Check-Up – Providing an Improved Outcome for the Dairy Industry

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Introduction

Worldwide, in both livestock production and human medicine there is an ever increasing amount of antimicrobial resistant organisms developing. There is now a critical requirement to ensure responsible antimicrobial use in order to prolong the effectiveness of antimicrobial treatments that are currently available.

Check-Up is a new product that has been developed by Farm Medix Ltd as an on-farm mastitis diagnostic tool that allows dairy farmers to grow cultures from infected quarters of cows within a 24-48 hour period. Currently, the majority of milk samples are cultured after being collected by the farmer, the sample frozen and sent to a diagnostic lab via a vet clinic. While this system does provide some information to the farmer, by the time the results are received, five to seven days later, the cow has generally already started her treatment. Check-Up allows farmers to culture the sample themselves or at their local clinic within 48 hours. This provides the opportunity for farmers to target the treatment of the infected quarter using the drug best suited for the organism present, providing a more effective treatment and better outcome for the cow.

This system has the potential to reduce the use of antimicrobials on cows that don't require treatment, and also the retreatment of cows which are still symptomatic after being treated due to the incorrect antimicrobial being used. The treatment of cows deemed unable to be cured due to the type of organism present will also reduce under this regime. Long term this will prolong the use of the antimicrobials currently available through less resistance build up both in livestock production and in human health.

Objective

The objective of this project was to determine if the use of the Check-Up plate test system (Check-Up), could improve the outcomes for the dairy industry by developing systems and a testing regime to support targeted, antimicrobial use to prevent and treat mastitis based on the identification of the specific organism present in the infected quarter of the diseased cow.

The Check-Up supply chain and life cycle are very short due to the limited shelf life of the product. The supply chain starts with the manufacturing of the test plates in Auckland. The product is then packaged and couriered to distribution partners or delivered direct to farmers who must then store these plates sealed, in the refrigerator.

To achieve the stated objective this project considers:

- Relevance to the New Zealand dairy industry
- Check-Up and how it works
- Target market
- The supply chain related to Check-Up
- The overall dairy industry supply chain
- Results from a Check-Up trial on Dunsandel Dairies, a Canterbury dairy farm
- An evaluation of the Check-Up system for use by commercial dairy farmers.

Relevance to the dairy industry

Products from the dairy industry were New Zealand's largest export earner in 2015, generating revenue of $NZ 11.5 billion (Govt NZ, 2016). From 2005-2014 there has been growth of 28% in the dairy sector. This growth has led to an increase in antimicrobial use in livestock production of 2.5% per year whilst total animal biomass in New Zealand has declined 4.3% (Hillerton et al, 2016). Antimicrobials used in the dairy sector to treat mastitis account for 85% of the total antimicrobials used in dairy (McDougall, 2014). Given these statistics, mastitis is identified as a major issue in the dairy sector and all farmers need to ensure the responsible use of antimicrobials to slow the rate of resistance to the current antimicrobials both in animal production and human health. The most important action required to reduce the spread and development of antimicrobial resistant organisms is a change in the way antimicrobials are used. Preventing the inappropriate and unnecessary use in animals will significantly slow the spread of resistant bacteria. (CDC, 2016).

More than 700,000 dairy cows across New Zealand are treated for clinical mastitis each year. At the individual herd level, the incidence can range from 1-70 cows. The success rate of these treatments can vary between 20 and 90 percent (Anonymous, 2015). This level of mastitis costs the dairy industry more than $280 million every year (LIC, 2016). Given there are 11,927 herds in New Zealand (Dairy NZ, 2016), this means it is costing the average farmer $23,476 in costs associated with mastitis. Any improvement in cure rates by the adoption of targeted application of remedies and better preventative measures will provide direct savings to the farmer.

The predominant reason farmers and veterinarians have not used culture specific decision making criteria frequently relates to the time delay in getting results. The long waiting interval commonly results in the cow already been treated before the test outcome is delivered. In one industry survey, 90% of veterinarians said they would use a rapid test that could give a highly accurate result (McDougall et al, 2015). Check-Up offers a significant step in this desired direction, providing highly accurate results within a 24-48 hour time period.

The Check-Up test plate

What is the plate made from?

The plate is a petri dish, divided into four quarters with each quarter containing special growth mediums used to culture the mastitis bacteria from the milk samples collected from infected cows. Each quarter of the plate has different growth mediums which will only grow specific colonies of microorganisms depending on what is present in the milk sample.

Storage requirements

Because each plate is a growing medium for microorganisms, they must be refrigerated at a temperature of between 2-8 degrees Celsius, in a sealed bag to prevent microorganisms growing and the agar substrate from drying out and making the results inaccurate.

How to use the plate

Firstly, farmers need to decide how they plan to use the technology. Either they may decide to test every case and make decisions on every individual cow or chose to use the technology to determine the most likely organisms present at a herd level and make herd level decisions at key times of the year.

To use the plate, there are 9 key steps:

Step 1:
The farmer needs to have a strategy to find cows infected with mastitis within the herd. This could be through stripping the foremilk of each quarter to check if there are clots present, using a rapid mastitis test, using inline milk sampling technology or through herd testing results.

Step 2:
The farmer needs to prepare the infected quarter of the cow to take a sample. This involves cleaning the entire teat with alcohol based wipes whilst wearing sterile gloves.

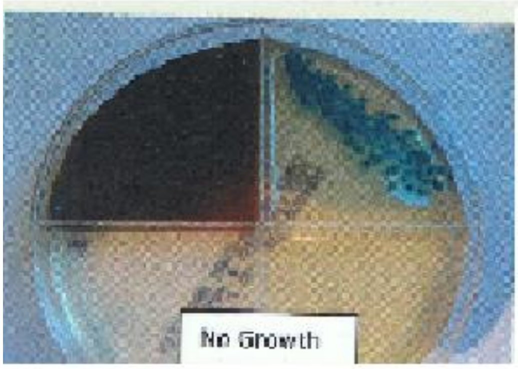
Step 3:
Collecting the milk sample is relatively simple. Once the teat is clean the first part of the milk is stripped (hand milked) from the cow and sent to waste, with the fourth strip then being collected by the farmer into a small, clean vile ready for testing. The farmer records the cow number, the quarter infected and the date. The cow can then be marked and drafted into the sick mob whilst the milk is being tested to ensure no mastitis milk is being sent to consumers.

The remainder of the steps can be completed on farm or by a vet clinic.

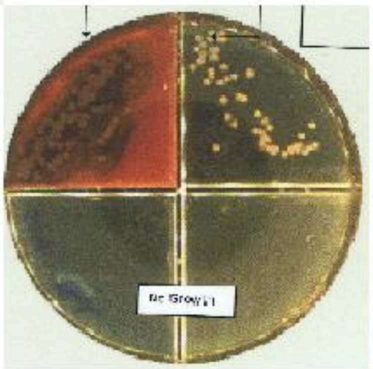
Step 4:
Once the sample has been collected, it needs to be cultured. If the farmer is busy at the time the sample is taken, it can be stored in the refrigerator and processed later (within 6 hours) or it can be processed straightaway (within 20 minutes). This involves spreading a small amount of milk, using the sterile loop provided, onto each quarter of the agar plate, always starting with the red quadrant and moving around in a clockwise direction ensuring hygienic conditions are maintained throughout the process in order to obtain accurate results.

Step 5:
Once the milk has been placed onto the agar plate the lid can be replaced and the cow number, date and quarter ID written onto the bottom of the plate for easy identification. The plate must then be sealed in a plastic bag and placed into an incubator (which is available with the start-up kit), upside down at 36-37 degrees Celsius for 24 hours.

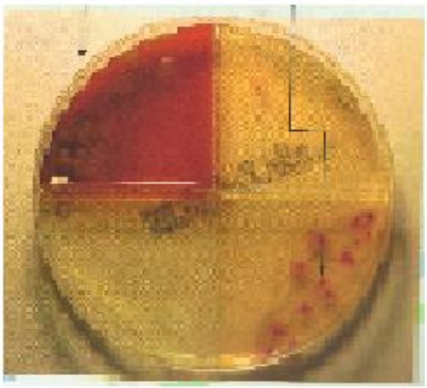
Step 6:
24 hours later the sample can be removed from the incubator and held up to light to determine growth over the 24 hour period. Depending on what growth occurs, it is possible to determine which microorganism is present by matching visible colonies with identification booklet images. If no growth has occurred the sample is placed back into the sealed bag and left for another 24-hour period (some organisms take 48 hours to culture). The three main organisms typically cultured are shown in pictures below:



Streptococcus Uberis



Staphylococcus aureus



Escherichia coli

Step 7:
The appropriate treatment for the cow can be decided based on the actual bug grown from the cow's quarter. A veterinarian can then be consulted to prescribe specific antimicrobials for each type of organism, or in some cases, the recommendation might be there is no benefit in treating the cow at all. During the Check-Up trial, the treatment protocol used was as follows:

- Staphylococcus aureus infections, 5 treatments of Cloxacillin (Orbenin LA)
- Streptococcus uberis infections, 3 treatments of Penicillin (Lactapen)
- Coagulase Negative Staphylococci (CNS) or Escherichia coli (E.coli), no antibiotic treatment although anti-inflammatory medicine may be used to provide pain relief for the cow.

Step 8:
With the culture results analysed, the plates should be stored in their sealed bags and refrigerated. Once three to four samples have been collected, these can be destroyed safely using the sterilisation tablets provided. This ensures the plates are clean prior to rubbish disposal, preventing any organisms negatively impacting the environment, animals or humans.

Step 9:
It is recommended the farmer keeps an accurate record of samples cultured during the season so different strategies can be applied depending on the culture results. For example, if many Strep Uberis infections are being found, the farmer will know environmental mastitis is the issue and can explore ways to keep cows teats extra clean. This may require washing the yard twice each day or filling in muddy gate ways. In contrast, Staph Aureus is passed from cow to cow so the farmer may consider milking the high SCC cows last and ensuring adequate teat spray coverage to help prevent the infections getting passed between cows.

Target Market for the Check-Up plate

The target market for Check-Up is all dairy farmers and dairy veterinarians who have a good understanding of milk quality and who want to achieve better outcomes for their cows and businesses.

As mastitis costs are incurred on a per cow basis, it makes no difference to the relative financial outcome for the business if the farmer is operating a 200 cow farm or a 2000 cow farm. The variable is how the information obtained from the plates is used. The Dairy NZ gap calculator shows that halving somatic cell count results in a 2.1% increase in milk solids production. Use of Check-Up is likely to improve milk quality and quantity by encouraging a lower somatic cell count.

One key element of the Check-Up supply chain is the support service offered. A free on call number is available 7 days a week. Extensive training is provided to farmers and veterinary practices which stock the product. This allows farmers to access accurate advice for the results achieved and therefore work on preventative strategies which may be farm specific, depending on whether environmental or contagious mastitis organisms are found in the cultured results.

A current market challenge is that the dairy industry has been struggling in terms of profitability for the past two seasons and the present season forecast milk price is also unfavourable. The majority of the benefits of using the Check-Up system come from indirect savings from treating less cows and achieving an improved cure rate, resulting in less cull cows and lower somatic cell count (Table 1).

Table 1. Dairy NZ Gap Calculator example

	Actual	Target	Difference
Herd Size	300	300	0
Annual Milk solids	100000	102100	2100
Milk price	$4.50		
Season Average BMSCC	300	150	-150
No. Cases clinical Mastitis	60	30	-30
No. Mastitis culls	15	5	-10
MS Gain from BMSCC reduction		2.10%	
Milk solids income gain			$9,450.00
Clinical Mastitis reduction			
Cost per case			$150
Savings			$4,500
Mastitis Cull Reduction			
Cull cow Value lost			$1,000
Savings			$10,000
Total Benefits			$23,950
Average Per Cow Benefit			$79.80

In this example the main benefits of improved mastitis management are increased milk production and reduced cull cow costs. Sometimes a farmer may not directly link this to the mastitis issues occurring in their herd. Whereas the direct cost savings of antibiotics, assuming 4 tubes average use per case, would be $20 which is a similar cost to one Check-Up plate. If the farmer only considers the direct costs, then not treating 1/3 of cases showing no growth results would increase the direct treatment cost on a per cow basis to $35.44. This would appear difficult to justify in the current economic environment if indirect costs are not accounted for appropriately.

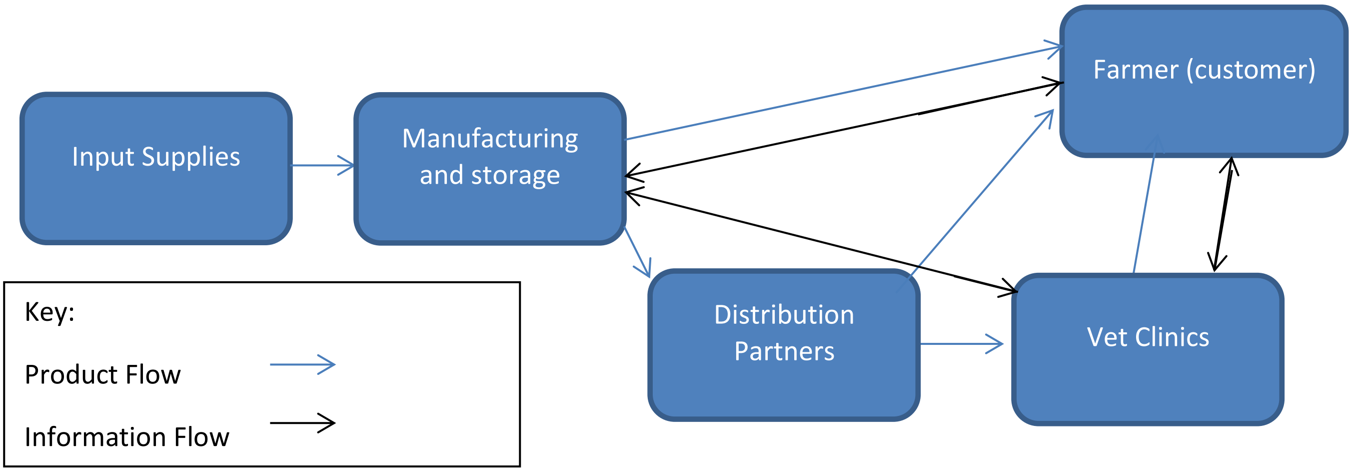
The Check-Up system may add value to dairy farming businesses that use the product in two main ways. The first is the targeted approach to individual cow treatment which will result in a better outcome for the long term productivity of the cow. The second means by which the system adds value is through the information gathered, and then working with associated partners in the supply chain to develop a preventative strategy to reduce the number of cows contracting mastitis.

In terms of the impact on the dairy industry supply chain, any consumer of dairy products is in fact part of the target market. Over recent years consumers have become much more engaged in the production of their food and seek confidence it is being ethically and humanely produced without excessive amounts of antibiotics in the process. Evidence of this is the price consumers are prepared to pay for organic milk powder at $14,600 per tonne compared to conventional milk powder at $2,800 (Hutching, 2016). Should dairy farmers choose the Check-Up diagnostic tool to improve prevention and treatment of mastitis in their herds, this could be promoted as a marketing tool to support low antimicrobial use dairy farms.

Supply Chain

The approach taken to analyse the supply chain for Check-Up is to not look only at the plate in isolation, but in terms of how it impacts the entire dairy farmers supply chain.

Supply Chain of Check-Up



The above diagram shows there are multiple ways the customer (dairy farmer) can access this product, either directly from Farm Medix who manufactures the product, direct from distribution partners such as LIC or from their local vet clinic.

One key aspect of the supply chain is the plates are sold in sets of 10, complete with all disposable items required to gather, process a milk sample and safely dispose of the plate. An initial starter kit is also required which contains the incubator and reference books. The plates themselves need to be kept sealed and refrigerated between 2 and 8 degrees Celsius and have a limited shelf life.

One benefit of using the distribution partners and veterinarian clinics is the facilities and partnerships with transport providers, available to keep the Check-Up plates refrigerated. This longer supply chain actually adds value to the dairy farmer (customer) as they have the ability to purchase smaller quantities of the plates, as required. The advantage is not incurring the additional transport cost of shipping a small volume in refrigerated form or having the plates expire before they are required. This is especially useful for smaller dairy farms which do not have the same demand as larger operations.

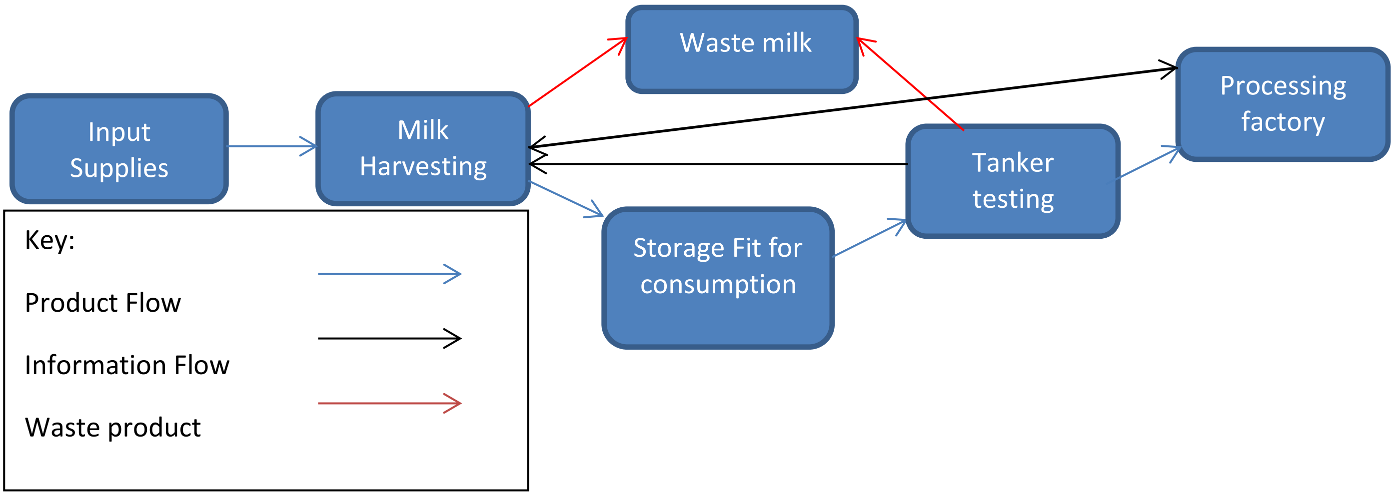
Table 2. Average Oct – May monthly mastitis cases based on herd size

Herd Size	400 cow farmer	2,000 cow farmer	15,000 cow vet clinic
Mastitis incidence	1%	1%	1%
Number cases/month	4	20	150
Time to use 1 shipment	2.5 months	0.5 months	0.06 months

Table 2 demonstrates that for the average sized dairy farmer of 419 cows (Go Dairy, 2015) over the majority of the milking season, where mastitis incidence is typically around 1% of cows infected per month, it would take 2.5 months to use up one package of ten Check-Up plates. Therefore more value is added by purchasing smaller quantities of plates from the vet clinics to ensure they do not expire and hence add additional cost to the operation. The other option available to farmers, depending on the vet clinic and distance to the clinic, is to take milk samples to the clinic for culturing, rather than investing in the incubator and training required to use the Check-Up system. This allows farmers to access the information without having the upfront cost, storage and destruction requirements from using the plates.

The aspect which adds the most value to the supply chain is the three way communication between the farmers, distribution partners and Farm Medix. This enables Farm Medix to receive feedback on Check-Up so they can continue to improve the product. It also enables the farmer to gain information related to their results and in consultation with their own veterinarian, tailor a solution to minimise the incidence of the specific mastitis causing organism on their farm.

Supply Chain of Milk from a Typical Dairy Farmer



The supply chain for the dairy farmer is very short. This is mainly due to the perishable nature of the milk which is the main product a dairy farmer produces. The quality of the product supplied is intensively checked for a number of parameters, particularly inhibitory substances. Milk from cows which have been treated with antimicrobials must be removed from the supply chain and hence this milk becomes a direct waste or cost to the farmers business. All major dairy companies now test every tanker for inhibitory substances prior to the tanker unloading to ensure these substances can never enter the food chain. If a tanker fails this test, the milk is discarded and the farmer has to cover any costs incurred. Any reduction in the amount of antimicrobials used on farms reduces the chance of an inhibitory substance being collected by the tanker and therefore the risk of milk being discarded.

In terms of the industry, once the milk arrives at the processing factory it can be turned into a number of different products and shipped all around the globe. However, from the quality perspective there is nothing that can be done during processing to improve the quality of the milk after it has left the farm. Therefore, any changes that the farmer can make to improve their milk quality, directly relates to an improved quality product for the customer. Currently there are very limited incentives from processors to supply milk of a quality that is higher than the minimum standard. However there is starting to be some differential pricing for specific favourable milk attributes so in time it is likely that milk quality premiums may become a reality.

Case study - Dunsandel Dairies

One farm that has been involved in the Check-Up trial with Cognosco is Dunsandel Dairies. Dunsandel Dairies is a commercial dairy operation located in mid Canterbury, New Zealand. It winters 2300 cows which are milked through two 50 bail rotary dairies by a team of 10 people. This is a high output farm, averaging 463kg MS per cow over a 270 day lactation with a bulk milk somatic cell count for the season averaging 90,000 cells per ml. The average mastitis incidence is higher on this farm than desired at 16%. The Check-Up trial was completed during the August to December period of 2015. A total of 204 mastitis cases were cultured and were randomly assigned to either a blanket treatment regime or a selective treatment regime. The treatment cows were milked twice daily through one dairy shed which made collection of the milk samples for testing much easier and resulted in a high success rate with only one contaminated sample.

The results from the trial showed there were eight different organisms cultured (see Figure 1), with the predominant organism being Streptococcus uberis (S.U) at 46%. The two other main organisms were Escherichia coli (E.coli) and Staphylococcus aureus (S.A) at 14% and 11% respectively. There were also 14% of cultures that did not grow any organisms at all which was lower than expected; a previous trial of mastitis had found no growth occurring in 23.4% of cases (McDougall et al, 2007).

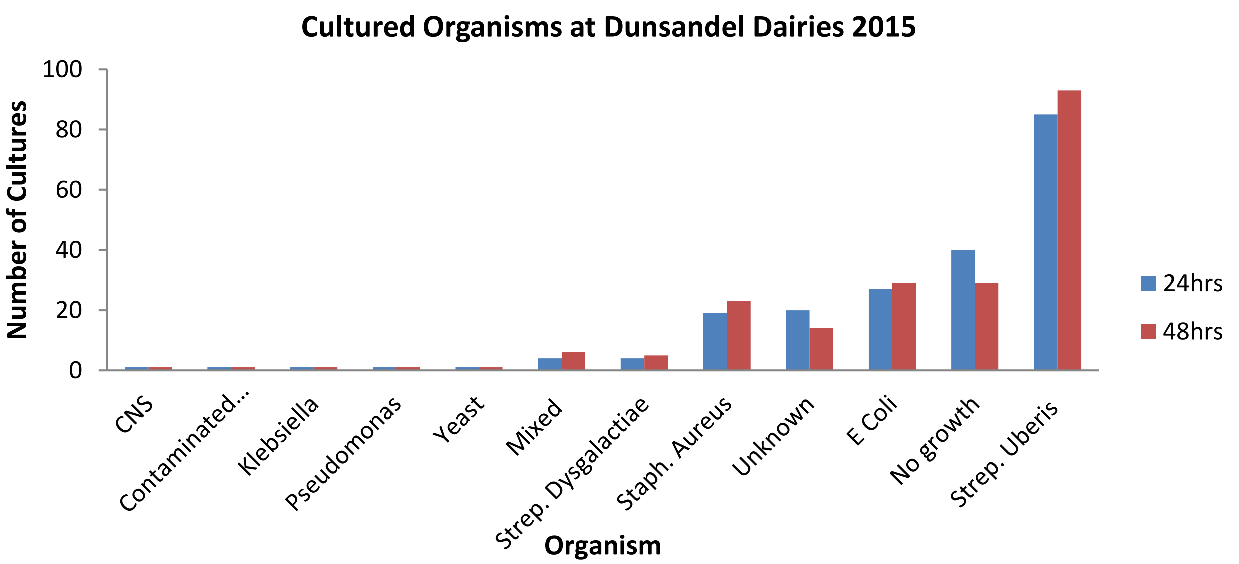
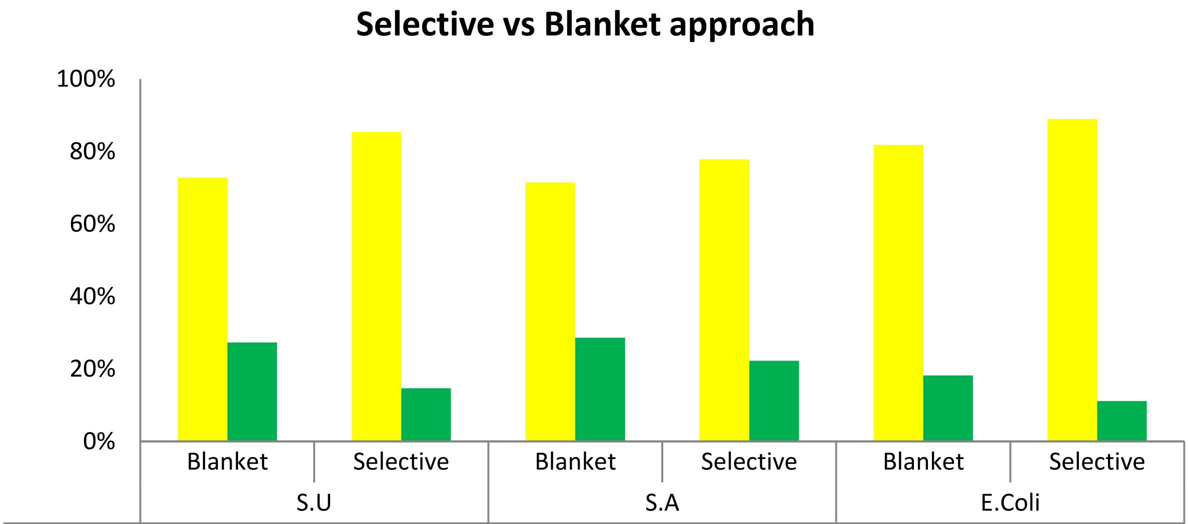


Figure 1. The number times each different organism was cultured at Dunsandel Dairies after 24 and 48 hours.

During the trial cows were randomly assigned to two treatment regimes:

- Selective: In this regime the milk sample was cultured for 24-48 hours and then depending on the organisms isolated, the treatment was chosen based on this result to get the optimum outcome *(see Check Up, Step 7 above for details)*
- Blanket: This involved collecting and culturing a sample in the same way as the selective regime however the cows commenced antibiotic therapy immediately, without the cultured result.

Figure 2 shows the results from the trial in relation to the % cure rate and failure rate for each of the three main organisms isolated. Across the three main organisms the selective treatment cows had an 85% clinical cure rate compared to 74% for the blanket treatment cows.
Assuming this outcome occurs for the entire season, based on the 16% mastitis incidence in this herd, it would equate to 368 cases for the season. In the selective treatment regime, 313 cases would be cured compared to only 272 cases under the blanket treatment. Given 30% of cows which do not cure on their first treatment in this herd are culled due to not being able to be cured of mastitis, this potentially equates to around 12 less cows being culled from the herd or approximately $12,000 saving based on Dairy NZ gap calculator.



	S.U Blanket	S.U Selective	S.A Blanket	S.A Selective	E.Coli Blanket	E.Coli Selective
% Cure	73%	85%	71%	78%	82%	89%
% Failure	27%	15%	29%	22%	18%	11%

Figure 2. The % cure and failure rate based on the blanket vs selective approach for the three main organisms cultured during the Dunsandel Dairies trial.

Evaluation of Using Check-Up for Commercial Dairy Farms

The decision for a commercial dairy operation to take up the use of the Check-Up system will be determined by the perceived financial, social and environmental benefits this can add to the business, relative to the costs associated with implementing this technology.

Farmers who are likely to have good culture results with this technology are those who have high attention to detail which is required to utilise the technology effectively. The downside, from a marketing perspective for Farm Medix, is the likely returns are lower for farmers who already have a very low mastitis incidence and bulk milk somatic cell count, who are generally those displaying high levels of attention to detail. This is illustrated in table 3 for the Dunsandel Dairies trial results, extrapolated out for an entire season of 16% mastitis incidence. The savings from using Check-Up equate to $19.97 per cow treated. On a per cow basis, for the entire herd at Dunsandel Dairies, the costs are $36.20 and $33.00 for the blanket and selective treatment regimes respectively, compared with the Dairy NZ example where mastitis was costing $79.83 per cow. This is due to the high attention to detail and milk quality at Dunsandel Dairies, already achieving low somatic cell count results and hence additional benefits are difficult to obtain. Compared with a herd with a higher mastitis incidence resulting in greater savings and also the additional milk production benefits of 2.1% for each time the somatic cell count of the herd is halved.

Table 3: Actual costs incurred based on the Dunsandel Dairies Results for 16% annual mastitis incidence.

Blanket Treatment Costs			Selective Treatment cost		
			Start-up costs	$	400
During Treatment	$	51,575	During Treatment	$	57,015
Cull cows	$	31,680	Cull Cows	$	18,491
Total Cost	$	83,255	Total Cost	$	75,907
Cost per cow	$	226	Cost per cow	$	206

Given the scale of operation at Dunsandel Dairies, the net benefit of using this technology equates to $7,348. This, coupled with a better welfare outcome for the cows within the herd, and the long term benefits from reduced antimicrobial use for both the dairy industry and consumers, I would recommend Dunsandel Dairies continues to use this technology into the future ensuring that the farm business can continue to operate in a sustainable manner both socially and environmentally. The above calculations are based on the current low milk price environment so any upside to milk price will generate favourable, additional financial returns.

From an industry perspective, if all farmers used the technology, this would ensure that the currently available antimicrobials may remain effective longer into the future. At the financial level, extrapolating these results, the benefit for the New Zealand dairy industry is $26 million. This is based on an average mastitis incidence of 12.4% (McDougal, 2007) and an average bulk milk somatic cell count of 170,000 cells per ml for the 2014-2015 season, reducing to 100,000 cells per ml by better outcome through mastitis treatment. In New Zealand there are 4.9 million cows producing on average 377kg MS per cow, for a total production of 1.84 billion kg MS. Lowering the bulk milk somatic cell count to 100,000 cells per ml from 170,000, there would be a 1.7% increase in production, therefore an additional 3.14 million kg MS or an additional $14.13 million dollars revenue. Calculating the savings based on the Dunsandel Dairies results of $19.97 per cow treated, for 4.9 million cows with a 12.4% mastitis incidence, this would add another $12.1 million in benefits and reduce our reliance on antimicrobials.

Conclusion

The Check-Up technology provides information to dairy farmers within 48 hours to aid in the identification of specific microorganisms causing mastitis within herds. Farmers can therefore strategically treat cows with the best product available for each specific organism, reducing the amount of antimicrobials used across the industry.

Check-Up allows farmers to be proactive around their management of specific mastitis bacteria. Over the long term, this will allow the introduction of mitigation options to reduce the incidence of mastitis, giving consideration to the different factors associated with each organism. Using Check-Up is cost-effective and has the potential to add $2220 to the average dairy farmers' profit.

Recommendation

I recommend the dairy industry adopt a more proactive attitude to mastitis management and display a more sustainable approach to the use of the antimicrobial products currently available to ensure these are effective into the future for both livestock and human medicine. I also recommend, all dairy farmers give serious consideration to the adoption of the Check-Up system to improve the sustainability of each individual business and protect the future of the entire New Zealand dairy industry.

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