EFFICIENT MILKING IN HERRINGBONE AND ROTARY DAIRIES

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Summary

All dairies

- Good cow flow is critical to achieving an efficient milking
- Ensure a calm, relaxed atmosphere with minimal possibility for cow injury

Herringbones

- Tactics, such as minimising the time waiting for cows to exit by early release of the head gate improves parlour efficiency
- Clusters managed per operator is determined by work routine and milking duration of the slowest milking cow
- Applying a maximum milking time (MaxT) increases cow throughput

Rotaries

- More ‘go-around’ cows do not decrease efficiency
- Optimal platform speed and end-of-milking criteria depend on rotary size, milk yield and cluster attachment time
- Setting an ACR threshold to ≥0.4 kg/min and a rotation time of ≤8 min generally results in efficient milking

Introduction

Milking requires a large capital investment in facilities and a significant amount of labour, up to 57% of time on New Zealand dairy farms (Taylor, *et al.*, 2009). Selecting the most appropriate dairy and operating it in an efficient manner is important to help maintain a profitable dairy business. With herd sizes continuing to increase, there is greater need to achieve efficient milking. The objective of this paper is to explain the principles (perfect world situation) behind the operation of herringbone and rotary dairies and how implementing certain strategies using today’s technology can improve milking efficiency.

Cow Flow

Good cow flow is essential to achieve efficient milking in both herringbone and rotary dairies (Eden & Jago, 2009). One of the key requirements of good cow flow is that cows are relaxed and comfortable and, therefore, cows should be milked in a calm atmosphere, without fear of injury. Design plays a significant part in ensuring the latter is met; for instance, ensure that horizontal stall work is cow-side of vertical structures so there are no protruding areas for cows to catch their hip bones. When a cow is injured, a negative association is formed with the place of injury (Pajor, *et al.*, 2000), so cows become hesitant and less willing to walk freely into the shed, reducing cow flow. In spite of this it is very common to see exposed vertical pipes in shed entrances, polished smooth by continued contact with cows. This also applies to the exits of herringbones, so, for example, pendulum gates need to lift up high enough to let cows walk underneath without striking their hips.

Minimising direct operator contact with cows is also important. In rotaries, this means the console with platform and backing gate controls should be located to the side rather than behind the cupping position, or else install a visual barrier to screen movement and prevent eye contact.

Entering the holding yard should be minimised, but for those occasions where it is required ensure slipways are located directly into the yard rather than the cow entry where flow may be disrupted. Similarly, in herringbones avoid entering the yard (e.g. to attach/remove row holding chains) to minimise disruption to cows waiting to enter the next row. Installing mirrors to assess the position of the backing gate also reduces the need for operators to approach the yard. Refer to Eden and Jago (2009) for more cow flow tips.

In short, evaluate design critically for factors impeding good cow flow. When good cow flow is achieved then efficient milking practices can be implemented.

Herringbone sheds

In herringbones (HB) the number of cows milked per hour is determined by the operator work routine time (WRT), which can include cow loading time, cupping time, cup removal, teat spraying, exiting time (waiting for cows to exit) and any idle time. Core components of the WRT such as loading and cupping should remain constant per cow regardless of the number units (clusters) in the HB. However, if the number of units is increased the operator is busier and idle time replaced by core components such as loading and cupping. The optimum number of units for an operator is determined by the milking duration of the slowest cow and the time to complete core components of the WRT. For example, if the slowest milking cow takes ~8 min (480 s) and it takes 24 s/cow to complete the core routine then an operator can manage 20 units (150 cows/hr). If more than 20 units are installed overmilking occurs, or if automatic cluster removers (ACR) are installed to prevent overmilking then clusters are idle. If a second operator is added, the operator time is effectively doubled, but without higher cow throughput operator efficiency is reduced through increased idle time. The idle time decreases as further units are installed until at 40 units both operators are fully occupied (Figure 1, ‘Standard’). Conversely, if less than 20 units are installed operator idle time is always present in the WRT.

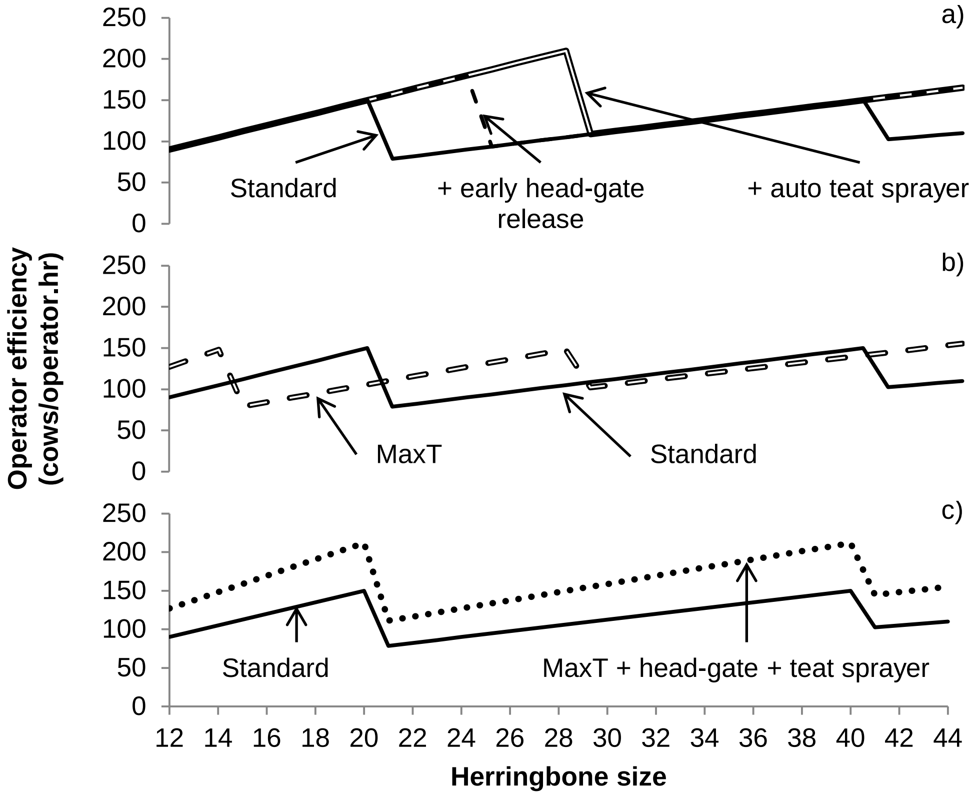

Figure 1. Operator efficiency for a range of herringbone sizes (a) comparing standard milking routine (─) with releasing the head gate early (---), and releasing the head gate early with auto teat spraying (═), (b) comparing standard routine (─) with MaxT (= =), and (c) comparing standard routine (─) with MaxT and releasing the head gate early with auto teat spraying (···).

So what strategies exist to improve HB efficiency? The milking duration of the slowest milking cow can be shortened, or the work routine streamlined, or both. Taking the above example of a 24 s/cow routine, this can be broken down into 4 s loading, 12 s cupping, 3 s teat spraying, 4 s exiting and 1 s miscellaneous, e.g. cleaning. Through efficient head-gate release the 4 s/cow exiting time can be eliminated. For example, if the head gate is released half way down the row the cows are exiting while the operator continues to change the final clusters. For HBs where two operators are required the optimal routine is where both operators start from the front (exit end) of the row moving down in a 'bunny hopping' movement (DairyNZ MilkSmart, 2013b). This means the time to when the head-gate can be released is reached twice as fast as if the second operator had started from half way. Elimination of the exit time, in the above example, means that a single operator can now potentially handle 24 units and milk 180 cows/hr (an additional 30 cows/hr; Figure 1a). An automatic teat sprayer can further reduce the WRT, in the example given by 3 s/cow, to 17 s/cow, so the operator can then handle 28 units, milking 211 cows/hr (Figure 1b). The use of ACR generally makes little difference to WRT, perhaps 1 s/cow of cluster removal, so an increase in throughput is not assured. However, the overmilking of fast-milking cows is reduced.

The other strategy is to implement a maximum milking time (MaxT), whereby clusters are removed after a fixed time regardless of whether a cow has finished milking or not (Jago & Burke, 2010). The aim is to truncate the slowest milking 20% of cows, reducing the row time, without impacting on production or somatic cell count (SCC). This is straightforward to apply in a HB, by moving down the row attaching clusters until the desired time is reached (e.g. 5.7 min for ~9 L of milk; see milksmart.co.nz for further details) then return to the front of the row and swing clusters over, in order and irrespective of whether a cow in the row is completely milked out or not. This has the effect of either reducing the number of units required to reach maximum throughput (e.g. the initial example of 150 cows/hr with 20 units can be achieved with 14 units), or if the work routine has been streamlined to 17 s/cow then 20 units can be handled, achieving 211 cows/hr (Figure 1b;1c). This is an equivalent throughput to that in the example with 28 units when MaxT was not applied. The added benefit is there is less overmilking in HBs without ACR installed, limiting teat-end damage. Overall, the use of MaxT and/or streamlining the work routine can improve throughput in an existing HB, or save capital when building as the same level of throughput can be achieved in a smaller HB.

Rotary sheds

In rotaries it is typical for cluster removal, and teat spraying to be automated and cow loading and exit to occur simultaneously. So, the number of cows milked per hour is a function of the number of bails, the speed of the rotation, and the average and distribution of cow milking durations (Edwards, *et al.*, 2012). In an existing dairy, the size of the rotary is fixed; however, platform speed and cow milking duration can be manipulated easily by the operator. Modelling of platform speed indicates that, contrary to popular belief, setting the speed to allow a maximum of 10% of cows to 'go-around' more than once does not necessarily achieve maximum throughput, which continues to increase with increasing platform speed (Figure 2). However, this does not necessarily mean operators should select the maximum speed as at very fast platform speeds there is little increase in throughput. As a guide, operators should aim for ≤8 min rotation time, even if that means 20% of cows are 'going-around' more than once at peak lactation. However, maintaining a sustainable speed for operator comfort should still be the primary consideration. Maximum operator efficiency (cows/operator.hr) is determined by the minimum amount of time required to attach clusters sustainably (in the order of 8-10 s per cluster) but the amount of time per cow or bail for a given rotation time varies depending on rotary size. For example, an 8 min rotation is 9.6 s/bail in a 50 bail rotary or 6 s/bail in an 80 bail rotary; however, at faster platform speeds there are more 'go-around' cows, so more time is available to attach clusters than indicated by these values as not every cow in a rotation needs to be cupped. A good guide is that if, on average, the cluster attachment time is less than 8-10 s then a second operator is required, which effectively means an average cupping time of 4-5 s can be sustained. At the point where a second operator is added much of this additional time is idle time (similar to the HB), which decreases with increasing rotary size until ~80 bails where two operators can be fully utilised. It is important to note that the throughput achieved in an 80 bail with two operators is typically less than double a 40 bail with one operator due to it being difficult to achieve a platform speed of 4-5 s/cow. The individual cow milking duration of the herd influences throughput by determining the percentage of 'go-around' cows at a given platform speed and rotary size. The operator can influence the milking duration of the herd by changing end-of-milking criteria (Jago, *et al.*, 2010; Burke & Jago, 2011; Edwards, *et al.*, 2013), although without ACR this is limited to MaxT. Reducing cow milking duration reduces the number of 'go-around' cows at a given platform speed or alternatively allows a faster platform speed to be achieved while maintaining a constant amount of 'go-around' cows, with both options improving cow throughput.

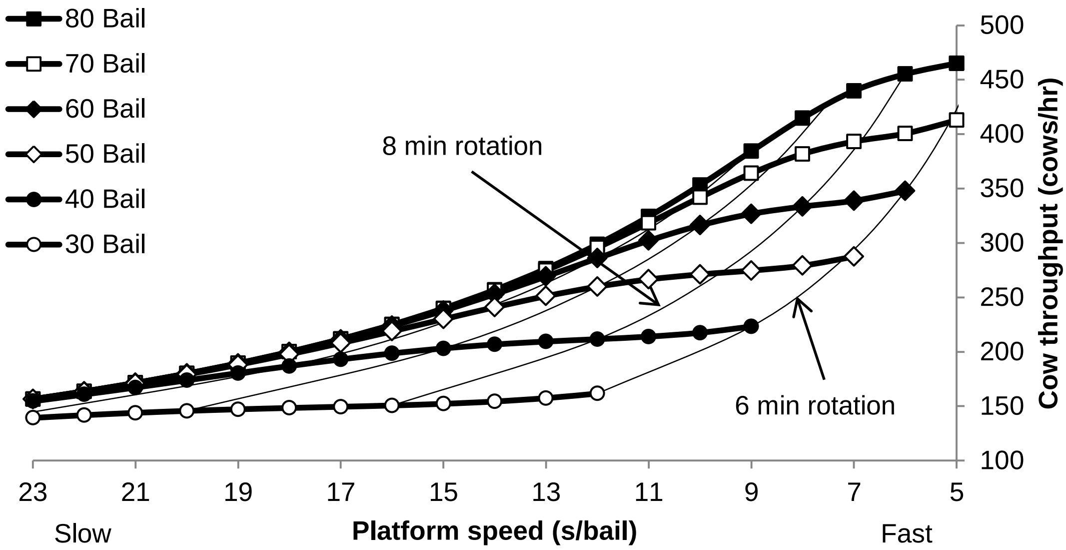

Figure 2. Potential throughput at various platform speeds down to 6 min rotation time for 30 bail (○), 40 bail (●), 50 bail (◇), 60 bail (◆), 70 bail (□), and 80 bail (■) rotaries.

So what platform speed and end-of-milking criteria achieve maximum operator efficiency? The interaction between platform speed, end-of-milking criteria and rotary size is shown in Figure 3, where it is assumed that 12 kg of milk is harvested and the operator requires 9 s to attach clusters and perform other essential activities. Maximum operator efficiency is 400 cows/operator.hr (3600 s/hr divided by 9 s/cow), and is achieved by a rotary of ≥60 bails. In general, operator efficiency increases with faster rotation time or with increasing ACR threshold, but there is a point where a second operator is required and the efficiency reduces. Figure 3 also demonstrates that maximum operator efficiency can be achieved by a number of combinations, of which the most appropriate varies from farm to farm. In this situation a rotary of ≤50 bails cannot achieve the maximum 400 cows/operator.hr because at faster platform speeds, even using higher ACR thresholds, cows are still ‘going-around’ resulting in the operator not being able to achieve the maximum cupping of 9 s. Figure 4 demonstrates that changing the cupping time alters the maximum operator efficiency (8 s, 450 cows/operator.hr; 10 s, 360 cows/operator.hr), highlighting the need for efficient cupping techniques (DairyNZ MilkSmart, 2013a) and that the milk yield (and therefore cow milking duration) affects the rotary size where maximum operator efficiency can be achieved. Consequently, the optimal strategy can change over the course of lactation, e.g. at peak lactation rotary size may limit throughput due to greater milk volumes but at late lactation cupping speed is more likely to be limiting. However, it is generally advantageous for the ACR threshold to be ≥0.4 kg/min and rotation time to be ≤8 min. If 10 s or more is required by the operator to attach clusters then platform speed may need to be slowed. In this example, farms with 70 and 80 bail rotaries cannot achieve greater operator efficiency than a 60 bail rotary (except high yielding herds), so to utilise the additional investment operator efficiency is generally sacrificed in order to achieve higher cow throughput. However, when considering building a rotary larger than 60 bails the requirement of additional throughput needs to be justified. For example, on larger farms the use of multiple herds and job rotation strategies can result in little disadvantage to a slightly longer herd milking time when building a more operator, and potentially capital, efficient rotary.

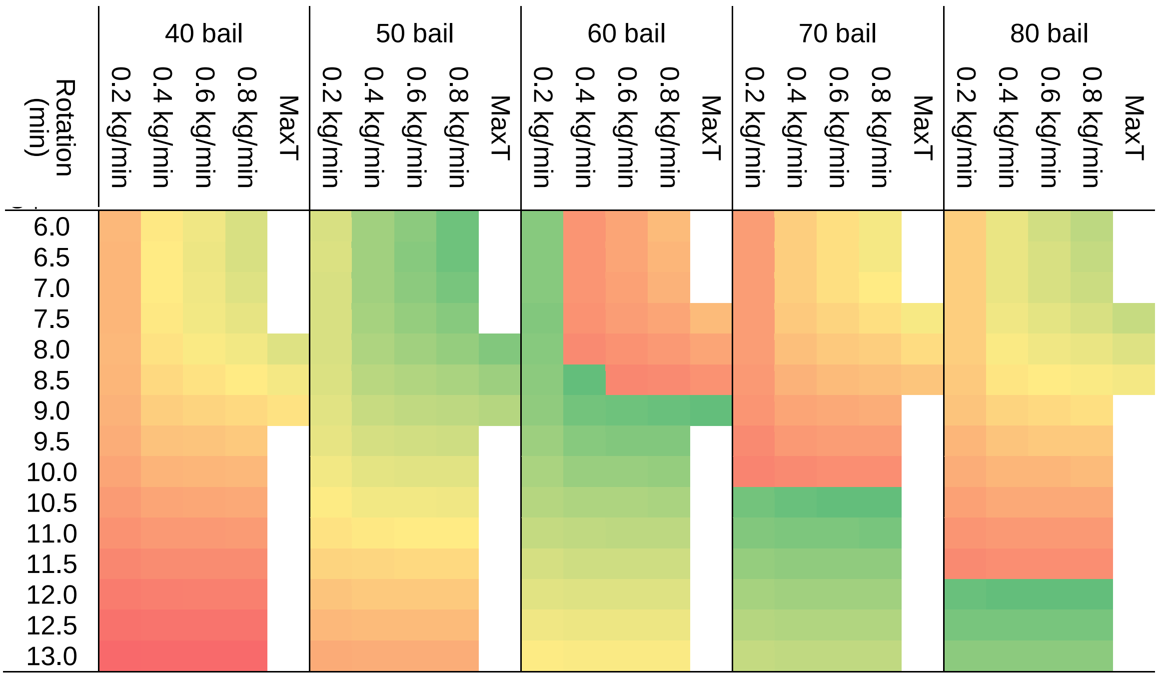

Figure 3. Potential operator efficiency ranging from dark green (400 cows/operator.hr) to dark red (185 cows/operator.hr) using different end-of-milking criteria (ACR thresholds of 0.2 to 0.8 kg/min and MaxT) and different rotation times for five rotary sizes assuming a milk yield of 12 kg and a minimum cupping time of 9 s.

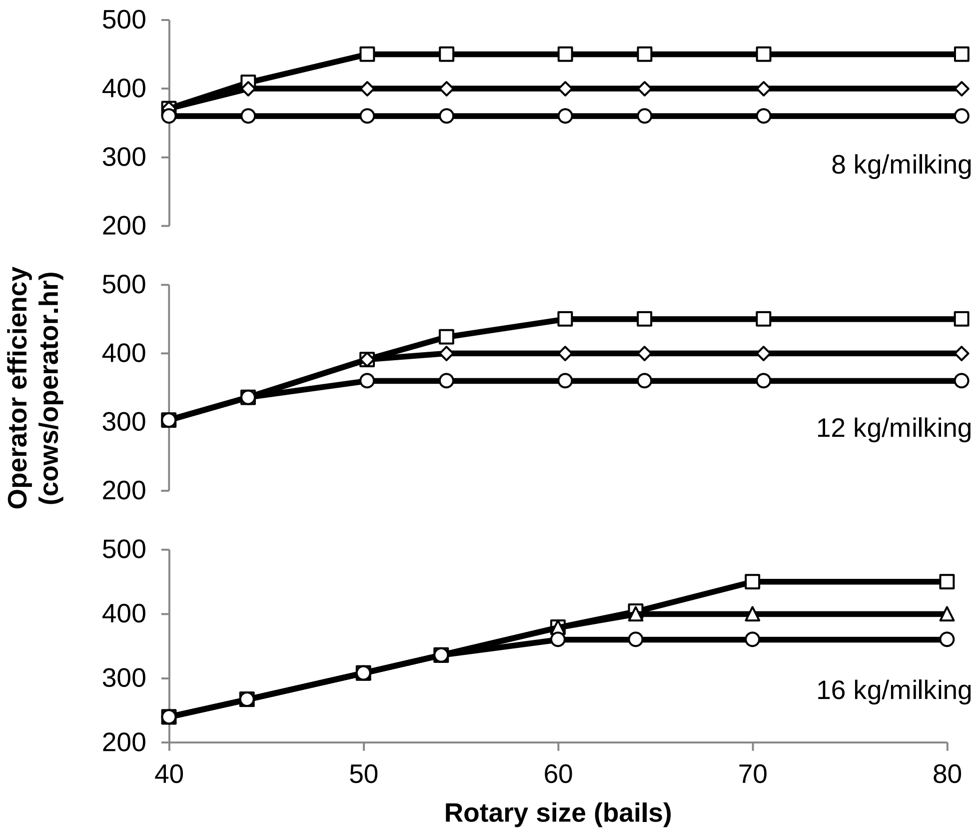

Figure 4. Maximum potential operator efficiency (cows/operator.hr) for different minimum cupping times 8 s (□), 9 s (◇), and 10 s (○) for three milk yields (8, 12, 16 kg/milking).

Conclusions

Good cow flow is critical to achieving efficient shed operation and is a product of a calm milking atmosphere and reduced risk of cow injury. Streamlining the work routine and using MaxT improves milking efficiency in herringbone dairies. The milking time of the slowest milking cow and the operator work routine determines the optimum number of clusters an operator can efficiently handle. In rotary dairies, maximum operator efficiency can be achieved by manipulating platform speed and end-of-milking strategies. Milk yield governs the rotary size where maximum operator efficiency can be reached, therefore lower yielding herds (<8 kg/milking) should consider smaller rotaries ≤50 bails. The minimum amount of time required for an operator to attach clusters controls the maximum throughput per operator, so efficient cupping techniques should be used. With today's technology operators of rotaries ≥70 bails likely sacrifice operator efficiency to achieve high cow throughput to justify the additional capital investment over a 60 bail rotary. Operators should use these principles to determine the optimum strategy for their situation but, in general, should aim for a rotation time of ≤8 min and set the ACR threshold ≥0.4 kg/min if requiring ≤9 s to attach clusters. Slowing the platform may be required if longer that 9 s is required by the operator to attach clusters.

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