decades co-existing with current skills and labour shortages in agriculture in many countries needs some explanation. The dual trend of reduced total labour requirements but more reliance on hired farm labour as a proportion of the farm workforce is reported in most developed countries (Findeis, 2002). For instance, 57% of the farm workforce is in the 'hired-worker' category in France (European Commission, 2012). Over 20 years, in developed economies the total workforce has declined by 50% and now holds a share of less than 5% of total employment in these countries (Table 1).

Table 1. Employment in agriculture, by region as share of total employment

Region	1991	2013	% Change
World	44.5	31.3	-29.7
Developed Economies & EU	6.9	3.6	-47.8

Source: ILO, Key indicators of the labour market Geneva, 2014

Yet agricultural sectors in industrialised countries report an agricultural workforce crisis. The apparently confounding situation can be explained by looking at what is occurring outside of agriculture. Firstly, the OECD employment outlook reports that the increasing pace of change, uptake in technology and globalisation are disproportionately affecting 'mid-skill/mid-pay workers', such as those in manufacturing (OECD, 2013). Secondly, global business analysts predict 20 years of a 'skills scarce world' (McKinsey Global Institute, 2012 p. 3). The recommended solution is for business owners to find talent pools with the skills they need and build strategies for hiring, retaining, and training. Sectors must invest and shape public education and training systems for new pipelines of skills.

Agriculture is therefore amid a 'perfect storm' for labour supply and growing future skills: relatively small proportion of the total workforce (i.e. less power to influence); transitioning from low to high skills and capacities

for modern farming (i.e. limited current 'critical mass' of the higher skills to provide 'scale' for education); shifts in social expectations of work (i.e. have to demonstrate farms meet millennial expectations whilst dealing with the other dimensions of the 'storm').

The changing roles and categories of the farm workforce

The dynamics of farm labour organisation and demand need to be considered. For instance, much of the farm workforce demand may exist in employment categories outside of the captured statistics. This can relate to family members and people employed casually, as migrant workers or as contractors (Nye, 2018). Consider these important roles in modern farm businesses:

- Investors (don't work on the farm – but can inject capital for labour replacing technologies).
- Farm owners/operators and family members paid and 'unpaid'.
- Farm managers (salaried, often categorised separately from employees in workforce statistics).
- Share farmers (a category sitting between 'contractors' and 'employees').
- Contractors (separate business owners servicing agriculture). An important category for farm work (e.g. 80% of Australian farmers use contractors and advisors for some aspect of their farming operations and this has been noted as an increasing trend in Australia and the UK (Nye, 2018; Nettle *et al.*, 2018).
- Employees: temporary, casual, permanent and migrant employees (e.g. working as calf rearers; farm hands; or pasture and herd managers, etc). This can involve work experience/youth workers through to older/semi-retired workers).

Each of these workforce categories represent different 'labour and skill pools' or segments that in combination reflect the options for designing farm systems that suit and fit the people. Each segment reflects different skill categories and the people in each category will hold different expectations requiring different management. For instance, the types of roles on Australian dairy farms (not including contractors) from a recent survey of 400 dairy farms is provided in Figure 1. All of the people that contribute skills and experience to farm operations from all these categories need to be considered.

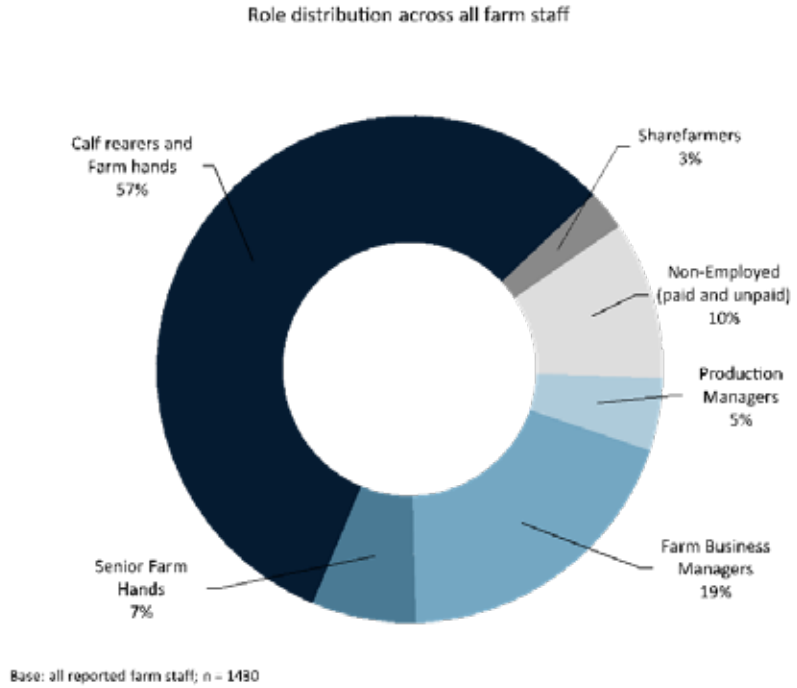

Figure 1: *Farm employee roles on Australian dairy farms reflected as the proportion of staff in each role across 1430 employees from 410 dairy farms (not including contractors, investors) (Dairy Australia, 2017).*

International examples of dairy farm workforce organisation and labour demand trends

- **In Australia**: Most farms are family farms. The 66% of farms that employ staff typically have one or two people working for them (Dairy Australia, 2013a). Skilled migration makes up 2% of the dairy farm sector's workforce and temporary/seasonal migration makes up 12%. Australian dairy production is approximately 50% to both export and domestic markets. A combination of drought and market and pricing volatility has seen only modest growth in dairy production over the last five years, with 28% of farms saying they are in 'growing phase' of the business and 16% of farms recruiting staff in the next 12 months (Dairy Australia, 2017). In terms of production systems and labour demand, whilst calving pattern can be a management strategy to even out labour demand, overall in Australia herd size is the main contributing factor for labour use and labour efficiency (Figure 2). Here, fixed costs (including labour) were 25-30% higher for smaller farms and reduced the Operating Margin of these farms when compared with medium to large farms (Dairy Australia, 2017).

- Nationally, calving patterns are distributed evenly between seasonal calving (spring); split or batch calving (e.g. spring and autumn) and all year around (33% in each category). This tends to reflect off-peak milk pricing by some milk companies rather than a deliberate strategy to reduce seasonal labour demand. Lower labour and management costs per cow due, in part, to more cows per full time equivalent (FTE) have been shown to contribute to high profitability when compared with farms with similar relative profitability. Overall there is a huge variation in labour efficiency on Australian dairy farms (<20,000 kg MS per FTE - >100,000 kg MS per FTE and from 40 to 190 cows per FTE) (Dairy Australia, 2017).

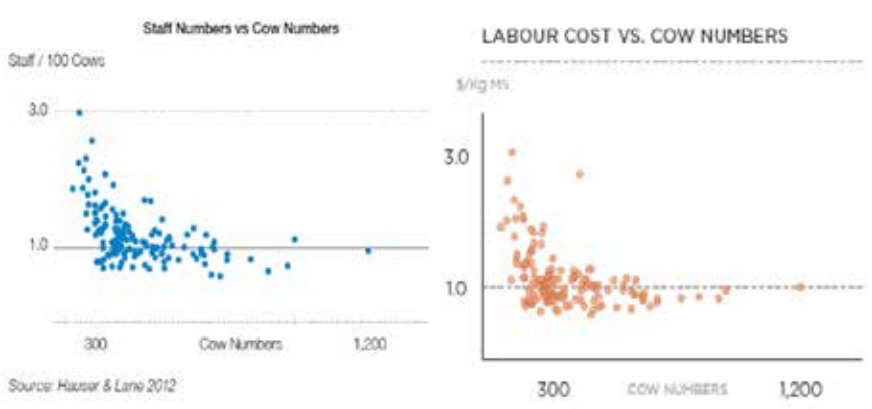

Figure 2: *Dairy farm labour productivity and costs in Australia (Dairy Australia; 2013b)*

- **In New Zealand:** significant labour shortages are being experienced across many areas of the economy such that all primary industry sectors are working together and with government to address issues such as skill formation strategies and migration. New Zealand dairy farms have a heavy reliance on migrant workers with approx. 3000 temporary migrants on dairy farms each year (predominantly from the Philippines) who fill entry-level, semi-skilled positions. Average labour productivity for NZ dairy farms sits at 143 cows/FTE. The overall trend of increasing labour productivity over the last 25 years is linked to increased use of technology, the expansion of dairying in the South Island and labour saving techniques (Dairy New Zealand economic survey, 2015).
- **In France:** Increased farm size has seen an increase in the number of employees on French dairy farms and the decrease in the size of the family workforce. In four years (2010 to 2014) 15,170 FTE'S of farmers have been lost. In the same period the number of employees has increased (+ 3,600 FTE or 23%); 14.9% of FTE's in 2014 were employee (full time, part time, etc.). The retention of employees on farms is an issue for dairy farmers and attention is being afforded to the employee's pathways of work (Terrier *et al.*, 2012, Malanski *et al.*, 2017). Major trends

are to maintain employees on farms and to reduce turn over, to help farmers to analyse their work, to recruit and manage employees, to enhance the image of the profession.

- **In Canada:** The Canadian agriculture sector is experiencing significant workforce shortages reporting that 26,400 jobs went unfilled in 2016 costing $1.5 billion in lost revenues (or 2.7% of product sales), (CAHRC, 2018). The dairy sector, as a supply-managed sector, reports less problems with labour shortages but more challenges related to hiring people who are well suited to their operations. This highlights the important difference between skills shortages and labour shortages. In this context different strategies were required relating to the provision of formal training and finding ways to retain qualified workers through improved work conditions such as finding ways to reduce the number of hours worked, also finding career paths for workers to generate more opportunities for advancement.
- **In Ireland:** Dairying is facing a 30% increase in workforce demand over the next 5 years. Considered to 2025, this is an additional 6,273 additional FTE's (Kelly *et al.,* 2017). This demand is largely created by dairy herd expansion, and when considered alongside the distinct seasonality of dairy farm production, the combination has created challenges from a workforce perspective. Farm expansion increases overall labour demand and seasonality impacts peak demand (Figure 3). For instance, a 230 cow farm deploying 4,300 work h/yr can have 50% of work hours taken up between February and-April. The use of contractors, seasonal staffing strategies and efficient milking systems in the peak are suggested strategies for farmers (Kelly *et al.,* 2017; Deming *et al.,* 2017).

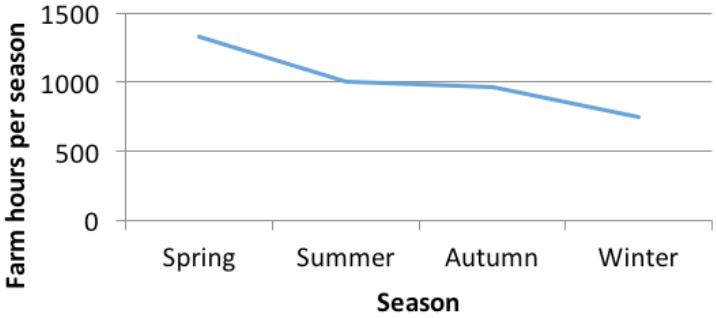

Figure 3.: *Dairy herd expansion and the seasonality of production are impacting overall workforce demand in Ireland. Graph is the average farm hours per season for a 212 cow dairy farm (Kelly et al., 2017 p178)*

Agricultural sectors need to be proactive when it comes to farm skills and the future workforce

The context for labour demand and supply outlined in the sections above requires a shift in thinking from making people fit the current farming systems to designing future farm systems to suit people. The risk if this shift fails to occur, is continual decline in workforce availability and importantly, the work and career interest or people to enter agriculture. To consider proactive responses, agricultural sectors also need to confront the following current issues and challenges to forge new workforce and skills pathways:

- *Agricultural employee turnover rates* are high in many countries, particularly at the entry level. For example in Australia, dairy farm hand turnover is over 50% per annum (Nettle, 2015); in Canada, agriculture has the second-highest (average) turnover rate of any Canadian sector at 18.3% (CAHRC, 2018). Turnover contributes to higher labour demand on top of demand from sector growth. High levels of involuntary turnover rates, are also an indication that there is a mismatch between the skills and expectations that a given position demands and the skill set and aspirations an employee brings.
- *The seasonality and variability in farm work hours* for different people on the farm, the quality of rural services and competition with other sectors for similar skills, impact the ability to recruit and retain workers and this requires specific strategies to match worker requirements with these needs.
- *Workforce planners and education and training providers* generally have a 'large employer bias' when seeking to understand workforce needs and issues. Farms, as predominantly small businesses find it hard to influence or present their needs to training providers or workforce recruitment agencies. This is an important role for industry and government groups seeking to support industry growth.
- *In some countries, there is a shrinking number of young people in the population*, let alone a pool to encourage into agriculture, here alternate strategies are needed – including looking at pools outside of the youth sector.
- *Changing agricultural technologies and work patterns and a lack of internal labour markets* (where people gain experience and are promoted in a farm business) mean it is hard for people to have the right skills and experience from day 1. This requires investment in training and mentoring employees 'on the job'. (CAHRC, 2018).

Conclusion

Farmers around the world need to develop their own workforce strategies, and these will intersect with the decisions of family members; the farm's innovation strategy (e.g. investment in new technology/labour saving technology) and will require a broadening of the farms 'traditional labour pools' to attract and develop the new skills sought. It will also require a paradigm shift in thinking from 'filling labour gaps' to 'offering better jobs and careers'. Farm advisers need to be better equipped to support these decisions.

The collective impacts of diverse farm workforce structures and highly variable demand at a regional scale creates challenges for workforce planning, identification and delivery of training programs, and engaging labour supply companies or other stakeholders to assist in meeting demand. Whilst agricultural workforce strategies are in place in each of the countries described here, a greater pace in change is needed, given agriculture will continue to push into the highly competitive labour pools in advanced skills and services such as that which accompanies automation and information, communication technologies.

Continued research is required on the longer-term implications of different human resource strategies that farmers progress for the types of jobs in rural communities and for future skill needs.

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Irish studies on farm labour issues

Bernadette O'Brien[1], Justine Deming[1,2] and Laurence Shalloo[1]

[1]Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland and [2]University College Dublin

Summary

- Average total farm labour input on a select sample of labour efficient Irish dairy farms was 4,512 hr/yr with an average herd size of 187 cows and average farm labour efficiency level was 24.1 h/cow/yr. Total farm hours increased but labour efficiency improved as herds increased in size.
- Milking' represented 33% of total annual farm labour (h/cow/yr) across all herds.
- The seasonality of the spring-calving system resulted in disproportionately high labour demands during the springtime (February-April) compared to the remaining seasons.
- A stochastic budgetary modelling exercise indicated that contracting out the task of 'milking' (during the period of peak labour demand (Spring)) resulted in the greatest reduction in hours worked/ day followed by 'calf rearing', and 'machinery' work.
- Maintaining the farm hours worked per day while contracting out particular tasks and increasing herd sizes all resulted in increased profitability.
- Results indicated viable options for dairy farms in Ireland to optimise the work/life balance, profitability, and opportunities for herd expansions through greater use of external providers to the farm. A key consideration is the relationship with key individuals that can provide services to the farm.

Introduction

Labour demand and supply is a challenging aspect of agriculture globally, irrespective of it being livestock or tillage based or which species of livestock. It is frequently challenging from the viewpoint of demand being too high. The short-medium challenge here is either (a) that the owner/operator has a much reduced quality of life due to long days or (b) being unable to conduct all of the work and having to hire in/employ labour, which is a cost to the system. This approach is associated with the risk of not being able to secure good, skilled labour; they may not be available in the required geographical area or with the required skills at a particular time. The long-term challenge is the negative impact that a high labour demand can have on succession on that farm.

There has been a significant focus on labour requirement on dairy farms in Ireland in recent times. Ireland has historically had low milk production per labour unit, thus optimisation of labour efficiency on farm must be addressed, particularly now in a period of herd expansion. Furthermore, labour input will impact on farm profitability depending on the level at which that labour is valued. This in turn will impact on herd expansion decisions and work practises on the farm.

Thus, the first objective in this study was to measure levels of labour input and efficiency on a selected group of commercial dairy farms and to identify practises associated with increased efficiency. Such practises may include outsourcing of particular seasonal tasks to contractors, and that would free up time for the farmer. However, this would come at a cost. Alternatively, it may be the choice of the farmer to retain the farm hours worked per day but to carry additional cows on the farm, where farm facilities and infrastructure allowed. Thus, the economic implications of (a) substituting own/family labour on the farm, through purchasing replacement labour/ services and (b) using these labour replacement strategies in conjunction with a proportionate increase in cow numbers that would leave the hours worked per day unchanged, were examined.

Materials and methods

Farm selection and data collection

Farms were selected for the study based on the criteria of being a spring-calving dairy farm with a herd size ranging from 60 to 600 cows and being highly labour efficient (as described by Teagasc advisory personnel). It was also required that the farmer own and use a smart-phone, participate in Teagasc discussion groups and have an appreciation of data collection. Thirty-eight farms were finally chosen for the study. Farms were assigned to one of three herd size categories (HSC). HSC 1 was based on herds with < 150 cows, HSC 2 was based on herds with 150 – 249 cows and HSC 3 was based on herds with ≥ 250 cows (Table 1).

Table 1. Descriptive statistics of farms in each herd size category (HSC)

	HSC 1	HSC 2	HSC 3
Herd size category (cows)	<150	150-249	≥250
Average herd size (cows)	120	185	323
Number of farms	16	13	9

Une appli utilisée par les éleveurs pour enregistrer leurs temps de travaux

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. Farmers were asked to record their labour data for three consecutive days (the last Tuesday, Wednesday, and Thursday) of each month for 12-15 months. There were thirty tasks listed in alphabetical order on the app that the farmers could choose from at any given time. The list was as follows: Advisory, AI (artificial insemination), breaks, calf care, calf feeding, calving tasks, cleaning yards, cubicle cleaning, driving jeep/car, drying off, feeding cows & heifers, fertiliser spreading, grass measurement, heat observation, herding post-milking, herding pre-milking, land & building maintenance, machinery maintenance, milking, office/ business, other dairy tasks, other enterprise tasks, silage pit management, slurry spreading, soiled water spreading, strip fencing, topping, trading stock, veterinary, and washing post-milking. As the app recorded the 'start' and 'stop' times of the different tasks, the data was automatically sent to a centralised database in the cloud.

A short online survey was also applied to the farmer group on a monthly basis to capture other factors, e.g. labour input by part-time employees, stock numbers and hours of machinery work conducted on-farm during each month. Additionally, a once-off phone survey was conducted with each farmer on their farm facilities and practices.

Economic data and modeling scenarios

A detailed evaluation of labour demand in the spring period was carried out as this is normally considered to be the pressure point for labour demand in a spring-calving pasture based system. Data for the springtime months from a subset of the farms (n=26) was used for this calculation. These farms had an average of 185 cows. The actual average farm hours worked/day in the spring (1st Feb to 31st Mar) was determined and then, different scenarios in which certain tasks of the farm were eliminated and substituted for by hired labour/service for those tasks were modeled to see how they affected the farm hours worked/day and efficiency (h/cow) in springtime. Finally, the different scenarios were modeled using a stochastic budgetary simulation model (Moorepark Dairy Systems Model [MDSM]) (Shalloo *et al.*, 2004) to examine the effects on profitability of using these services, e.g. contractors to do the milking tasks, calf rearing and machinery work. These options were evaluated in each of two situations, when the farm hours worked/day were to be reduced and when the farm hours worked/day were to be maintained but allowing for increased cow numbers. The MDSM combines animal inventory and valuation, milk supply, feed requirements, land and labour utilisation, and financial and economic analysis of the production system.

Financial and biological model assumptions for a farm size of 185 cows was used, with a stocking density of 2.1 cows/ha. Annual milk production of 430kg milk solids (MS) per cow, concentrate supplementation input of 770 kg/cow, grass growth of 10 tons DM/ha and annual replacement rate of 22% were assumed in the analysis. Labour (own, family and casual) was valued at €15/h. Milking labour contracted in was valued at €18/h. The opportunity cost of land was included at €445/ha and calf rearing costs of heifers were included at €1.25/day. Contractor costs for machinery work which included spring feeding of cattle, fertiliser and slurry spreading was included at €45/h with a corresponding reduction in machinery expenses on the farm when the contractor was used. It was assumed that the contractor would be capable of doing 25% more per hour (than the individual farmer) due to the size of the respective machinery.

Results

On-farm labour input

Average total farm labour input was 4,512 h/yr across all farms with an average herd size of 187 cows (Table 2). This resulted in an average farm labour efficiency level of 24.1 h/cow/yr. Total farm hours increased but labour efficiency improved as HSC increased. Hours worked by the farmer were similar across HSC, however, the farmer performed 74, 54, and 35%, respectively of the total farm work, in HSC 1, HSC 2 and HSC 3, respectively.

The remaining hours were filled by hired staff, family labour, and contractor work (for machinery tasks) (Table 2). A larger proportion of overall labour was also contributed by hired staff in HSC 3 (2,348 h/yr) at an average of 1.30 full-time staff. 'Milking' represented 33% of total annual farm labour across all herds. This task group was followed by 'cow care' at 17%, where the majority of time was attributed to winter feeding of cows and heifers. With regard to labour efficiency of different tasks, 'milking' and its associated tasks ('herding pre- and post-milking,' and 'washing post-milking') were performed significantly more efficiently in HSC 3 at 5.3 h/cow/yr than in HSC 1 (8.7 h/cow/yr; $P = 0.006$).

Information from the facilities and management phone survey were used to explain various differences in labour demand. In regard to 'cow care', farms in the most efficient group had an average of three areas in which they fed cows and heifers, whereas the least efficient farms had an average of four areas. Additionally, the majority of the most efficient farms delivered fresh feed every second day while the least efficient farms delivered the amounts daily. While 'calf care' only accounted for 8% of total annual farm labour, when broken down by season, this task was the second highest consumer of labour (after 'milking') in the spring season. Time spent at calf care was 185, 319, and 473h for HSC 1, 2, and 3, respectively. There was a positive relationship between amount of machinery work performed by contractors and level of overall farm efficiency ($P < 0.01$) with the most efficient farms having a greater proportion of overall machinery work performed by contractors. The 25% most efficient farms spent 598 h at machinery tasks compared to the 25% least efficient farms that spent 1,201 h.

Table 2. Labour input (h) on farm across herd size categories

	HSC 1	HSC 2	HSC 3	Study average	P-value
Total labour (h)	3,015	4,499	6,023	4,512	
Farmer	2,234 (±128)	2,420 (±153)	2,099 (±187)	2,251	ns
Hired	245[a] (±147)	1,319[b] (±160)	2,348[c] (±187)	1,304	< 0.05
Contractors	207(±128)	380 (±160)	736 (±187)	441	ns
Family	330(±187)	380 (±187)	840 (±265)	517	ns
Efficiency	25.1	24.7	18.7	24.1	

Farm hours worked per day and efficiency in springtime

The farm labour efficiency figures for the farm group examined in spring were 23.3 h/cow and 7.5 h/cow/spring, respectively. Overall, there was a good correlation between spring labour efficiency and annual labour efficiency ($r = 0.75$). Labour demand of the farm was significantly higher in terms of total hours worked/day in springtime at 1,214 h (Cows milked/hr0.05) compared to other seasons. The most time consuming tasks in the spring on an h/cow and h/day basis across farms were 'milking' (442 h/cow; 2.6 h/cow/spring; 5.0 h/day), 'calf care' (217 h/cow; 1.2 h/cow/spring;

2.4 h/day), 'grassland' (147 h/cow; 0.9 h/cow/spring; 1.7 h/day) and 'winter feeding' (146 h/cow; 0.9 h/cow/spring; 1.6 h/day).

The total farm hours worked daily in the springtime and the effect of eliminating some tasks are shown in Table 3. The tasks showing the most influence on daily labour demand in the springtime included 'milking', 'calf care', 'grassland', and 'winter feeding'. The 'grassland' and 'winter feeding' tasks were almost entirely machinery-work based, thus, 'machinery work' (alongside 'milking', 'calf care') was chosen as one of the options to 'contract-out' and thus, reduce the work h/day contributed by the labour available on-farm. The average farm hours worked/day in the springtime was 16.6 h. Eliminating the milking task had the greatest effect on changing the average farm hours worked/day in the springtime with, on average, a 5.6 hour reduction in farm labour/day. Removing the milking task also had the greatest effect on the annual farm labour efficiency and average h/cow savings over the course of the year. The removal of calf care and machinery work, respectively, both resulted in approximately 2 - 3 h of labour reductions to the average farm hours worked/day.

Table 3. Total farm hours worked per day in the spring both with and without the elimination of certain tasks and their influence on annual farm efficiency

	Farm hours worked/day	Reduction in Hours / day from task elimination	Annual farm efficiency	Average saving over course of year
	(h)	(h)	(h/cow/yr)	(h/cow/yr)
Original	16.6	N/A	23.3	N/A
Milking eliminated	11.0	5.6	20.6	2.7
Calf care eliminated	13.9	2.7	22.0	1.3
Machinery work* eliminated	13.6	3.0	21.8	1.5

**Machinery work includes winter feeding, fertilizer spreading, slurry spreading, soiled water spreading, agitating, reseeding, pit silage, spraying, farm yard manure spreading, hedge cutting, lime spreading, digger work, and other.*

Modelling

The economic impacts of three different strategies to reduce labour demand in the spring are shown in Table 4. Based on the farm scenario modelled (185 cows), any of the strategies to reduce labour demand, that is contracting out the milking task, calf rearing and machinery work, did not have a substantial negative impact on the financial returns from the farm (i.e. < 5%). Therefore the hours contributed by the labour on-farm per day can be shortened in the springtime through greater use of contractors for the milking process, rearing of calves and machinery work. But the

impact on farm profitability will be dependent not only on the cost of the contractors but on the value given to the work of the farmer and any other available labour sources on the farm. If the farmer (and others) does not consider their own labour as having a value, then the financial impact of contracting out tasks to external labour sources would be negative. The alternative scenario of the farmer considering to retain the original level of labour input on-farm (e.g. 16.6 h/day), but using the contractors to save labour that could be otherwise associated with increased cow numbers, is also shown in Table 4. When cow numbers were increased to avail of the time saved by contracting out tasks, there was a substantial positive effect on the net profit. Cows numbers could be increased to 279, 221 and 210 (an increase of 94, 36 and 25 cows, respectively) when contracting the tasks of milking calf rearing or machinery work, respectively, in the spring without increasing the length of the working day. An increase in profitability of 40, 20 and 15%, respectively was associated with greater use of contract milking, calf rearing and machinery work, respectively, when cow numbers were increased.

Table 4. The impact of different strategies to reduce labour requirement in the springtime on spring calving dairy farms

	Baseline	Contracted milking	Contracted milking/ increased cow numbers	Contract rearing	Contract rearing/ increased cow numbers	Contracted machinery work	Contracted machinery work/ increased cow numbers
Cow nos	185	185	279	185	221	185	210
Milk Solids sold	73,283	73,283	110,518	75,532	90,230	73,283	83,186
Total receipts	403,322	403,322	608,253	373,699	446,419	403,322	457,825
Total costs	300,980	303,845	465,090	274,508	323,495	303,460	340,518
Net profit	102,891	100,006	143,605	99,644	123,329	100,430	117,858

Discussion

Overall, as herd size increased, the amount of labour required on farm increased and that labour was increasingly supplied by hired staff. Farmer labour hours did not vary significantly across each of the three HSCs. Farmers of small herd sizes may expand the work to fill the day, whereas farmers of larger herd sizes have more hired labour to complete the tasks. Thus, it is necessary to focus on improving work organisation to shorten the working day of the smaller herd size farmers and reduce the duration or members of hired labour on the larger herd size farms. As reported in previous studies on pasture-based systems (O'Donovan *et al.*, 2008; Deming *et al.*, (in press)), the spring season is the most labour-intensive time of the year, with the tasks of 'calving' and 'milking' commencing while 'cow care' (feeding of cows indoors) may still be continuing. Particular focus is placed on labour-saving techniques such as once-a-day milking in New Zealand at this time of year. Also, while automatic calf feeders represent new technology adopted by farmers with the intention of easing the calf feeding task (Medrano-Galarza *et al.*, 2016), farms likely keep their calves indoors for longer periods of time to make the most of their investment. On the other hand, when calves are housed indoors there is the associated higher labour requirement to clean out wet group-housed pens (Gleeson *et al.*, 2007).

Identifying labour-saving techniques for tasks in springtime is of particular importance in order to help pasture-based farmers to overcome this labour bottleneck. When the tasks of 'milking' and 'calf care' were contracted out in springtime, the hours worked/day were reduced by 5.6 h/day and 2.7 h/day, respectively. The National Farm Survey (NFS) of Ireland investigated the proportion of farmers utilising collaborative farming arrangements such as contract rearing of heifers (NFS, 2016). The survey indicated that approximately 5% of dairy farms were utilising contractors to rear their calves and they tended to be larger farms. In addition to the options of contracting out the specific tasks of 'milking' and/or 'calf care,' farmers also have the option of hiring contractors to perform machinery work on-farm. Machinery work during this time period in the spring is primarily focused on grassland management and, thus, choosing to reduce or eliminate machinery work that could be outsourced to contractors could be a labour-saving and logical decision. Contractors generally have larger equipment, reducing the time spent at the tasks. Less machinery owned by the farm means lower depreciation and running costs, and finally, the farm labour that would have been spent at machinery tasks would now be freed to perform other tasks on farm or remove these hired staff altogether. In reality if the farmer was to decide to contract out all machinery work, it would be expected that the profitability of the farm would increase as all machinery could be sold, there would be no machinery running or depreciation costs and reduced labour, in the scenario modelled the machinery was still on the farm.

There has been an increased interest in improving the work/life balance of farmers by reducing the farm hours worked/day in the spring, while recognising the opportunities for dairy herd expansion in Ireland. While

the elimination or outsourcing of certain tasks had a significant effect on spring time farm hours worked/day and spring efficiency, there was little effect on the overall annual efficiency measure. This was to be expected as it was anticipated that a change to the system in the spring would have implications during that peak time but would have little effect on the system on an annual basis. However, reducing the daily labour demand on the farmer during this period of maximum workload could have a very positive outcome for the farm overall. The profitability of dairy farms is vital to their sustainability. The results from this study highlight economically viable options which pasture-based dairy farms may use to manage the labour-intensive springtime period. Removing the milking task from farm labour requirement and having this contracted out had the greatest impact on average farm hours worked/day and overall farm labour efficiency. This was followed by contracting out the task of calf rearing. These alternatives reduced the farm hours worked per day with only marginal negative implications on farm profitability when own labour costs were included. When these strategies were used in combination with increased cow numbers there were positive effects on net farm profit. Results from this study indicate viable options for dairy farms in Ireland to manage labour in the post-quota era and opportunity for expansion while optimising profitability and work/life balance.

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Irish dairying – rapid expansion, structural change and future plans

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Summary

- In response to milk quota removal cow numbers in Ireland have increased by 32% to 1.4 million cows (2017 compared with 2007-2009 base reference) while milk production has increased by 48% to 7.3 billion litres and 53% (in milk solids).
- The structure of Irish dairy farms has changed significantly. In 2016 almost half of Irish dairy cows are now milked in herd of >100 cows and 23% of farmers are milking >100 cows.
- This change in both scale and structure means that the requirement for employed labour on Irish dairy farms has increased dramatically.
- Projecting that cow numbers will increase to 1.6 million dairy cows by 2025, Irish dairying needs to attract over 6,000 people to the industry to fulfil succession and labour needs of the industry.

Introduction

This paper will summarise the changes that have happened in Irish dairying and outline projections for future change. Milk quota removal in 2015 has fundamentally changed both the scale and structure of dairy farming in Ireland. Herd size increased from <1.1 million cows on average during 2007-2009 (this time period was used to set expansion objectives in the Government Food Harvest 2020 plan) to 1.4 million cows in 2017. Cow numbers began increasing in 2011, but the most significant increases happened between 2014 and 2016 with 5, 8 and 6%, respectively compound growth in cow numbers occurring over this period.

Crucially during this expansion phase Irish dairy farmers maintained strong levels of international competitiveness in terms of both total cost of production and debt per kilo of milk solids decreased. This is largely due to the ability to increase herd size on Irish farms from existing resources (grazed grass and existing animal facilities) and as land leasing (as opposed to the more expensive land purchase) was predominantly used by farmers who accessed extra land to expand.

For the first time in over 30 years when milk quotas were first introduced, the numbers of dairy farmers in the country stopped declining and has stabilised at around 18,000 farmers for the last seven years (having declined almost annually from approximately 80,000 dairy farmers in 1984). This trend was largely driven by increased numbers (approximately 1,000 since 2009) of 'new entrants' (non-dairy farmers converting to dairying) as dairy farming has proven to be much more profitable than beef, sheep or tillage farming over the last number of years in Ireland.

Increased scale and structural change

Average herd size increased from 52 cows in 2007 to 76 cows in 2016 but within this change lays a significant change in herd structure. Table 1 shows the changes in herds milking >100 cows between 2007 and 2016. In 2007, just 18% of the national dairy herd was milked in herds of 100 cows or more and just 7% of farmers were milking >100 cows. By 2016, 47% of Irish cows were in herds of >100 cows, 23% of farmers were milking >100 cows and the average herd size of this group was 155 cows. This is seen as a significant statistic as it indicates the number of farmers who will need extra labour to manage the farm workload, thus indicates a dramatic increase in the requirement for employed labour (both seasonal and full time) on Irish dairy farms.

Table 1. Changes in herds milking >100 cows between 2007 and 2016

Year	2005	2007	2010	2013	2016
Cows in herds > 100	144,620	184,910	302,060	400,690	659,149
Per cent of national herd	13	18	28	34	47
Farmers milking >100 cows	1,080	1,350	2,080	2,740	4,262
Per cent of farmers	5	7	11	15	23
Average herd size of this group	134	137	145	146	155

Future requirements

Recent supplier surveys from a number of milk processors in Ireland suggest there will be significant further expansion over the next number of years. In order to access the human capital requirements of future expansion, a study was completed to analyse the effects of further national herd size increases on human capital needs. A labour model was created using Microsoft excel which qualified the potential human capital requirements of cow numbers increasing by 2% per year from 2016 to 2025, representing a total increase of 250,000 cows (using CSO from 2013 to 2016 to establish a baseline).

The following assumptions were used in the model:

- Only herds milking >30 cows in 2016 were used to establish the baseline as during milk quota removal this category of herd size decreased while all categories >30 cows increased significantly.
- Improvements in labour efficiency allowing more cows to be managed per person (in line with a study by O Donovan *et al.* (2008) looking at variations in labour efficiency with herd size).
- A human capital requirement for succession which involved every farm business requiring a successor on average every 35 years (this did not account for the potential front loaded succession challenge Irish dairying faces as the average dairy farmer is 58 years of age).
- A continued change in structure of Irish dairying towards larger scale herds in line with trends seen between 2010 and 2016.

Based on this model it was projected that over 6,000 people will be needed to enter Irish dairying over the 2016 to 2025 period. Of the total number required, 3,958 of these will be successors to cater for farmers who plan to retire and 2,315 will be new employees to work on larger scale farms.

Conclusions

Due to the both the dramatic change that has occurred, and potential future change, Irish dairy farming drastically needs to review how it attracts, develops and retains people (both future successors and labour) in the industry. Anecdotal evidence from farmers and various industry bodies suggests there is already a shortage of labour on dairy farms and previous studies have identified a lack of potential successors as a major issue. A national working group, put in place by the Minister for Agriculture, has been working on this issue and suggested the following as a programme of actions to ensure Irish dairying is successful in the future:

- Better utilise available labour in rural Ireland and Europe.
- Reduce the workload by making dairy farms more labour efficient.
- Improve retention by helping farmers to become better employers.
- Ensure excellent training opportunities for everyone on farms.
- Provide career progression routes.
- Promote dairy farming as an attractive career.

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Work organisation in dairy farms: work durations, changes of practices and precision livestock farming

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Summary

- Labour time requirements and labour productivity on dairy farms are very diverse. Farmers' expectations regarding work, the equipment available, the composition of the workforce and the location of the farm can explain this variability.
- Simplified practices can reduce the amount of work with or without reduced productivity losses.
- The use of fewer inputs and a search for autonomy could lead to improved working conditions but may also induce an increasing complexity of production systems.
- Precision livestock farming can have a positive impact on dairy farmers' work and can be attractive for young people.

Introduction

In Europe, the changes affecting dairy farms (Common Agricultural Policy reforms, open markets, increasing environmental concerns and changing consumer awareness) have made work organisation a central concern for both the sector and for farmers themselves (Garcia-Martinez *et al.*, 2009). As the agricultural working population and the number of farms have continued to fall, increasing work productivity has remained the key to farm competitiveness. Dairy farms are also evolving with the adoption of simplified practices (Pomies *et al.*, 2007), agro-ecological practices (Coquil *et al.*, 2014; Aubron *et al.*, 2016) or the use of precision livestock farming (Schewe and Stuart, 2015). These technical choices can modify the amount of time spent on farm work and its organisation. A better understanding of work duration and efficiency and the factors affecting work organisation is useful to help livestock farmers making reasoned changes and assess the impacts of innovations on their work.

Variability of work durations in dairy farms

Studies show the variability of labour time requirements and labour productivity on dairy farms (Cournut and Chauvat, 2011; Fagon and Sabatté, 2011; Hostiou and Dedieu, 2012). In France, a study of 190 dairy farms shows average total routine work of 3,060 hours per farm and per year with a large variability (1,750 to 5,030 h/year). The total routine work increases with the number of people working on the farm and the farm size. Dairy farms with crops have the highest amount of routine work. The main part of the routine work is carried out by family members, and in

some case by employees. The routine work with the dairy production is on average 2,790 h/yr (1,660 to 4,270 h/yr). The work efficiency criteria, i.e. the number of hours of routine work per livestock unit or per 1000 l of milk, is 53 h/cow and 8 h/1000 L of milk. The technical management explains work time requirements (Hostiou and Dedieu, 2012). Farmers' expectations regarding work, especially free time, can explain the variability of work requirements between farms and determine technical and production preferences. For example, annual or seasonal once-a-day milking, which reduce the total amount of work, is a technical choice dictated by the desire to free up time on a daily basis (Pomies *et al.*, 2007). Other factors explaining this variability in work times are the equipment available, the composition of the workforce and the location of the farm (Cournut and Chauvat, 2011; Hostiou and Dedieu, 2012; Poulopoulou *et al.*, 2018).

Changes of practices in dairy farms

Practices to manage dairy animals are affected by two main changes. First, simplifying farming practices (reducing the frequency of feed distribution for example) would reduce the amount of work with reduced productivity losses. However, other authors show that the reduction of working time on dairy farms, linked to farmers' expectations to work less, sometimes leads to a reduction in profits, such as with the practice of once-a-day milking (Clark *et al.*, 2007). Simplification of practices is directly related to the increase of herd sizes on farms. Thus the economic gains (current income) are not obtained in all cases. A second factor affecting farmers' working conditions is the transition to more agro-ecological forms of dairy farms. The use of fewer inputs and a search for autonomy should lead to improved working conditions (Aubron *et al.*, 2016). However, the reduction of the workload is not systematic and there is the possibility of an increase in the amount of work (Aubron *et al.*, 2016). Some authors point out that systems relying more extensively on grasslands would lead to improved working conditions (Brummel and Nelson, 2014). In contrast, other studies demonstrate that dairy farmers adopt zero-grazing systems due to better labour efficiency, a reason sometimes given by farmers for moving from a cow grazing to a zero-grazing system (Meul *et al.*, 2012). The implementation of agro-ecological principles may also coincide with an increasing complexity of production systems; crop-livestock systems are a potential example of this, as their management may involve high workloads and complex organisation.

Use of precision livestock farming to modify equipment

The quest for improved efficiency and productivity in response to the current economic and structural context is motivating the adoption of precision technology methods on farms. Most authors highlight the time saved when precision livestock farming is associated with automation that ensures milking, feed distribution, animal monitoring, and regulating of the environment (inside buildings) in the place of the farmer (Schewe and Stuart, 2015; Hostiou *et al.*, 2017). The time gained can be reinvested in production or management tasks, but also in personal activities. Precision technologies allow replacement of physical work with management tasks (De Koning,

2010), and also allows verification of the information produced, using previously set alerts, which reduces the physical strain of work on dairy farms. However, these new tasks can sometimes reduce the time savings resulting from the removal of the task itself (Schewe and Stuart, 2015). But new technologies can have a positive effect on reducing the mental burden on livestock farmers because they help to anticipate physiological signs that are sometimes only barely visible to the human eye (temperature change, heart rate, etc.), (Allain *et al.*, 2016). Yet the mental burden can also increase in this scenario. Indeed, a large amount of information is regularly produced by certain sensors, rendering it difficult to select the information useful for decision-making (Hansen, 2015). The scientific literature has yet to fully explore the consequences of precision livestock farming on the work and profession of livestock farmers using precision technologies, in terms of farmers' working time, organisation and productivity, physical and mental health, new tasks and therefore new related skills (management of automation and data produced), and relationships with animals (Hostiou *et al.*, 2017). These consequences must therefore be described to gather supporting evidence for these new technologies.

Conclusions

Livestock management practices are changing rapidly. Technology and automation have a direct impact on labour hours. While precision livestock farming is likely to make the profession more attractive, especially for young people in search of modernity, it may also prove to be a source of failure if it is not adapted to livestock farmers' needs and skills.

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LEADINGEDGE GROUP

We Listen. We Enable. You Grow.

LEAN DAIRY FARM CASE STUDY

Pat and Pauline Ryan, Captal Group

SITUATION

Milk price volatility and the increased frequency in *boom-bust* cycles has driven farmers to seek opportunities to stabilise farm earnings and spend. The influence of global factors such as removal of milk quotas, lower oil prices, weather events, & political volatility has seen milk prices vary from 24c/Lt to 36c/Lt, which for large farms or farm groups can see a difference in earnings of €120k per 1 million litres produced.

This case study outlines how dairy farming in Ireland can build resilience to fluctuations in earnings through adopting the Lean operations approach. The case study will show how standard Lean techniques used on a large dairy farm in Co. Waterford, Ireland resulted in cash savings as well as freeing up time for the owner to work on growing the farm business.

Lean includes a set of techniques and a way of doing business originally developed by the automotive industry but evolved over the last 30 years to meet the needs of almost all sectors. If you have people, processes or problems, you can reap the benefits of Lean. In Ireland, dairy processing groups have benefited from Lean transformation over the last 10 years and the time is now set for dairy farmers to benefit just like their counterparts in New Zealand through the Dairy NZ FarmTune programme.

The approach advocated in Lean, challenges farm owners and employees to carry out their day-to-day work easier, better, faster and safer. Lean seeks to identify and eliminate unnecessary activities so that work requires less effort, less capital and less time, but with excellent milk quality.

In late 2016, Leading Edge Group collaborated with the Captal Group to pioneer the application of Lean on the dairy farm of Pat & Pauline Ryan at Cappagh, Co. Waterford Ireland. Captal farms milk 1,500 cows on four farms with a herd size of 450 cows on the home farm in Cappagh.

Analysis of labour cost at Cappagh farm for 2016 showed that labour carried throughout the summer/autumn period and unplanned daily work resulted in cost overruns. The goal of this collaboration was to "*implement a sustainable labour cost structure that work's within the constraints of the land and infrastructure, both of which cap the volume of milk produced*" that would:

- Improve resilience to impact of milk price volatility
- Improve productivity
- Reduce operating costs
- Provide job certainty for farm workers
- Enable focused, flexible, and quick management
- Enable managers run the farm & the owner to run the business
- Enable teamwork & shared learning within the farm group
- Ensure everybody is working optimally

COMPLICATION

The busy nature of dairy farming and the desire to get the job done means that labour planning and communication can sometimes take a back seat which results in labour cost overruns. This has the knock on impact of drawing the farm owner into micromanaging the day-to-day activities of the farm; therefore distracting the owner from growing the overall business.

The dairy farm demand for labour varies throughout the year and although this demand is predictable, there is no detailed budget plan to flex labour capacity to demand in the most efficient way. A high level plan is available to use additional labour when it is required, but this labour can be carried into subsequent periods where it is not needed.

Cappagh, like many large farms use non-English speaking workers that may not have a background in farming but still rely on verbal communication to roster jobs. The result is that day-to-day hour-to-hour roles, responsibilities, goals & objectives are not clearly understood. The upshot is that the farm owner or manager has to micro-direct basic tasks throughout the day. Ultimately jobs are not always done right first time with resulting labour cost overruns.

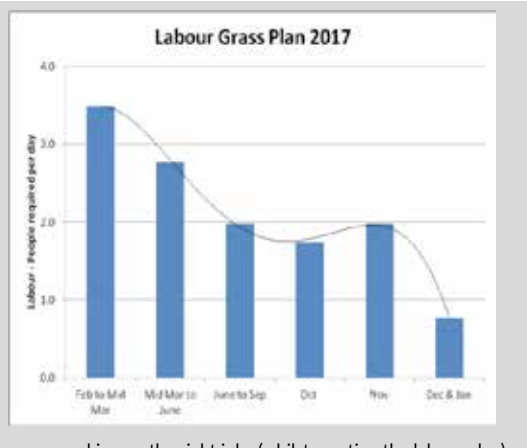
In Ireland, dairy farming takes a scientific approach towards herdsmanship and care of the land. The standard day-to-day processes such as milking are well refined and therefore have limited scope for waste removal without significant innovation and investment in new milking techniques. In reality, it is the accumulation of a frequent number of small issues that can have an impact on daily productivity e.g. broken gate posts, dung wash down and clean up, broken milk cluster etc.

With a large farm group like Captal, unstructured communication between farms inhibits the ability of the group to reach its true potential, as not everyone in the group is working on the right thing, in the right way and with the same goals notwithstanding that they are all working hard in good faith.

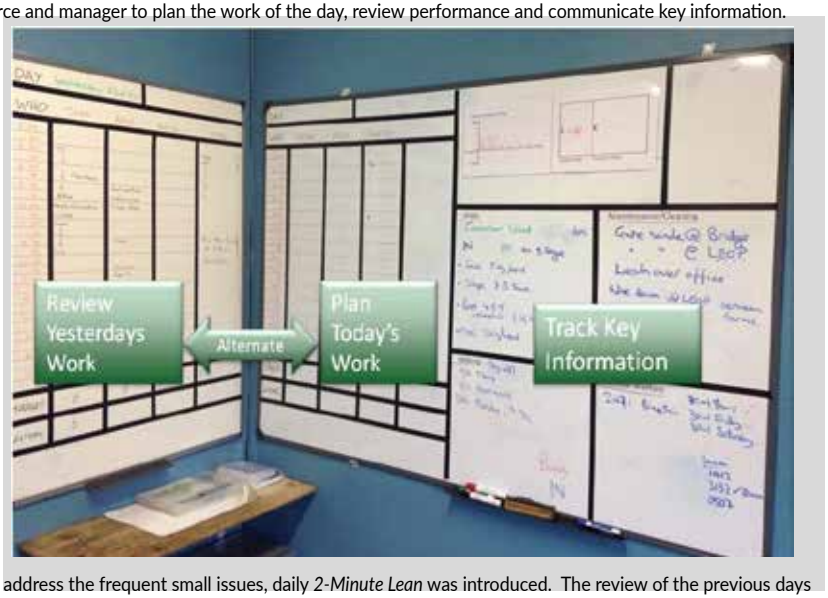
The aim of Lean is that employees can do more of the valuable good work and less unnecessary work.

WHAT IS THE RESOLUTION

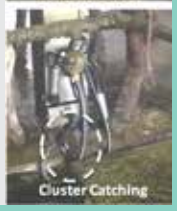
In order to run to budget, a labour demand/capacity plan was created to hire labour only when it is needed. To do this, we divided the year into farm work periods based on milking once or twice per day, calving season and winter period. For each period we created a workload chart to understand where the work is to be done and the labour required to do it. The result was a labour 'grass' plan that set out the quantity of labour required throughout the year, and a labour budget plan to track the monthly cost of direct labour.



To ensure that everyone was working on the right jobs (whilst meeting the labour plan) a daily farm management process was put in place. Daily management is the process for ensuring that everyone knows what to do and are working on the right task. A daily stand up meeting process (DSUM) was set up with the labour force and manager to plan the work of the day, review performance and communicate key information.



To address the frequent small issues, daily *2-Minute Lean* was introduced. The review of the previous days performance at the DSUM highlights areas of work that may not run as planned. Managers and labour are encouraged to '*Go See & thoroughly understand*' the real situation and to work together to implement simple ideas that might only save 2 minutes. However, practicing 2-Minute Lean everyday will see significant improvements over time.

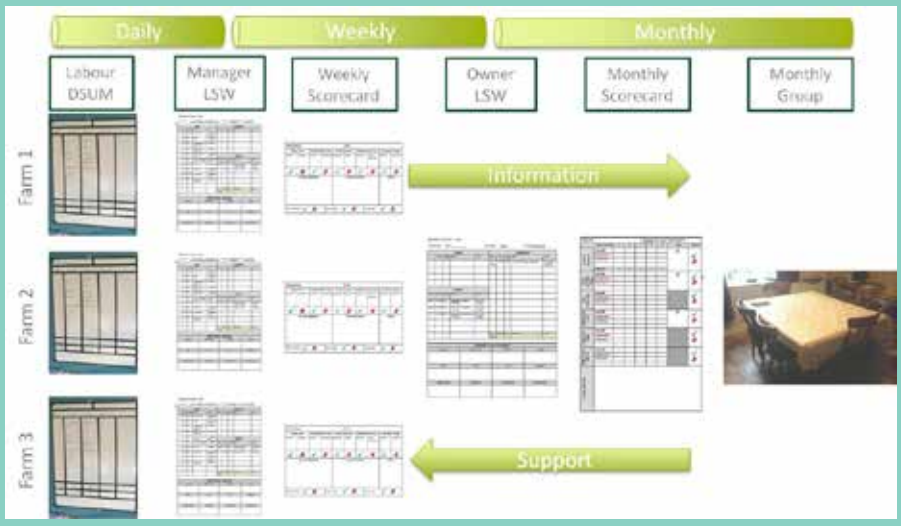


To ensure that everyone was focused on supporting the farm group to reach its true potential, a Lean technique called 'Leader standard work' was introduced, the benefits of which include:

- Consistent practice across different farms
- Highlights managers that are overloaded
- Frees up time to work on the business
- Clear accountabilities, roles, responsibilities & expectations

Leader standard work is built from the bottom up so that everyone is aligned to supporting the farm:

- Manager is focused on supporting planned day-to-day farm jobs
- Owner is focused on supporting the managers & driving the business
- Board is focused on supporting strategic work of the owner



ACTIONS

This case study shows that by utilising the Lean operations approach to the day-to-day running of a farm, dairy farming in Ireland can build resilience to earnings fluctuation. It shows how simple Lean techniques used on a large dairy farm saved money and freed up time for the farm owner to work on growing the farm business.

The next steps for the Captal Group Lean journey will be to continue to engage in breakthrough projects such as night calving processes, contractor management, streamline paperwork and farm maintenance. Ultimately farms like Captal will want to undertake training to learn Lean skills for themselves.

CLOSING COMMENTS

Leading Edge Group collaborated with Captal Group to pioneer the application of Lean on the dairy farm of Pat & Pauline Ryan at Cappagh, Co. Waterford Ireland, and used Lean techniques to implement a sustainable labour cost structure that work's within the constraints of the land and infrastructure, both of which cap the volume of milk produced.

At the farm at Cappagh, recently applied Lean techniques were utilised to great effect during the calving season. The benefits of the collaboration included:

- Certainty and control over labour costs for farm owners, with significant cost saving
- Increase cash available to plough back into the business
- Job and earnings certainty for labour
- Team work and the *power of many*
- Everyone knows they are working on the right thing
- Owner and managers time freed up
- Reduced frustration as work is done right first time
- Problems are solved quickly without any fuss
- Clear communication for all employees

Lean techniques will work on Irish dairy farms, but to engage the appropriate experts and training, financial support will be required.

Kitchen [Lean] Meeting

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Leanfarm

Making farms safer and more sustainable
Saving farmers time, money and effort

Dairygold Leanfarm Pilot Review

"Making tomorrow better than today"

Lean is an approach most commonly used in manufacturing to drive continuous improvements and efficiencies that utilise less time, effort and resources thereby giving greater returns.

Dairygold's Continuous Improvement (CI)/Lean journey began in 2011, with support from Enterprise Ireland, when we commenced to apply lean principles across our processing and supply chain operations. Through this CI/Lean programme, we examined each element of our processes to identify problems and in turn solutions. Transforming the way in which we think and work has delivered greater efficiencies and financial savings to our business. The focus is now very clearly on making tomorrow better than today.

In a survey in 2017, 25% of Dairygold Members revealed that labour is a main obstacle to their future dairy farming plans. 30% of Members also identified that "finding labour" is a significant challenge that needs to be addressed in order for them to fulfil their potential.

Believing that our CI/Lean programme learnings should be extended beyond our factory floors, we implemented a pilot programme at farm level in 2017. With the guidance and support from our CI coaching staff and Milk Advisors, a pilot group of farmers of varying scale and herd size implemented lean tools and techniques over a period of six months.

The Approach

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The Core Tools

Visualisation	Using visual aids to help you manage key information
5 S	A place for everything and everything in its place. **S**ort, **S**et in Order, **S**tandardise, **S**hine, **S**ustain
Standardisation	Guiding instructions on how your farm is operated – 'One Best Way'
Problem Solving	Techniques to help you to determine the root cause of problems
TIMWOOD	Identifying the 7 different types of wastes on your farm: **T**ime, **I**nventory, **M**otion, **W**aiting, **O**verproduction, **O**ver-processing, **D**efects

Examples of Implementation

Milking parlour standard work

Visuals Boards

Organise spray and keep safe in locked storage cabinet

Shed Layout - less time searching for items

The benefits achieved in the pilot

The pilot demonstrated that the application of lean principles on-farm can deliver improvements in safety, reduce physical labour and have a significant positive impact on farmers' quality of life and mental wellbeing.

The results of the pilot programme clearly demonstrated that the application of lean principles on farm also offers significant efficiencies and benefits.

BENEFITS

18 DAYS
Number of labour days saved

€1440
Average cost saving

116 km
Reduction in walking distance

93%
Of farmers saw safety improvements

100%
Recommended to farmers

2,900
All Dairygold milk suppliers can avail of Leanfarm training

STATISTICS GATHERED FROM A 6-MONTH PILOT PROGRAMME WITH FARMERS OF VARYING SIZE AND SCALE

Sean Moher
Croughmore, Mitchelstown

"Leanfarm has changed the way I think about everything on the farm now. I don't accept the 'norms' - I question everything, each individual step striving for a better, easier, more effective way to do things. I'm more conscious and proactive about improving the processes on the farm. I have more pride in my work as it's more structured and organised. Lean has made farming as a career more sustainable."

Ned O'Brien
Carrigane, Kilbehenny

"I definitely think that 'lean' has made my farm safer – a cleaner yard is a safer yard. Leanfarm has given me a new lease of life on the farm. It has been very beneficial to have a new perspective on how I work – what's necessary, what can be eliminated and what can be improved and streamlined. Leanfarm is about releasing the genius in people – it helps you to look at things differently, to innovate, to strive for better and easier."

Joe Morrissey and his father Tom
Rostellen, Midleton

"My father and I really benefited from the Leanfarm training. It helped us to identify where we were wasting time and energy and often simple fixes made a big difference. Leanfarm saved us time and money - financial saving through labour and it helped us to put a value on our time. We put items closer to where we need them. We now have the right tools, in the right place, at the right time so that there is less time spent searching and walking."

Tom Walsh
Mourneabbey

"Through Leanfarm, I've been able to save between one and two hours a day. I've two kids so being able to spend that time with my family in the evenings has been life-changing. I can take the kids to tr hich is great – that time is precious, you're only young on"

The Future Focus

Based on the positive results and feedback received the decision was made to extend the Leanfarm programme to all Dairygold members.

Leanfarm Pillars

Complete Integration

Implementing factory lean-learnings to the farm benefits our farmers across the supply chain

Better Quality of Life

Making a sustainable living and creating an improved work-life balance

Thinking Differently

Empowering farmers to improve efficiencies by adopting lean systems

Knowledge Sharing

Sharing knowledge across our Member suppliers to improve output, whilst sustaining rural life

Health and Safety

Ensuring the welfare of our shareholders, their families, farms and livestock

Sustainability

Supporting our farmers in meeting their sustainability requirements to future proof farming for the next generation

Closing

Following a review of the pilot programme the Minister for Agriculture, Food & the Marine, Michael Creed said:

“With significant growth in milk production across the country in the last three years, the dairy farmer's working day is becoming more demanding. I believe that Dairygold's pioneering Leanfarm programme will be quickly adopted by farmers because of the very practical and useful help it provides. Seeing how the working lives of the participating farmers are now safer and more profitable, Leanfarm could have a transformative impact on dairy farming”.

To support the launch Dairygold Chairman John O’Gorman added:

“We are very excited to launch Leanfarm which we firmly believe is an initiative capable of changing farming forever.

Through Leanfarm, we want to drive a cultural shift in how farming is carried out and enjoyed with the right tools, techniques and a new perspective on every aspect of the farming process which enables and empowers farmers to identify and resolve problems and increase efficiencies to achieve improvements that can be life-changing.

This knowledge-sharing programme is in line with our objective to help Members maximise their return from farming”.

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Milking time distributions on Irish dairy farms

John Upton and Michael Breen

Teagasc, Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork

Summary

- There is a lack of knowledge around the milking duration and milking time distributions of Irish dairy farms, and it is not known if the abolition of the milk quota system has resulted in an increase in milking duration.
- Of the 37 farms studied, there was an overall trend towards increasing herd size, with average herd size increasing from 106 cows in 2014 to 125 cows in 2016.
- Most farmers in this study started the AM milking between 06:30 and 07:00. The average AM milking duration was 134 minutes.
- Most farmers in this study started the PM milking between 17:00 and 17:30. The average PM milking duration was 120 minutes.
- The average milking duration was 254 minutes per day across both 2014 and 2016. Milking duration increased by 5% to 260 minutes in May 2016 compared with May 2014.

Introduction

Irish milk output has increased by 30% since the recent abolition of milk quotas (CSO, 2018); however it is not known how this has influenced milking times. To answer this question milking times from May 2014 were compared with those of May 2016 on the same set of farms. This information is interesting because milking acts as the anchor points of the farmer's working day. Milking, and its associated tasks of herding pre- and post-milking and washing post-milking, in a pasture-based system accounted for 33% of the total farm labour input over the course of the year (Deming *et al.*, 2015). This was consistent with a previous Irish labour study where milking accounted for 34% of overall labour demand (O'Donovan *et al.*, 2008).

Understanding farmer behaviour around milking habits and the duration of milking on commercial farms will be useful in designing strategies to reduce time spent milking, hence freeing up time for other tasks or for off-farm activities. Therefore, the objective of this paper was to describe the times of the day when milking occurs, along with AM and PM milking duration across two different years, on a subset of commercial Irish spring calving dairy farms.

Data collection and processing

Data were collected from 37 commercial dairy farms for May 2014 and May 2016. Run-time meters were installed on the vacuum pumps within the milking parlour. Data were recorded every 15 minutes. Hence, milking times presented here do not encompass herding tasks or cleaning tasks

associated with milking that occur outside of the times where the milking machines are turned off. Milking machine run-times associated with the washing of the milking machine were not included. Milk production and herd size data were gathered from the Irish Cattle Breeding Federation (ICBF) milk recording database. Farm infrastructure data regarding the number of milking units were recorded during an on-site farm survey.

Data were processed in Microsoft Excel and the following parameters were computed for AM and PM milkings for both 2014 and 2016: milking start-time, milking finish-time, milking duration and row time.

Results

During the period from 2014 to 2016, herd size increased by 18% from 106 cows to 125 cows on this sample of farms (range +49% to -35%). There was an overall trend towards increasing herd size; with just 4 farms reducing herd size. Most farmers in this study started the AM milking between 06:30 and 07:00 (35%). The average AM milking duration was 134 minutes. Figures 1 and 2 show the distribution of farm milking schedules for the AM and PM milkings, respectively. A summary of the results obtained are shown in Table 1. Most farmers in this study started the PM milking between 17:00 and 17:30 (24%). The average PM milking duration was 120 minutes. The duration of milking across 2014 and 2016 was very similar, with total daily milking duration increasing by an average of 11 minutes from 2014 to 2016.

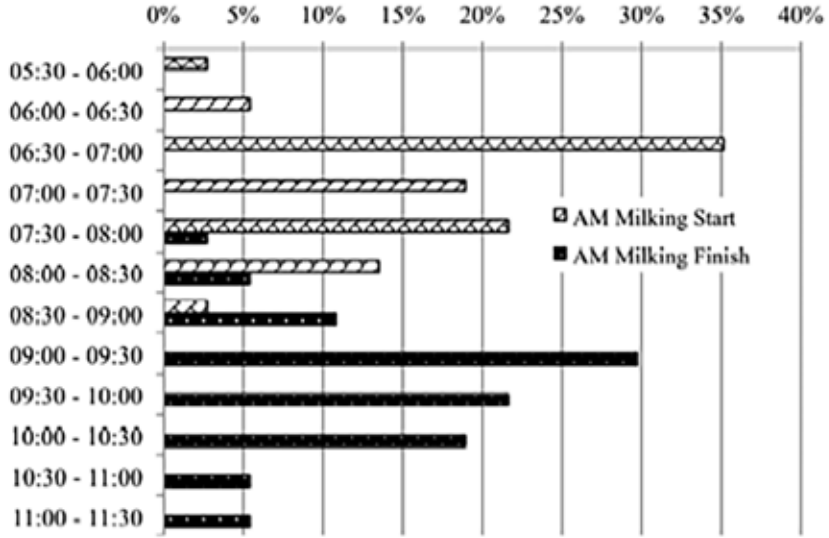

Figure 1: *AM milking start and finish time distributions for May 2016 from 37 farms*

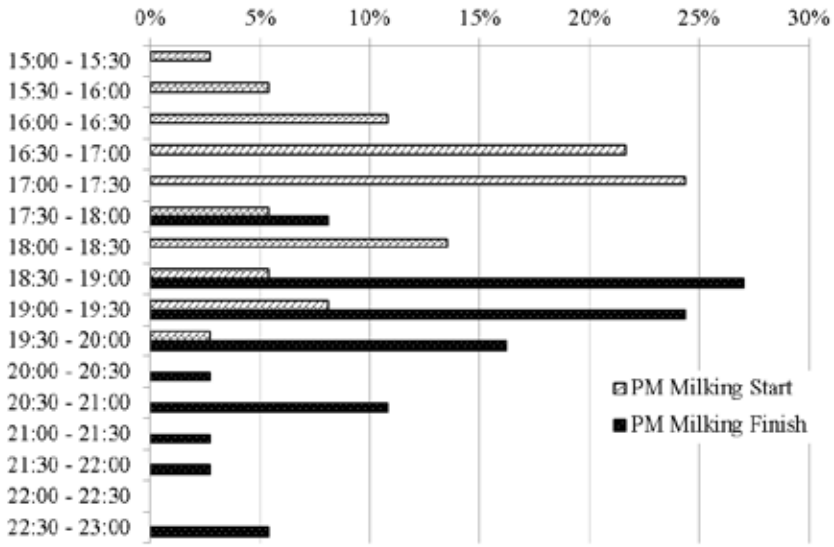

Figure 2: *PM milking start and finish time distributions for May 2016 from 37 farms*

While this average increase of 5% seems quite benign, it is hiding some large increases at the individual farm level. For example, four of the farms in the study experienced an increase in milking duration of 15% or greater, along with a herd size increase of 34%, resulting in total daily milking duration exceeding 5.5 hours per farm. On the other hand, there was a number of examples (6 farms) where farm size increased by a moderate amount (<20%) while achieving a reduction in total daily milking time of 10%. The row-time decreased by 10% (from 15 to 14 minutes) between 2014 and 2016. This highlights the incremental and additive savings that are possible by implementing efficient milking-parlour work routines. Of course, these incremental savings can only go so far as regards reducing farm working hours. In order to make substantial savings in milking duration a more in-depth review of both the facilities and the way these facilities are managed would be required.

Table 1: Minimum, mean and maximum milking start-times, milking finish-times, and milking durations for AM and PM milkings during May 2014 and May 2016

	Herd size	# Rows[1]	AM Milking Start Time (hh:mm)	AM Milking Finish Time (hh:mm)	AM Milking Duration (mins)	AM Row Time (mins)	PM Milking Start Time (hh:mm)	PM Milking Finish Time (hh:mm)	PM Milking Duration (mins)	PM Row Time (mins)
2014										
Min	58	6	06:18	08:12	100	9	15:48	17:59	86	8
Mean	106	8	07:20	09:31	131	16	17:43	19:40	118	15
Max	189	14	08:33	10:58	204	27	19:45	22:05	183	24
2016										
Min	41	6	05:58	07:48	69	8	15:16	17:38	85	8
Mean	125	10	07:18	09:35	137	15	17:32	19:35	123	13
Max	265	18	08:27	11:10	239	22	19:13	21:13	219	19

[1] *# Rows = number of rows of cows to be milked through the parlour*

Discussion

This study sheds new light on the working patterns and behaviours of farmers around the main labour-consuming task in dairy farming. It is unclear at this point how well the difference between AM milking start-time and PM milking finish-time represent the length of the working day on dairy farms. However, it is clear from the data presented that the majority of dairy farmers are working quite early in the morning and unusually late in the evenings by modern industrial worker standards. While there was quite a tight spread in AM milking start and finish-times, we found that 11% of farmers started the PM milking after 19:00, resulting in PM milking finish-times after 21:00. On average, 5% of farmers were finishing milking after 22:30 consistently, for the month of May, over the course of this study (Figure 2).

Furthermore, the average daily milking time of 260 minutes in May 2016 (or 4 hours and 20 mins) does not paint a sustainable picture of milking efficiency or labour utilisation, especially given that these times did not include any herding tasks, or time spent cleaning down the milking facilities after the milking machine was turned off. The average milking times were also much longer than the 90 minutes per milking session recommended by Teagasc.

A number of features of dairy farming expose these farmers to greater financial instability and potential stress than workers in other sectors. First, as we have seen in this study, the constant work commitment associated with milking constitutes a consistent burden. Second, dairy farmers have greater exposure to uncontrollable external factors, such as the weather, sick animals, government policy, and the economy (Rosenblatt and Keller, 1983). Finally, in recent years, dairy farmers have faced high levels of financial instability (Kolstrup *et al.,* 2013). Stress (both physical and psychological) is a strong predictor of farm injury and resulting safety behaviours (Xiao *et al.,* 2014), as well being a connector between financial problems and injury in farming (Thu *et al.,* 1997). Hence, in order to ensure safe working conditions and promote significant generational renewal within farming, much more focus is required by policy makers, knowledge generators, training providers and advisory services to generate and disseminate the strategies and facilities knowledge necessary to make substantial progress on the milking efficiency aspect of farm labour.

Conclusions

This study described the times of the day when milking occurs, along with AM and PM milking duration across two different years, on a subset of commercial Irish spring-calving dairy farms. We found that most farmers in this study started the AM milking between 06:30 and 07:00. The average AM milking duration was 134 minutes. Furthermore, most farmers started the PM milking between 17:00 and 17:30. The average PM milking duration was 120 minutes.

The duration of milking across 2014 and 2016 was very similar. The average milking duration was 249 minutes per day in May 2014 which increased by

5% to 260 minutes per day in May 2016. We can conclude from these data that milking times on Irish dairy farms were above levels recommended by Teagasc before quota abolition, and have increased slightly as herd size increased. Significant measures are necessary to generate and disseminate knowledge around reducing farm milking times to ensure safe working conditions for farmers and encourage the next generation of farmers to enter the industry.

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Comparing Rotary and Herringbone milking facilities: My experience

Patrick Hickey

Ardnacranny, Co. Westmeath

Summary

- We are operating a 30-point herringbone parlour on a 100ha farm in Westmeath for almost 10 years and a 40 point rotary parlour on a 169ha farm in Roscommon for 4.5 years.
- Running costs are fairly similar on both, but throughput is far higher with the rotary with a difference of 1.5h milking time/cow/yr less in the rotary parlour. That has to be put in context with the €100k higher capital cost of the rotary parlour.
- As we have full-paid labour on the Roscommon Farm, the cost savings are more visible and it has allowed us to take on other opportunities that have arisen since we moved to Roscommon.
- Having milked in both locations, it is possible to say that the rotary parlour is much easier physically for the operator and less stressful for the cow. I can safely say installing a rotary parlour has been one of our better decisions.

Description and experiences of each parlour type

I farm with my wife Elaine and in partnership with my brother John. We are responsible for the operations of two dairy farms in the Midlands and I also have three other brothers actively involved in dairying, so suffice to say we have seen and milked in all shapes and sizes when it comes to parlours.

We purchased Ardnacranny Farm in Westmeath in 2005 and I moved from Kilkenny with 220 heifers in January 2006 and commenced milking in a 10 unit double-up parlour. We spent about €5,000 getting it into working order until we could get a new parlour built. As the existing yard was at one end of the farm, we decided to move to a centrally located Greenfield site for the new parlour on the 100ha milking platform. We were planning on carrying 300 cows, so we put in planning for a 30-unit herringbone parlour. As we had high borrowings due to purchasing the farm, we put in a very basic 30-unit De Laval swing over with duo-vac to allow it to be operated by one person when required, which happens to be most of the time. We fitted an Alfco semi-automatic drafting facility and a 20,000l DX tank and a flood washing system on our rectangle shaped collecting yard. We also decided to take "*advantage*" of the Farm Waste Management (FWM) grant scheme, which turned out to be a mistake, as it added a lot of time and expense to the build with the result that it was September 2008 when we commenced milking in our new parlour At that stage we were putting 280 cows through the 10-unit double up. Suffice to say when sales people try to tell me of the efficacies of double-ups, I "*politely*" disagree.

In 2012, Fortview Farm Roscommon was advertised for sale. At that stage we had 300 cross-bred cows in Ardnacranny and my brother John had 200 cows in Kilkenny, so we had a lot of the young stock required to stock the farm. We purchased 90 ha and leased the remaining 40 ha for ten years. It was a complete Greenfield site with no buildings. We laid out the farm to carry 350 to 400 cows and planned our facilities accordingly. Our initial thought was a 36-unit herringbone with automatic cluster removers (ACRs) and we were pricing companies on that basis. Bertie Troy of Grasstec and an agent for Milfos came to price the job and after viewing the property asked had we considered a rotary. We laughed saying "*no, definitely outside our budget*" but he got us thinking and when we considered the benefits we realised that he was right. So we looked at rotary parlours and decided to go with a 40-point with removers being the only frill. So have we realised the benefits? I asked our farm manager of the Fortview farm, Brendan Elliot, about the comparisons of the two parlours and he looked back and just said "*there is no comparison*"

How each farm operates

Both farms are compact spring-calving cross-bred systems and cows go out to grass as soon as possible after calving. We calved 84% in 6weeks and would normally be at grass for 270+ days. Labour consists of myself and Robert Swiercz who is with us 10 years in Ardnacranny. My wife Elaine is on a career break from primary teaching and is rearing our three kids. In springtime, we employ a local lady for four hours in the morning and Elaine rears the calves. We also hire a student for the spring, however this year there was none available so we hired a local man to work three days per week. We calved around 320 cows in Ardnacranny and will milk on average 280 with the balance going to Fortview. We also rear all of the heifer calves in Ardnacranny for both farms. The heifers come back from Fortview at about 10d of age and we rear them to calving.

Fortview, which is about 40 minutes away has two full-time employees. The aforementioned Brendan Elliott who is with us since we started in Fortview 5 years ago has full control over the daily operations and to be honest we are blessed to have him. In the first year, I was there 2 to 3 d/week but now, I just do 2 to 3 flying visits per month. Brendan has an assistant manager, and this spring had a night calver who worked 4 nights and one full day for the 6 busy weeks of the spring. They carried the empties and late calvers for both farms and calved down 360 cows. All males are sold off the farm and heifer calves are reared in Ardnacranny. As a result, milking is the main job each day for the remainder of the year. All other jobs except winter feeding and some fertiliser spreading are done on contract on both farms. We have built up a very good relationship with our local contractor and we get a great service in return. As milking is a one-person operation in Fortview, Brendan can come back to help in Ardnacranny with any large jobs such as testing, scanning, dosing, etc.

Comparing the parlours

Fortview has an automatic washer, ACRs, a backing gate on a circular yard, but no drafting. We fitted retention this springtime which we found (to our cost) is a necessity. We pre-spray the cows with a low cost spray unit. Ardnacranny had an automatic washer, but I sent it to Fortview as I didn't like it. Throughput for the rotary parlour in Fortview would vary from 240/h at peak to 300/h in the autumn (Table 1). Ardnacranny is fairly steady at 130-150cows/h with one person, this would increase to 180/h with the addition of a second person (Table 1). But after doing a milking in each, there is no doubt even though there are more cows going through the rotary, that it is much easier on the operator. We have fitted the retention in Fortview and without doubt, an automatic backing gate is a must in Ardnacranny. To be honest, in hind sight, if I had a choice between drafting and a backing gate, I would have fitted the backing gate first. There would be about €2,000/unit difference in the purchase price between the rotary and the herringbone. However, if the comparison was done on a per cow basis, it would be closer. The ancillary construction cost would be similar for both. However, there is 3-phase power on the Fortview farm.

Table1. Characteristics of herringbone and rotary milking parlours and set-ups

Farm	Ardnacranny (Westmeath)	Fortview (Roscommon)
Size	100 ha	169 ha
Cow numbers	300	400
Parlour type	30 unit herringbone	40 unit rotary
No of Operators	2 in spring,1 for rest of year	2 in spring, 1 for rest of year
Automation	Drafting, Duovac,	Backing gate, auto wash, cluster removers, teat spraying
Litres produced (2017)	1,450,000	1,940,000
Throughput at peak	140 cows/hr	240 cows/hr
Throughput in autumn	180 cows/hr	300 cows/hr
Milking time per year	3.5 hrs/cow	2.07 hrs/cow
*Capital cost of plant	€85,000	€180,000
Energy cost/l	0.37c	0.38 c

**This cost only includes plant, stallwork and automation, all other costs including shed, concrete work, milk tank, site development, ESB supply etc. would be very similar for both set-ups.*

Alternative milking technologies – factors influencing preferences

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Summary

Swing-over herringbone parlours

- Advantages include: cheaper to build and maintain; cows are in full view of the milker while in the parlour; can increase capacity (by lengthening the pit if starting from a small dairy size). Disadvantages include: requires a lot of walking and turning for milkers; an efficient milking routine is important to achieve maximum throughput; cow entry and exit can be slow; slower milking cows can slow down the row.

Rotary parlours

- Advantages of include: quick entry and exit times; cow flow less affected by cow/people interactions; little walking required of the milker; slower milking cows do not hold up more than one cluster; platform speed can be varied with the stage of lactation and yield; automation often easier to install; generally more space in working environment. Disadvantages of rotary include: expensive to build; difficult to expand; without automation, it requires at least two milkers; difficult for the milkers to see the cows for at least some of the milking; cows frequently milked out before they get to the cluster removal station (if no automatic cluster removers (ACRs) in place); more moving parts than a herringbone, requiring more maintenance.
- The comparative cash costs of the herringbone and rotary were 1.0 and 1.17 when the cost of labour was €15/hr. It was 1.0 and 1.08 when the cost of labour was increased to €20/hr.
- Automatic milking (AM) systems can reduce overall farm labour requirement by 36%. Although AM was less profitable than with medium specification (MS) conventional milking (CM) swing-over herringbone technologies, it was competitive when compared with a CM parlour of similar high specification (HS) technology.
- Increasing the cost of labour from €12.50/hr to €20/hr increased the competitiveness of AM relative to CM technologies.

Introduction

Most recent labour figures for Irish dairy farms indicate average time associated with the milking process as being 33% of total labour input (Deming *et al.*, 2018). In absolute terms, the time associated with the actual milking task (not accounting for herding of cows and washing of plant and yard) was 3.2 h/day in April and 2.7 h/day on average over the year. Thus, it is clear that with such a high proportion of labour associated with milking, the selection of a milking technology appropriate to the persons and farm system

is of critical importance. The decision to opt for a particular technology will affect the capital management and the work organisation and conditions of the farm owner/operator for a considerable number of years. Some key factors to be taken into account include: cost of investment; current and future dairy herd size; preferred length/proportion of time to be associated with milking and personal preference for different type of milking tasks (e.g. walking the length of the milking parlour pit attending to a range of tasks, mainly attaching clusters at one location or checking milking data and cow flow).

While variations exist in the designs of milking facilities, there are 3 main alternative systems, i.e. swing-over herringbone, rotary and automatic milking (AM) systems. In this paper the principles, operation and efficiency parameters of each of the systems will be examined in relation to labour requirement. Comparative costs of investment of the different systems will also be considered.

Swing-over herringbone milking system

Milking the herd is the most time-consuming task on pasture-based dairy farms using batch milking, and thus requires significant labour input (O'Donovan *et al.*, 2008; Taylor *et al.*, 2009). A recent study (Deming *et al.*, 2018) has shown that farmers (and their staff) spend 590 hr/yr, 948 h/yr and 1,199 h/yr milking in herds of <150 cows, 150-249 cows and ≥250 cows, respectively. As herd sizes expand, efficient milking parlour performance is critical to permit increased farm labour efficiency. Of the two batch milking systems (swing-over herringbone and rotary) being considered here, the swing-over herringbone is the most common and accounts for >90 % of parlours in Ireland. The swing-over herringbone is popular owing to its lower investment cost relative to other parlour types (double-up herringbone, rotary) and potential for expansion of the parlour. However, it is important to establish the level of milking efficiency of these parlours and the effect of unit number and work routine on efficiency.

A study by Edwards *et al.* (2013a) collected and analysed milking data from a sample of Irish commercial farms with swing-over herringbone parlours. Data were collected from 19 farms (ranging in size from 12–32 milking units) equipped with electronic milk metres and herd management software that recorded data at individual milking sessions. Efficiency benchmarks such as cow throughput (Cows milked/hr), milking efficiency (kg of milk removed/h) and operator efficiency (cows milked/operator per h) were calculated. Additionally, a mathematical model was developed to illustrate the potential efficiency gains that could be achieved by implementing a maximum milking time (i.e. removing the clusters at a pre-set time regardless of whether the cow had finished milking or not).

The milking efficiency characteristics of parlour sizes ranging from 12 to 32 units are presented in Table 1 (Edwards *et al.* 2013a). Cow throughput and milking efficiency (Cows milked/hr and kg of milk removed/h) increased linearly with parlour size. Conversely, work-routine time decreased linearly with parlour size. Operator idle time waiting for a cluster decreased with increasing parlour size. No trend was detected between the time required

to attach clusters and number of units. The combination of operator idle time waiting for a cluster and the time required to attach clusters decreased with increasing numbers of units. Likewise, exit and post-milking spray time decreased with increasing parlour size. Cluster idle time was variable and no differences were detected between parlour sizes. Average row time, cows milked/operator/h, and the work-routine times/operator were not different between the various parlours. Milking efficiency increased with parlour size but operator efficiency was not different between parlour sizes (Table 1).

Larger parlours were not necessarily more operator efficient (Cows milked/hr and kg of milk removed/operator per h) despite achieving greater throughput. In principle, what was operator idle time in smaller parlours was replaced by core components of the work routine, such as attaching clusters and post-milking teat spraying, as cluster number increased. This can continue until the routine contains no operator idle time, at which point if cluster number is increased there will be no throughput advantage and cluster idle time will begin to increase, as observed by O'Brien *et al.* (2012). Thus, there is a trade-off between operator idle time and cluster idle time. At this point another operator can be added, effectively doubling the work-routine time available. Larger parlours, without automatic cluster removers (ACR), have a greater risk of over-milking because in some cases more clusters are being handled per operator (O'Brien *et al.*, 2012).

Table. 1 Milking efficiency benchmark values, components of milking routine and milking characteristics of 19 farms with swing-over herringbone parlours of different sizes

	Parlour size, units					
	12	16-18	20	22	24	30-32
Av herd size	45	91	115	86	237	169
Cow throughput, cows/h	42	82	94	88	106	129
Total work routine time, s/cow	92	46	40	43	34	29
Row loading time, s/cow	3.9	2.9	3.6	3.6	4.3	3.4
Idle waiting for cluster, s/cow	3.7	6.6	4.8	2.7	-0.2	-
Cluster attachment time, s/cow	23.8	16.3	17.2	17.1	17.4	-
Waiting+attachment time, s/cow	27.5	22.9	22.0	19.8	17.1	-
Exit and spray time, s/cow	18.0	6.9	5.1	3.6	6.2	-
Average row time, min/row	18.5	13.5	13.3	15.6	13.7	14.9
Operator efficiency, cows/operator per h	43	72	71	88	76	95
Work routine time/operator, s	91	59	60	43	51	42
Milk yield, kg	12.1	12.0	11.8	13.3	11.6	11.0
Milk removal efficiency, kg/h	497	950	1098	1187	1231	1430
Operator milk removal efficiency, kg/operator per h	521	833	810	1187	880	1031

Mean cluster-on time was 6.4 min (386 s) (with SD 1·4 s). Increasing parlour size and the percentage of cows with truncated milkings resulted in less operator idle time and improved cow throughput. However, higher levels of truncation were not achievable in larger parlours owing to insufficient operator time for the routine applied, and thus maximum throughput (133 cows/h) was reached at this point.

Operator efficiency was variable between farms and probably dependent on milking routines in use and cow milk yields, and thus no clear trend with parlour size was detected. Estimated over-milking was not associated with parlour size in this study probably because additional operators were added as required, though it was greater than 120 s for all parlour sizes. Modelling indicated that through the use of a maximum milking time large improvements in throughput were possible, allowing herd milking duration to be maintained as herd sizes increase, or capital expenditure minimised.

Rotary milking system

Larger herds tend to be milked through rotary dairies in New Zealand. While herd size in Ireland is relatively small, the proportion of farms with >100 cows has increased from 4.5-23% between 2005 and 2016 (Teagasc, 2017). A number of studies have been conducted on the effect of rotary size, platform speed, and end-of-milking criteria on cow throughput and operator efficiency using data collected on New Zealand commercial dairy farms. Edwards *et al.* (2013b) indicated that cow throughput (Cows milked/hr) and milking efficiency (milk removed/h) increased linearly with rotary size, during both spring and autumn and there was a relationship between operator efficiency measures and rotary size, which peaked at ~60 clusters. Larger rotary dairies on average achieved greater throughput; however, they were not more operator efficient than medium-sized rotaries. Thus, large rotary dairies are best suited to farms where the additional throughput is required.

A further study by Edwards *et al.* (2012) examined the effect of increasing rotary platform speed on cow throughput and the percentage of cows requiring multiple rotations to complete milking. Milking data were collected from 62 commercial farms with rotary dairies in New Zealand. Average rotation time, a function of platform speed and rotary size, was 10.0±1.5 min, mean milking duration 6.3±2.1 min, and mean milk yield 11.9±3.8 kg/milking session. Results indicated that throughput continues to increase with increasing platform speed, despite a greater number of multiple rotation cows (Table 2, Edwards *et al.*, 2012). From a milking efficiency perspective, the optimum percentage of cows requiring multiple rotations was ~20%. It was concluded from this work that aiming for the previous target of 10% multiple rotation cows would limit rotary performance in many circumstances. Instead, platform speed should be set to match the abilities of the operator attaching clusters.

Table 2. Effect of three platform speeds on milking performance for a 718 cow herd milked through a 60 bail rotary

	Platform speed			
	8 s/bail	9 s/bail	10 s/bail	11 s/bail
Rotation time (min)	8	9	10	11
Multi rotation cows %	30	18	11	6
Rotations	15.5	14.2	13.3	12.7
Total milking time (h)	2.1	2.1	2.2	2.3
Difference[1] (min)	-8.6	-5.3	0	7.2
Throughput (cows/h)	347	338	325	308

[1]*Difference relative to mean rotation time of benchmark farms, 10 min*

The rotary size required to achieve maximum operator efficiency increases with increasing milk yield for a given cluster attachment time. For example, at a milk yield of 16 kg and a cluster attachment time of 10 s/cow, maximum operator efficiency is reached in rotaries ≥60 bails. At a lower milk yield of 8 kg/cow and cluster attachment time of 8 s/cow, maximum operator efficiency is reached in rotaries ≥50 bails, but could be reached in all rotary sizes examined at a cluster attachment time of 10 s/cow. In the study of Edwards (2013c), the estimated maximum throughputs of cows at different end-of-milking criteria of 0.2 kg/min to 0.8 kg/min were determined for a 50-bail rotary (Table 3; Edwards, 2013c). Throughputs ranged from 305 cows/h for the 0.2 kg/min ACR threshold to 391 cows/h for the 0.8 kg/min ACR threshold. The rotation time required to achieve these results varied from 8.1 min to 6.2 min, respectively.

Table 3. The modelled effect of different end-of-milking decision criteria optimised to achieve maximum cow throughput in a 50 bail rotary harvesting 12 kg/cow per milking

	End of milking criteria			
	0.2 kg / min	0.4 kg / min	0.6 kg / min	0.8 kg / min
Rotation time (min)	8.1	7.0	6.7	8.2
Cow loading time (s/bail	9.7	8.4	8.0	9.9
Cluster attachment time (s/bail)	11.9	10.3	9.8	9.9
Multi rotation cows %	22	23	22	0
Throughput (cows/h)	305	350	367	365

The choice of platform speed and end-of-milking criterion had a large impact on rotary performance and some important operating principles were highlighted during the optimisation of milking efficiency in the 50-bail rotary. The rotation time corresponding to the maximum estimated throughput, for each ACR threshold, resulted in 22-24% of cows requiring multiple rotations to complete milking. The presence of multiple rotation

cows meant the operator did not have to attach clusters to every cow in a rotation, highlighting that despite fast rotation times (<7 min; <8 s/bail) the average amount of time available to attach clusters did not decrease below 9 s/cow. However, the time per bail available for cow loading decreased, highlighting the need for good dairy design and stockman ship to maintain good cow flow. If using ACR thresholds >0.2 kg/min, the platform speed must be increased simultaneously to ensure that the higher potential throughput can be achieved.

Economic comparison of herringbone and rotary systems

Labour is now one of the most limiting resources on dairy farms. This is often the main driver in the decision made around which type of milking system to install. New Zealand studies showed that economically, the 50 bail rotary allowed the greatest labour saving per dollar invested for a typical farm conversion in New Zealand. Achieving high operator/labour efficiency is important in rotary dairies due to their higher capital cost relative to herringbone dairies. The trade-off between capital investment and operator efficiency (labour saving) is important in the evaluation of the most economic rotary size.

To investigate the economics of the herringbone and rotary parlours in the Irish context, a case study of a large scale farm requiring a new milking parlour and the capital, cash and profit implications of each of two options are examined. This farm has a dairy herd of 280 spring calving cows and the options of a 30 unit herringbone and a 40 point rotary are investigated (Table 4). The assumptions include: milking extends over 323 days (January to December 10th), the plant is depreciated over 10 years i.e. 10% p.a. and herringbone and rotary are financed over 15 years at 5% interest. The average time/day (over the year) spent at milking is three hours in a conventional parlour. To achieve this standard of 3h milking/day in the conventional parlour, it was necessary to increase unit numbers to allow the cows to be milked in 6 rows at ten min/row, averaged over the year. The additional time is allocated to washing down the parlour daily. All labour for the milking process is charged in this paper at €15/h. The rotary is assumed to require 1.3 labour units to complete the milking over the milking season. In the herringbone parlour, 2 people are required to operate the parlour efficiently for approximately 2/3 of the year (233 days of the 323). The herringbone parlour is assumed to require 1.72 labour units over the year.

The comparative cash costs of the herringbone and rotary were 1.0 and 1.08 when the cost of labour was increased to €20/hr. The availability of labour is not considered. It is very difficult to put an economic value on having "*good facilities*" that will attract labour and potentially retain them for longer.

Table 4. Economic implications of two milking parlour options for a 280 cow herd

	Herringbone (1 x 30 units)	Rotary (1 x 40 point)
Costs Plant, building, auto drafter, feeders, holding yard, auto wash, plate cooler	120,000 + 90,000 + 10,000 + 21,250 + 10,000 + 4,700 + 2,625	200,000 + 110,000 + 10,000 + 14,000 + 10,000 + 4,700 + 3,600
Total investment cost, €	258,575	352,300
Cash costs Repayments @ 5% interest, Direct costs = Service costs (A), ESB (B), Labour at 15€/h (C)	24,538 + 2,500 + 7,300 + 25,000	34,381 + 4,000 + 11,700 + 18,896
Total cash costs, €	59,338	68,977
Comparative	1.0	1.16
Impact on profit		
280 cows at 5,265 l/cow, litres	1,474,200	1,474,200
Depreciation plant, Depreciation buildings, Interest (av/year), Direct costs (A + B + C)	15,858 + 5,000 + 7,299 + 34,800	23,230 + 6,000 + 9,944 + 34,596
Total	62,957	73,770
c/litre cost	4.27	5.00
Comparative	1.0	1.17

Automatic milking (AM) system

The AM option is being considered by an increasing number of farmers. There are currently approximately 600 AM systems units in place on 400 farms within Ireland. Almost all of these systems are operated within a grass based system of milk production. An AM system is operational on one Teagasc Research Farm. It milks a herd of 85 cows with a mean calving date of February 21st (2018) (20 January-18 April). Cows received 420kg meal in the 2017 lactation. A 4-way grazing system was operated and average cow intake of grass was estimated at 17kg DM/cow/day during the main grazing season. The performance of this herd (78 Friesians, 7 Jersey-cross) was 5,000kg milk, 436kg milk solids (MS), 126 x10^3 cells/ml SCC. Comparable parameters during the average peak week of lactation in 2018 were 26 kg/cow/day milk, 2.0 kg MS/cow/day and 82 x103 cells/ml, respectively. Cow milking frequency was at 1.7 times/day and cows were allocated 6, 2.5, 3 and 6 kg DM/cow/day grass in sections a, b, c and d, respectively, within the 4-way grazing system.

The daily work organisation associated with AM is as follows: data checking, grass allocation, maintenance of machine, cow management. Thus the time

bound element of milking labour input is eliminated with the AM. A labour audit was conducted on both AM and CM farms over a 12-month period. Total dairy labour input was less on AM compared with CM farms, with AM farmers requiring 15.8 h/cow/yr and CM farmers requiring 25 h/cow/yr. As milking with an AM system does not require the farmer to be present at milking time, the milking process (AM cleaning and data monitoring) only consumed 40 min/day (range 25 to 60 min/day). This saving in labour associated with the milking process (from 3 h/day with CM to 40 min/day with AM), was partially counteracted by an additional 15 min/day being spent at grass allocation on farms with an AM system. Despite labour being reduced by 9.2 h/cow per year, daily end of work times were similar for each milking system, at 18:32. However, daily start times were different with AM farms starting work 50 min later than CM farms, at 07:55 and 07:05, respectively. Overall, the 36% reduction in labour demand could represent a key motivator for farmers to adopt AM.

Economic comparison of AM and herringbone milking systems

A study was conducted in Ireland on a pasture-based system in which the pre-tax profit of AM and CM systems were compared at two different levels of automation, across two farm sizes, over a 10-year period following the initial investment. The scenarios that were evaluated were (1) a medium size farm milking 70 cows twice daily with either a single AM unit, a 12-unit CM medium-specification (MS) parlour or a 12-unit CM high-specification (HS) parlour; and (2) a large farm milking 140 cows twice daily with two AM units, a 20-unit CM MS parlour or a 20-unit CM HS parlour. The capital required for each investment was financed at an interest rate of 5% and repaid over 10 years. Milking equipment was depreciated over 10 years.

In the medium farm scenario, lowest profitability was observed with the 12-unit CM HS system; intermediate profitability by the single AM unit and greatest profitability by the MS technology. The difference in profitability was greatest in the years immediately after the initial investment; the single AM unit was €8,102 less profitable than the 12-unit CM MS system in year 1, but that difference had reduced to €4,740 as interest on the debt was reduced greatly by year 10. Trends for the large farm scenario were similar to those for the medium farm, with the 20-unit CM MS system displaying the greatest profitability. However, the double AM unit achieved just marginally lower profitability than the 20-unit CM HS parlour. The reduction in profitability associated with AM (compared to the CM MS parlour) was less in percentage terms for the large compared to the medium farm situation (20 and 43%, respectively). However, despite the reduction in labour associated with AM, MS CM technologies consistently achieved greater profitability, irrespective of farm size. The availability of individual cow data at each milking with an AM system may lead to more accurate decision making on a daily basis. Despite the potential benefits of such information, it is difficult to establish the monetary value data to the farmer, as it is at the discretion of the individual farmer what role the available data plays in supporting decision making on the farm. This study indicated that although milking with AM was less profitable than MS technologies, it was competitive when

compared with a CM parlour of similar HS technology. Increasing the cost of labour from €12.50/h to €20/h increased the competitiveness of AM relative to CM technologies for both farm sizes. Any decision to invest in AM should consider several factors, such as the availability of skilled labour, lifestyle sought by the farmer, interest in technology, as well as the initial capital investment requirement by the milking system.

In conclusion, all options of herringbone, rotary and automatic milking plants have been tried and tested and do conduct the milking task well. Farmers may decide to install one over the other for specific reasons, but the main issue is to understand the implications of that decision. An Agri benchmark survey of the European Dairy Farmers Group of 2,660 farmers (average herd size of 143 cows) suggests that both rotary and robotic milking systems are likely to increase in popularity in the future. There is evidence of this at present, as shown by a growing interest in rotary and automatic milking systems. Of the business plans currently being completed by the Teagasc Dairy Expansion Service, 13% are associated with rotary and 12% are associated with automatic milking systems across approximately 300 farms.

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New dairy workplace design – the challenge of attracting and retaining staff to the NZ dairy farm of 2030

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Summary

- New Zealand dairy farmers face issues with attracting and retaining high quality staff.
- Dairy farms of 2030 will demand farm teams with flexibility, understanding of consumer and community expectations, ability to effectively use technology.
- Dairy employees in 2030 will have expectations related to hours, job satisfaction and safety, quality accommodation and social connection.
- New career paths are needed for future farmers that are not just focused on future farm ownership.

Introduction

Future dairy farms will need to be designed around people, rather than the cow, to increase the desirability of dairying as a career and to enhance the productivity, safety, and wellbeing of people on farm. Attracting young people to the dairy industry is vital not only for successful dairying, but also for succession and to enhance innovation (McKillop *et al.*, 2018). Farmers and their teams commonly work long hours on New Zealand (NZ) dairy farms (Taylor *et al.*, 2009, Deming *et al.*, 2017), which is a disincentive for many potential employees. Currently, milking tasks take up a significant proportion of the working hours. For farm owners and managers, increasing effort is also required for recording and compliance tasks. Additionally, farm systems changes required to meet environmental pressures in NZ may lead to greater impacts on people productivity and wellbeing. Here, we briefly outline the challenges for the NZ dairy industry in relation to people on farm, identify approaches currently used by farmers to make dairying more attractive and productive for people, and suggest future research priorities.

Challenges associated with attracting and retaining people in dairy

Expansion of the NZ dairy industry in the past two decades has led to an increase in the on-farm labour force. What was an industry predominantly driven by owner-operators and family labour has grown into an industry with an average herd size over 400 cows, and with a total dairy farm workforce of 33,700. This has created new imperatives for farm owners to learn how to manage people effectively, and brought the dairy industry into direct competition with other industries for staff. Major issues identified in the initial project scoping stage of this work are listed in Table 1.

Recent work to identify opportunities

In 2017 and 2018, we conducted research in a variety of areas to further understand the challenges listed in Table 1. The research included imagining future dairy workplaces, developing core requirements for people in those future dairy workplaces, examining approaches such as varying milking intervals, learning from innovative farmers, and potential application of technology for people productivity.

Table 1. Issues facing NZ farmers when attracting and retaining staff

Issue	Description
Recruitment and retention	• Dairying is not an attractive career for many potential entrants (hours, and wage v effort) • Demographic change is drawing people away from rural regions • Expectations of younger generations include social networks and hubs of activity not accessible in farming locations
People productivity and remuneration	• Long hours and days of work, mostly milking • Lack of flexibility around hours worked, farmers are tied to the farm • Farmers are faced with constant changes in compliance and regulation • Highly physical farming practices are unsustainable • Few farmers have developed policies and procedures to save time and increase people productivity
Skills and learning	• Lower skilled people need to perform quickly at a higher level (e.g. migrants, and New Zealanders with limited prior experience) • Skills development pathways should link with specialisation, generalisation, and progression
Structural issues	• Stigma associated with farmers reducing the hours worked (e.g. 'lazy') which acts as a barrier to adoption • There are many sunk costs that inhibit change (e.g. animal breeding, dairy infrastructure)
Profitability	• Opportunities to address issues outlined above often negatively impact farm profitability. • The cyclical milk price and overall farm profitability compound this.

Imagining the dairy workplace of 2030

A one-day workshop was held in Hamilton to begin a process of designing dairy farm systems that are productive and attractive for people. We had a range of participants, including farmers, consultants and service providers, dairy technology experts, academics, dairy training representatives, and industry representatives. We also ran two workshops with Massey University and Lincoln University students to collect their perspectives. A summary of outcomes is outlined in Table 2.

Table 2. Factors important in the dairy workplaces of 2030

Issues and opportunities for the farm of 2030	Creating attractive and productive dairy workplaces for 2030
• Development of niche and speciality products, connected to the NZ brand story and connected to consumers, paid for through specialist milk supply systems and differentiated payments. • Changing farm ownership structures due to debt burdens and less defined ownership progression. Co-owned companies may evolve, along with fewer but larger farms with a smaller national herd. • Changing stresses in the labour market, including different movement of labour, less labour through technology, changed availability of low/medium skilled people, greater use of specialists and contractors. • A change in roles on farm through use of automation and data, and also a need for professional land managers who adopt aspirational quality assurance. • Greater connection between the consumer/community and the farm, through traceability. Compliance will be business as usual and will require accurate record keeping that may be automated. • Agriculture/Horticulture sectors will be more integrated, with a wider landscape perspective	• Facilitating pride in dairy farming • Fostering the achievement of personal goals • Creating more time for management • Minimising the drudgery on farm • Providing career pathways • Providing financial freedom • Providing a safe workplace • Highlighting a connection to the outdoors and the farming lifestyle • Treating farm teams as 'customers' • Creating a place where people can learn and grow • Creating a sense of community - one that is connected and nurturing

Developing a people-focussed 'Brief of Requirements'

Previous studies have shown that when designing for the future, it is important to build a standard against which the success of new farm systems approaches can be assessed (Elzen and Bos, 2016). We developed a Brief of Requirements (BoR) to outline the needs of dairy farmers and employees. We split the BoR into three categories (farm owner, sharemilker, employee), and developed draft requirements in conjunction with industry experts, farmers, and future farmers. Some of the high-level factors include: sense of purpose, rewarding careers, maintaining self-respect, control, a healthy place to live, and a sense of job continuity. The draft BoR will be further refined in the next year, with a particular focus on the needs of future farmers.

Variable milking intervals

Milking-related tasks account for around 50% of time on farm, and the interval between milkings set the length of the working day. While significant research has been conducted on once-a-day milking (OAD) in past decades (Edwards, 2018), there has been less attention on other milking interval options. A 2018 survey found that while 59% of farmers use all season twice a day milking, 7% were using full season OAD, 22% were using tactical within-season OAD, and 7% were using a 16 hr milking interval. We ran focus groups with farmers in three NZ dairying regions which highlighted that farmers used OAD as a tactical tool at different times of the season, depending on factors such as body condition, climatic events, feed availability, and staffing. Variation in milking start/finish times was not common, and variations such as 16 h milking were also rare. Farmers questioned longer term impacts of different milking intervals on milk production and profit, environmental implications, and how to determine the trigger points to initiate milking intervals changes.

Innovative practices of leading farmers

In 2018, we interviewed 20 dairy farmers throughout NZ, using a semi-structured interview approach based around themes of: core requirements for people (owners, employees) on dairy farms; indicators of successful people-focussed dairy farming; innovative practices farmers are using; and what new workplace design concepts would be attractive. Initial reflections include: hours of work are a big issue and tactics such as OAD are often attractive to employees, new progression models are required to draw people into the industry, good leaders make people management look easy. But the challenge is to improve leadership among those to whom it does not come naturally.

Discussion

The dairy workplace of the future will probably be highly dynamic, more open to consumers and the community, and largely data-driven (Cardoso *et al.*, 2016, Nuthall and Old, 2017). This presents a range of challenges and opportunities for farmers and their farm teams. In moving toward the dairy farm of 2030, the industry needs to facilitate the structures and capability for people to be fulfilled and effective within this future workplace context.

Social and nurturing workplaces

Dairy farmers and their employees can experience geographical and social isolation. They can also work long hours and, therefore, struggle to get sufficient time away from the farm, or engage in non-farming activities. This can lead to overwork, increased stress, fatigue, and depression. Opportunities for improvement that we found were based around several factors. One major factor was the quality of housing, as many employees live on farm, and provision of accommodation as part of the overall package is often a major driver for people working in the industry. There is significant room for improvement in the quality of housing offered on many dairy

farms. An additional factor is the opportunities for social interaction. With many farmers and staff socially isolated there is a need to explore ways of helping people feel connected, particularly in the current social media era.

Innovation on farm for communication and productivity

New technologies offer options for current and future farmers to minimise time spent on manual tasks, or streamlining decision making. These technologies include automation tools, robotic milking technologies, greater use of communication technologies and the Internet of Things, automated pasture measurement, and artificial intelligence. In addition, the use of simple apps like WhatsApp and Facebook Workplace, have changed the way farmers communicate with their teams. Research has shown greater use of precision technologies as herd size increases (Gargiulo *et al.*, 2018). However, many of these technologies have seen limited uptake on farms to date, with the major barriers for farmers being lack of a clear value proposition and integrated solutions that clearly lead to better decision-making (Eastwood *et al.*, 2016). In the longer term, a more technologically driven dairy sector will enhance the image of dairying as an innovative workplace for future employees.

Flexible workplaces that access a diverse source of labour

Different and diverse sources of employees will need to be accessed in the future, such as career changers, urban dwellers looking for a career or farming lifestyle, and part time casual employees. However, these people will have different expectations compared with previous generations of farmers. For example, the goal of farm ownership may not be the main driver for many, and expectations around working hours and working conditions will be increasingly compared with those that could be found in urban jobs. This means we need to understand better what people in these alternative employee sources seek in a job, and what might attract them to dairy farming. The use of different approaches to managing dairy farms needs to be further researched, such as use of a 'total hours per farm' approach, flexible milking start times, variable milking intervals, team-based rosters and milking shifts, and use of shared employees across farms. Also, the value of good people management needs to be quantified, enabling farmers to justify increased wages or employee numbers.

Providing visible and varied career paths

High land prices and large farm sizes have increased the magnitude of difficulty in eventually purchasing a farm. This has impacted on the traditional dairy career path that involved contract milking and sharemilking to build the equity required. When combined with different expectations of work held by the future generations of farmers, there is a need to develop and promote the different careers possible within dairying. An example is the possibility of being a well-paid farm manager or operations manager, rather than striving for farm ownership.

In summary, our future research will test new systems that implement a range of options to provide people with meaningful work and a good lifestyle without compromising profit. The aim will be to create knowledge and guide development of dairy farming systems that are focussed on people, by being engaging and attractive workplaces with a reputation for innovation and vibrancy.

Acknowledgements

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Attractive careers and people management on dairy farms: two sides of the same coin

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Summary

- Attracting and developing a farm workforce is now a crucial aspect of farm business success alongside other strategies related to farm performance and sustainability.
- Research in numerous sectors and workplaces worldwide demonstrate that progressive human resource management practices lead to engaged workforces which increases productivity and business success either through profitability or lower workforce turnover, which also reduces the impact of workforce shortages.
- Farm employers should consider working conditions, remuneration and benefits packages and career development and promotion in the design of quality jobs.
- Formal HRM practices assist the communication between employees and employers about roles and responsibilities, wage rates and remuneration, as well as the potential for career development.
- Farm employer's leadership of people and comprehensive employment strategies can be considered the ultimate 'attractor' for the future workforce in agriculture.

Introduction

This paper provides an argument as to why farms need to prioritise progressive human resource management (HRM) practices in their overall farm strategy. Examples of different dairy farm human resource management approaches are provided from Australia along with the experience of farm employees being provided rewarding work and career pathways. The paper concludes with suggestions for tailoring human resource management approaches to attract and retain the farm workforce.

Why 'people management' has become so important in farming

Worldwide, farm management and leadership responsibilities have changed because of larger farms and greater numbers of non-family employees (or others) deployed in farm work. There are more decisions and more complex decisions relating to:

- family member roles
- which workforce strategies to take (e.g share farming, specialist managers (herd/pasture), use of contractors)
- methods to best recruit and select employees
- setting retention policies (eg. blanket or targeted) including development of talented employees

- engaging beyond the farm gate in labour markets and where the level of education attainment, labour market profile and prospects for job seekers varies considerably depending on where you live or which 'labour pools' you are drawing from.

Farm workforce issues can change the farming game for many, challenging the very reason farm owners began farming in the first place. Now, you need to consider: ***'Why would anyone come and work on my farm and for me?'*** or ***'How can I promise a career when I'm not planning on stepping back from control of decisions for a long time?'*** Attracting and developing a farm workforce is now a crucial aspect of farm business success alongside other strategies related to farm performance and sustainability.

What HR practices matter?

Research in numerous sectors and workplaces worldwide demonstrate that progressive human resource management practices lead to ***engaged workforces*** which increases productivity and business success either through profitability (Jiang *et al.,* 2012) or lower workforce turnover, which also reduces the impact of workforce shortages (Nettle *et al.,* 2011). Progressive human resource management practices don't involve 'carrots' and 'sticks', but tapping into people's intrinsic motivations and needs for: 'autonomy' (having some control over the way they do their work for their role), 'mastery' (ability to apply skills and develop skills to achieve something of importance), and 'purpose' (doing something meaningful) (Pink, 2009).

However, the reputation of agriculture to attract and retain employees continues to be eroded by:

- Poor working conditions which impact on employee living standards or family life;
- Lack of career development and promotion opportunities on farm, low interest of employers in supporting employee careers or limited understanding of careers available in farming;
- Concerns for occupational health and safety;
- Availability of alternative employment with better job and career opportunities.
  (adapted from Nettle, 2015).

Farm employers can consider the following factors in the design of quality jobs:

Working conditions

Working hours, particularly for owners and managers, remain a critical issue for agriculture. In a national survey of Australian dairy farmers, the average number of hours worked on a farm in a week was 63 hours (Dairy Australia 20143. Annual hours of work of farm owners and managers was two-thirds more than hours worked in the Western world (1,776 hours) (OECD, 2013). Excessive work hours have been associated with human wellbeing and can lead to burnout (Nettle *et al.,* 2018). An important consideration is the impact of working hours on the image of farming careers and workplaces to potential entrants, whether that be family members or employees. Improved working conditions have been linked to the retention of farm workers (Gabbard and Perloff, 1997).

Remuneration and benefits packages

Whilst the influence of pay levels in agriculture in attracting and retaining staff has been the topic of much debate, farm employers and employees both report uncompetitive wages as a factor influencing the relative attractiveness of agriculture. In a study of dairy farm employment in Australia, current employees that experienced higher wages in the dairy industry, for their role were more likely to intend to stay with their employer (Nettle *et al.*, 2011, p. 3). For employees already working in agriculture, it was the relative pay for the specific industry and the role rather than the gross pay level that influences their intentions to seek another job in agriculture. Using pay as the key method to attract and keep employees is costly when employers can also put in place measures such as: treating people well, addressing individual employee needs; good employee induction; provision of opportunities for career development; and meaningful work assignments.

Career development and promotion

Whilst vocational training provision in the agricultural sector is largely geared to skill needs, the role of training and development opportunities in attracting and retaining employees is often overlooked. The provision of growth and development opportunities and an employers' interest in the career trajectory of their employees are one of the most desired attributes of jobs. Further, when this is provided, employees reported greater commitment to the employer (Nettle *et al.*, 2011). This can be a combination of informal and formal training and professional development opportunities. Employers are a significant source of career development and mentoring for employees. Some farm employers are beginning to recognise this and are implementing mentoring, training and career planning practices as part of their employment practices.

What farm employers are providing and what employees want?

A recent dairy employment survey in Australia (Dairy Australia, 2017) asked farmers what they did to retain staff (Figure 1).

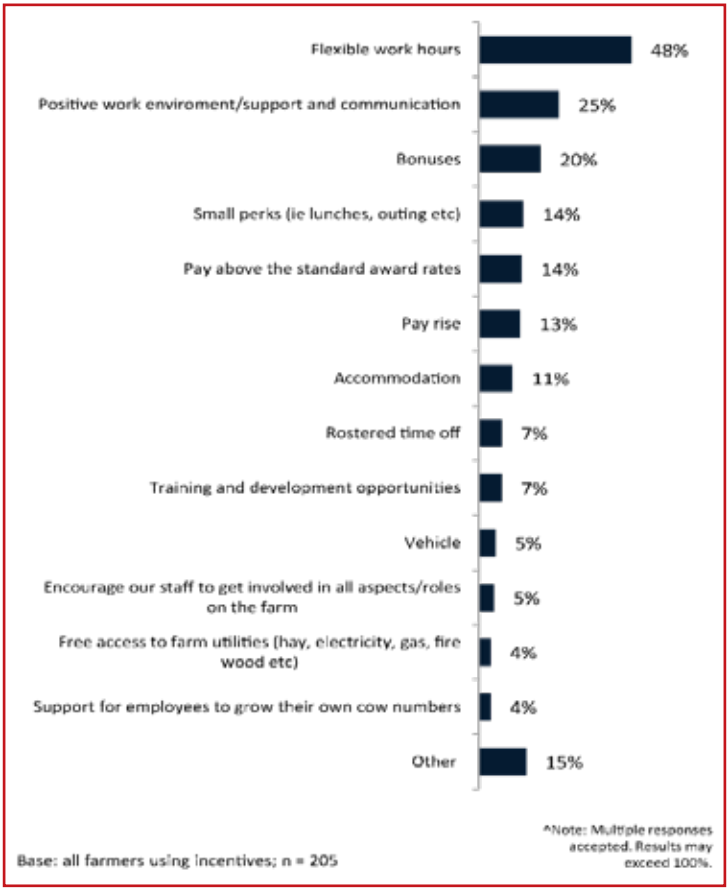
In a study of dairy farm employees (Nettle *et al.*, 2011), the most common practices appreciated by employees were:

- flexibility in work hours
- rostered time off
- training and development (including mentoring, career planning)
- recognition of a job well done.

Studies of farm employee's decisions regarding working in agriculture suggest that a family background in farming, the farming lifestyle and working outdoors or with animals are attractive.

Why do dairy farm employees leave?

High voluntary turnover rates in agriculture in many countries suggests agriculture can attract people (farming can 'tap into intrinsic motivation' to work outdoors or with animals and machinery), yet agriculture struggles to meet expectations and fulfill other needs. In a study of dairy farm employees (Nettle *et al.*, 2011), reasons for leaving dairy farming were: better options available elsewhere; to 'move up the ladder' and 'seek personal growth or skill development'; being dissatisfied with the work-life balance; experiencing poor working conditions, poor remuneration and poor management support; bad employment relationships'; 'non-competitive salary'.



Staff retention measures they have pu in place †

Figure 1.: *Australian dairy farm employee retention strategies (Dairy Australia 2017) (NB 'award pay': Australia's industrial relations system applies legal framework for remuneration and conditions in different sectors. Dairy farm employees come under the pastoral 'award' for minimum pay levels.)*

Why do dairy farm employees stay?

When these elements are addressed, farm employees show high levels of engagement in their work. Studies of farm employee engagement have shown employees appreciate being trusted and valued and when managers are concerned with developing individuals and building a supportive environment. Employees in an Australian study said their employers 'stood out' from other farm employers (Nettle *et al.,* 2011, p. 55).

How is all this linked to attractive careers?

Farm employee careers are forged from their intrinsic motivation that can be further developed in farming; from the experience and skills developed through dairy farm work and, the formal and informal training along the way. Attractive careers come from the actions of employers in providing vision for what farming can provide – through how they employ, mentor and grow their employees. This is conceptualised as a social contract between employers and employees and in the industry to grow attractive careers through progressive human resource management (Figure 2). The diagram starts with the employer, recognising the importance of people to farm business success.

Conclusion

There is big scope for improvement in HRM in agriculture. Whilst some farm employers are leading the way, more farmers able to provide career pathways, supportive work environments, flexible working hours, opportunities for work exchange and community development programs can support staff attraction and retention in regions. Formal HRM practices assist the communication between employees and employers about roles and responsibilities, wage rates and remuneration, as well as the potential for career development. The benefits farmers associate with retaining and developing employees should not be overlooked. Farmers report that employees build skills appropriate to the farm; farm owners/managers can take time-off away from the farm with confidence; the farm runs more smoothly and employees develop ownership and commitment toward the goals of the farm, becoming a source of future share farmers and business owners in the sector. Farm employer's leadership of people and comprehensive employment strategies can be considered the ultimate 'attractor' for the future workforce in agriculture.

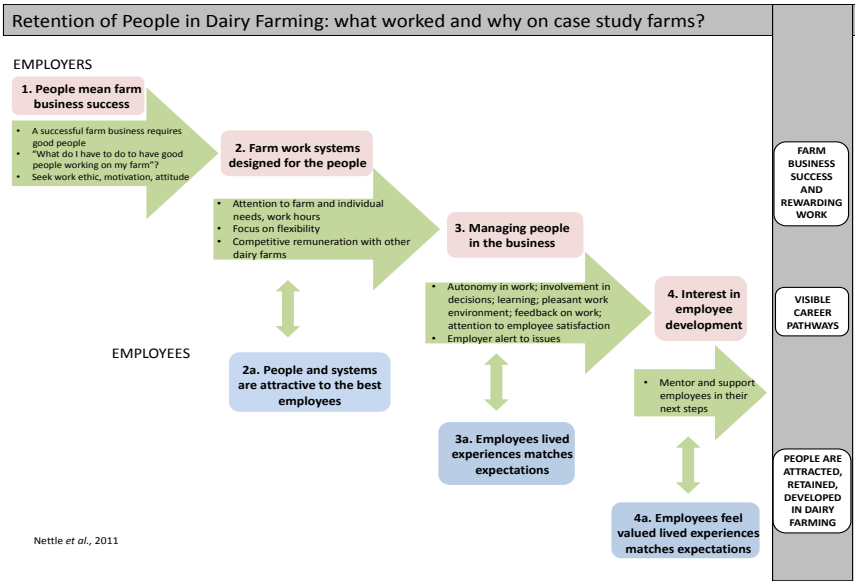


Figure 2: *The interrelationship between employers' actions (pink/green), the impact on employees (blue) and the outcomes for farm productivity, careers and workforce outcomes.*

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People management for a successful spring

Mark Cassidy

Cookstown, Kells, Co. Meath

The purpose of this presentation is to summarise my thoughts on getting ready for the calving season. The idea of calving 90% of 340 cows in 6 weeks is daunting. But by being well prepared I am able to cope with the tsunami of calves that's ahead of me and survive calving without too much stress.

Some background

I farm 121 hectares of land of which 100 hectares comprise milking platform, with 66 hectares of the land farmed on long term leases for 10 and 15 years. This year, I have an average of 319 dairy cows on the farm. All male calves and beef heifers are sold shortly after birth. The heifer calves are moved for contract rearing to an out farm within a week of birth and these heifers do not return home until two months before they calve.

"Tsunami of calves" is my description of the first six weeks of the calving season. With a large and compact-calving, seasonal herd, during the month of January I have an impending sense of doom. It is like a Tsunami – It is coming and there is nothing I can do to slow it down or prevent it! And there is an expectation that a lot of the herd will calve quickly, 50% in the first three weeks; at that point, up to 20 cows would be calving/day.

It might be your first reaction but… don't panic

How do I avoid the panic?

My farm management mentality is to save time in every way possible: we can all make more money, but we can't make more time. To give myself more time I use:

- *Farm Relief Service:* All labour is paid through the Farm Relief Service (FRS). If I source a new worker, I let them know that they will be paid through the FRS. This eliminates any paperwork and all employment responsibilities are dealt with by FRS.
- *Contractor:* I have a very good relationship with my contractor, maintaining that is key to the business. As all machinery work is contracted out, it is simpler and cheaper than the running costs, repairs and labour to operate it, without the other major costs of purchase and depreciation.
- *Procedure sheets:* These are essential to allow me to step back and mean that everyone on the farm knows exactly what is required of them.
- *Getting the message across* to people can be challenging but I have found that if it is clearly expressed in black and white and on the wall, getting that message received is much easier.

Key areas

Preparation for calving begins now. For my farm there are four key areas that are equally important in making sure we're ready for calving. These are: animals, facilities, personal and people.

Animals:
The biggest stress points you will ever have during calving season is health problems in cows or calves!

- *Cows:* I try to avoid having thin cows at drying off by feeding a high energy and low protein ration to put condition on cows for at least a month before drying off. The dry cow is fed according to her body condition score taken in December. Thin cows are separated and managed to achieve a condition score of 3.25 at calving. Minerals are fed to counteract any deficiencies in silage and Iodine is added to water for all dry cows and in-calf heifers. All of the cows calve on a woodchip area on the farm or on a silage pit when the silage is finished. They will be on the woodchip for up to a week before calving. Once calved, the cows are moved to the transition herd for 4 days (grazing by day only), and then to the milking herd.
- *Calves:* All cows are vaccinated for calf scours in January. New-born calves are moved shortly after birth. Calves are iodined, tagged and stomach tubed with 4 litres of pooled colostrum. I place huge emphasis on having healthy stock, so this routine is religiously carried out. It is important that all calves remain healthy as the space is not available or the time to keep calves longer that we need to. Everyone must disinfect before entering the calf shed. Access to the calf shed is restricted, I have a "*No entry disease precautions*" sign on the door. Nobody from outside the farm is allowed past the door EVER. Especially calf buyers and vets! It's not worth risking an outbreak of disease!!

Facilities:
Facilities on the farm are pretty basic and consist of the following:

- A 28-unit milking parlour where freshly calved cows are milked after the main herd in spring.
- Topless cubicles (300) where the cows are wintered in groups according to condition score.
- Roofed cubicles (67) for in the in-calf heifers.
- The wood chip pad which can accommodate up to 60 cows near calving.
- The calf shed which can accommodate 72 calves in groups of six.
- The calves are batch fed on teats, with whole milk once-a-day, with milk pumped to each feeder with a metered nozzle.
- Replacement heifers are gone within a few days to the heifer rearing farm.
- All other calves go to the mart for sale as soon as possible.

- Doing the best you can with what you have got; having yard lights that work and are in the right place and gates working saves time and reduces stress.
- A good welder for a day is money well spent. It is important to have all gates hanging properly and open easily, not tied and falling down!
- Gated narrow walkways so cows and calves are unable to run around as they would in open yard.

If you think the facilities are perfect, then ask the workers what they would change! They represent a fresh pair of eyes and you might be surprised with the answers you get!

Personal:

- Calving season is very physically demanding and, in preparation, I start fitness training. I like to run obstacle course races and I train for calving season in the same way.
- Stress can have a very negative effect on our mental health. I actively plan for stress reduction by being prepared. I look back at last season's stress points and put a plan in place to prevent them repeated.
- I use a checklist to keep track of the on-farm preparations which begins in December. When a job is completed I tick it off on the list and focus on the next task. I find a checklist to be a great motivator especially around the lazy Christmas holidays, and I can be confident that I am ready, facilities are ready and that everything that will be needed for the calving season is on the farm by 1st February. This reduces extra pressure, when busy during the calving season.
- I also take the pressure off myself, by delegating – selecting jobs and giving them to one of the workers, effectively making the job Somebody Else's Problem.

People:

Planning a worker's meeting in January to discuss roles and procedures. This allows everyone to know their job on the farm well before calving starts. For all the major roles involved there is a standard operating procedure. I have a team of 6+ people including myself that work on the farm during the busy part of the calving season which extends from early February until St. Patrick's Day.

- Once-a-day milking: During the calving season there are always two people in the milking parlour to milk the cows in the morning. From the start of calving until March 1st. Their role is to milk and draft out and manage the freshly calved cows. These two people are rostered from a team of three. After 1st March one person does evening milking but no freshly calved cows are milked in the evening.
- In the calf shed one person feeds all the calves on the farm during the spring. This person is rostered from a team of two people who fulfil this role.

- Grass and new-born calf management – these are my main roles during the springtime. I ensure that all new-born calves get sufficient colostrum, are tagged and navels are disinfected. My other role in the spring is setting up the grass sections for the cows to graze.

Support:
I also have an absolutely essential support team on hand to support the work we do with the animals on the farm.

- The contractors who look after all of the machinery work from feeding silage to spreading fertiliser and slurry throughout the spring time
- The calf seller who takes all calves destined for sale to the mart every Monday morning throughout the spring
- The contract rearer, who takes replacement calves.

Staff Moral
I have found that it is vital to maintain moral, if possible to watch for times when it is low, to listen to workers opinion on why moral has dropped and then do something about it. We all know that there is nothing worse on a cold miserable day in March than to be hungry. Every day during calving season all people working on the farm are given lunch, with at least one fry up during the week, that and a hot cup tea makes a tough day much more do-able.

Everyone needs time off
All workers are part time and work through the FRS. They need to be rostered on to suit other commitments that they have such as other work, kids, study, etc. I want to give everyone 1 day off after 2-3 days on, to keep them fresh. This past spring, I had a separate team of 3 milkers for the weekend, to give the weekday team a well-deserved break, this worked really well and I will continue this for next calving season. I'm also looking for a night-time calving person for 2 or 3 nights to give myself a break – these are harder to find!

It does not always work out, but there needs to be some slack in the system or it will snap!

And finally—what is an SEP?

Profiles

Bernadette O'Brien

Dr. Bernadette O'Brien is a Research Scientist at Teagasc Animal and Grassland Research & Innovation Centre, Moorepark. Bernadette's work has previously focused on milking technology and milking frequency. Since 2013 she has focused in particular on large-scale research projects funded through the EU, undertaken in conjunction with colleagues in a number of European Research Centers and Farming Organisations. Currently, she is working in the areas of automatic milking in grass-based systems; precision technology for grazing management, e.g. field-based grass quality sensor and calibration of image data; further precision technologies for direct use by farmers, such as devices that monitor cow location and cow grazing behaviour; the demand, supply and efficient use of labour on dairy farms; and in milk quality, particularly focusing on investigation and minimisation of residues TCM and chlorates in milk.

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Callum Eastwood

Dr. Callum Eastwood is a Research Scientist at DairyNZ, a farmer-levy funded organisation focussed on enhancing profitability, sustainability, and competitiveness for NZ dairy farmers. Callum is based in Lincoln in New Zealand's South Island, and his research centres around people, technology, and innovation systems. He leads a project focussed on making dairy systems more attractive and productive for people. His areas of interest include: effective use of new technologies in farming systems, technological innovation systems, improving coordination between farmers and technology developers, and integration of data into farm decision making. Callum previously studied and worked at the University of Melbourne in Australia, and at Massey University in NZ.

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Joe Aherne

Joe Aherne is a proud CPA and Past President of his Institute with over 30 years' experience in industry both at home and abroad. Joe has also attained qualifications from the Marketing Institute of Ireland and from City Bank in the U.S. together with a Postgraduate Diploma in International selling from DIT and looking to start an MSc in Sales Management in 2019.

During his qualification years, Joe worked for a diversity of companies including the meat industry prior to his departure abroad in 1984. Joe joined the Almarai food company in Saudi Arabia and was subsequently appointed to the executive board of the Dairy Division, one of the largest dairy companies in the world. After working in the Aviation and technology sectors in the UK and Ireland, Joe established the Leading Edge Group in 1995, an international boutique consulting company supporting a variety of manufacturing and service organisations in Ireland, Canada and Australia. He is also chairperson and founder of the Court of Experts, a networking body of top multinationals in Ireland. Joe is currently actively involved in bringing a new SaaS product to market targeting large multinationals and food based organisations. The company has worked with the top Dairy food companies in this country and are currently partnering with Bord Bia on implementing Lean in the Irish Pig sector.

John P Murphy

John P Murphy is Head of Continuous Improvement for Dairygold Co-op since 2014. This role incorporates the Lean & Six Sigma Programmes, the Technical Teams and the Quality Control Group.

My role is to set the direction and implementation to ensure that Dairygold improves in all aspects of its business and that we are constantly adding value.

I graduated as a Chemist from University College Cork in 1989, completed my Lean Six Sigma Black Belt in 2009 with Rath & Strong and finished my academic career with a Masters in Engineering & Science (Biopharmaceutical Technology) in 2010.

I started my working career as a med Lab Technician working for the Blood Bank in Dublin. From there I returned to Cork and worked in the Chemical and Pharma industry as a development chemist, production supervisor, project manager, plant manager and then headed a continuous improvement program. After twenty four years working in the Chemical/ Pharma sector I moved into the Dairy sector.

My greatest achievement in 2017 was turning the concept of Lean Farm into a reality with the commencement of a pilot and subsequently securing Board approval to launch a Lean Farm programme across all Dairygold suppliers.

John Upton

Dr. John Upton is a Research Scientist at at Teagasc Animal and Grassland Research & Innovation Centre, Moorepark. He has a degree in Mechanical Engineering and obtained his PhD in 2014 from Wageningen University, the Netherlands. His research interests include milking machine performance and milking management, congestion of the bovine teat during milking and milking research techniques and methodologies. He is also involved in energy consumption on dairy farms including energy audits, renewable energy experiments, energy efficiency trial work, smart metering networks and demand side management in agriculture, renewable energy integration, water consumption on dairy farms and developing guidelines for best practice in dairy production.

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Marion Beecher

Dr. Marion Beecher is currently working with Teagasc at Moorepark, Fermoy, Co. Cork, Ireland as a Research Officer. Her focus there is on labour efficiency and productivity on dairy farms. Prior to this she co-ordinated the Teagasc Professional Diploma in Dairy Farm Management programme designed to train the next generation of dairy farm managers. Marion graduated from University College Dublin with a 1st class honours degree in Animal Science in 2010 and a PhD in Animal Science in 2014.

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Mark Cassidy

Mark farms 121 hectares of land (66 hectares of which is leased). The milking platform accounts for 100 hectares. In 2017 Mark had an average of 304 kiwi cross dairy cows on the farm and milked 311 cows at peak. He grows approximately 16.5 tonnes of grass DM/ha with the cows fed 400 kg meal per head. Male calves and beef heifers are sold at two weeks old. The heifer calves are moved for contract rearing within 1-week of birth and do not return home until two months before they calve. Fertility is good with 9% empty after 15 weeks breeding, he sells the later calving cows and brings in around 70 heifers every year. In 2017 the calving interval was 365 days with 91% calved in 6 weeks.

Nathalie Hostiou

Dr. Nathalie Hostiou (INRA, UMR Territoires) carries out researches on labour in livestock farming systems in different countries. She studies the consequences of precision livestock farming on farmers' work, changes in labour profile due to employment of hired labour and the assessment of work efficiency and flexibility. She co-authored the Quaework approach to qualify work organisation and evaluate its efficiency and flexibility with a deep analysis of how livestock farming system management is involved. She coordinates the Mixt Research Education and Extension Network "*work in livestock*" since 2014.

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Paidi Kelly

Paidi is a Research Officer based in Teagasc Moorepark. His work project is titled 'Career pathways in dairy farming' and is focused on collaborative farming models and projecting national labour requirements. Originally from a dairy farm just outside Nenagh in Co. Tipperary, Paidi graduated with a degree in Agricultural Science from UCD in 2012 and went on to work as a Dairy Specialist in the Irish Farmers Journal for over a year before then joining Teagasc. Paidi is also involved in a dairy farming partnership which operates on non-owned land.

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Pat Hickey

Pat operates two dairy farms in Westmeath and Roscommon with herds of 300 and 400 cows, respectively. He manages a spring-calving, grass-based system and rears approximately 300 young stock annually. Pat operates both herringbone and rotary milking parlours. He supplies milk to Aurivo. Pat is originally from Kilkenny and purchased these farms in 2005 and 2014. He is also involved with family members in six other farms as well.

Patrick Shine

Patrick started full time farming in 1998 after attending Rockwell Agricultural College. He initially milked and he currently milks 130 spring-calving high EBI Friesians on 42ha. Patrick also has a calf-to-beef and cereal production enterprises on outside blocks consisting of 52ha. Patrick is a member and former chairman of a discussion group and was one of the 15 dairy farmers who took part in the Dairygold Lean pilot project in 2017.

Priscila Malanski

Dr. Priscila Malanski is an Animal Scientist specialised on farm labour in livestock systems. She is Executive secretary, documentalist and webmaster of IAWA *https://orcid.org/0000-0002-4145-3431.* She carries out multidisciplinary studies on:

- changes on work organisation and its relation with farm changes
- development of employees career in livestock farms
- scientometric analyse of international bibliography about work in agriculture.

Priscila works in collaboration with French researchers and agricultural advisors from INRA, Livestock Institute (IDELE) and the Mixt Research Education and Extension Network "*Work in Livestock*" (RMT Traval en Elevage), as well as Brazilian researchers from State University of Maringa, Federal University of Para and Federal University of Rio Grande do Sul.

Ruth Nettle

A/Professor Ruth Nettle leads the Rural Innovation Research Group in the Faculty of Veterinary and Agricultural Science at the University of Melbourne, Australia. Along with a University teaching role, Ruth conducts engaged research with industry groups, communities and stakeholders, with outputs that are meaningful and directly used by these groups to inform policies, strategies and the design and evaluation of change interventions. Ruth's specialist research fields include: agricultural workforce development; farm employment relations and farm workforce planning; agricultural advisory and extension systems; agricultural innovation. Ruth was the research lead for Dairy Australia's 'People in Dairy program' for six years (2006-2012). Ruth has extensive experience in designing, implementing and evaluating agricultural extension programs in the rural sector, including a previous career leading the dairy extension team in the Tasmanian Department of Primary Industries.

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Notes

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