BVDV

Bovine Viral Diarrhoea Virus

MANAGEMENT GUIDE

- Dairy Edition -

Australian Cattle Veterinarians
a special interest group of the Australian Veterinary Association

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ABOUT THE BVD MANAGEMENT GUIDE

The BVDV management guide is a resource to provide Australian Cattle Veterinarians practical BVDV management strategies to help control and manage BVDV for their clients. The aim is to enable veterinarians to develop appropriate programs to define, manage and monitor BVDV on their clients' farms, accounting for Australia's varied farming practices.

The BVDV Special Interest group (BVDV SIG) has provided the technical and management content for this BVDV management guide based on the best international and local evidence and research available at the time and is intended to remain a living document, updated by the SIG as appropriate.

WHAT IS BOVINE DIARRHOEA VIRUS (BVDV)?

Bovine Viral Diarrhoea Virus (BVDV) is one of the most costly endemic diseases within Australia. Animals exposed to the virus suffer immune suppression and/or reproductive losses. Estimates have varied from $20 to $90 per breeder unit on beef and dairy properties harbouring the disease. 90% of Australian herds have animals with evidence of exposure to BVDV. It is reasonable to assume that well over half of Australian beef and dairy farms are harbouring a PI and are therefore actively infected with BVDV.

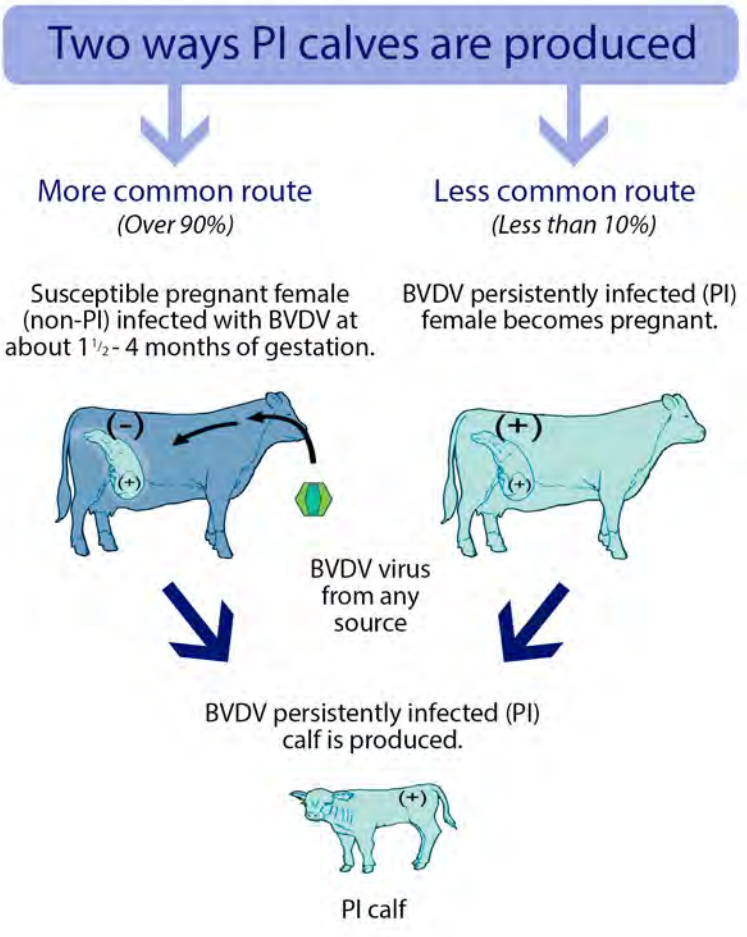
The variability in the cost of BVDV relates to timing. When previously unexposed or unvaccinated animals make close contact with a *Persistently Infected* animal (PI), they almost invariably contract BVDV, resulting in significant reproductive losses and/or immune suppression. Reproductive losses can occur at any stage of pregnancy, but are most significant during mating or early pregnancy. Immune suppression can be significant if the affected animals are under stress or other disease challenge such as during weaning or the early phases of lot feeding.

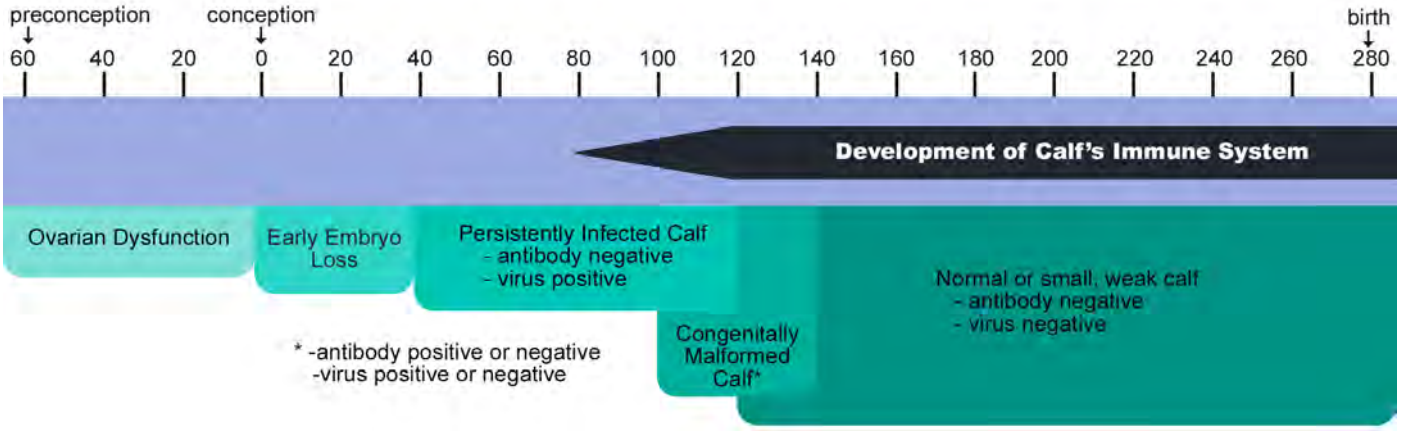
BVDV AND PI'S

BVDV is unique in that it is transmitted almost exclusively by PI animals. PI animals themselves were exposed to BVDV before they were born, whilst *in utero*. Either their dam was a PI herself, or, more commonly, she became infected with the virus whilst pregnant. When exposed between one and four months of gestation the calf's developing immune system mistakenly assumes that the virus is "normal". If the calf survives to birth, its immune system will continue to ignore the virus. They are born and remain *Persistently Infected* with BVDV for life.

From birth, PI calves continually excrete enormous amounts of virus. All animals they come in close contact with will be exposed to the virus, resulting in a high proportion becoming transiently infected with BVDV.

Transiently infected animals typically swiftly mount an immune response, neutralizing the virus. Some transiently infected animals will show mild signs of





illness. However, most exposed animals suffer transient immune dysfunction reducing their ability to fend off other infectious agents. Transiently infected animals usually don't spread the virus to other animals. Without the presence of Persistently Infected animals the virus simply ceases to propagate in most management situations.

Whilst only BVDV exposure between the 1st and 4th months of gestations results in the production of another PI, exposure to the virus at any stage of the reproductive cycle can have serious financial consequences. BVDV has been shown to significantly impair ovarian function, reducing conception rates directly. Animals exposed within the first 30 days of pregnancy usually suffer early embryonic death. Animals exposed from three and a half months to five months may be born with congenital defects, especially of the eyes and central nervous system. Finally, abortion or stillbirth is a risk at any stage of pregnancy.

Significant BVDV outbreaks are often associated with the introduction of new animals to existing management groups. However, many endemically infected farms harboring PI's sporadically suffer significant and noticeable losses when groups of animals become exposed at critical times. Often producers are unaware that the virus is being maintained on their farm. Farms harboring PI animals are always at risk, and whilst the impact of the PI animals may not be consistently evident, maintaining the virus has been found to limit almost every aspect of production.

DIAGNOSING AND MANAGING BVDV INFECTION

There are 3 classes of tools available for managing BVDV.

ANTIGEN (VIRUS) TESTING

BVDV antigen testing is used to diagnose and identify PI animals, a direct indicator of PI presence. *PI animals are almost always BVDV antibody negative*. BVDV antigen testing is routinely conducted on ear notch samples, blood samples, hair samples, or milk samples.

ANTIBODY (IMMUNITY) TESTING

Antibodies to BVDV are produced as a result of an animal's immune system mounting a response from exposure to the virus. Antibodies protect the animal against future exposure, significantly reducing the risk of further infection to the virus. Positive BVDV antibody results indirectly indicate past or present PI presence, as most infections result from exposure to PI's. BVDV antibody testing is used to measure herd risk, identifying groups of animals without immunity or groups that may contain a PI. Antibody testing allows veterinarians to measure the status of individual management groups and to prescribe the most cost effective intervention. Antibody testing can be conducted on blood or milk samples.

VACCINATION

Currently, there is only one commercially available vaccine for BVDV in Australia, Pestigard. The vaccine requires 2 preliminary doses 1 to 6 months apart, followed by annual boosters. Whilst it is quite efficacious, up to 30% of vaccinated animals may still produce PI animals if exposed during pregnancy. Vaccination of a PI animal itself is ineffective, it does not change its status.

DAIRY BVDV MANAGEMENT

Before implementing a control program for a given dairy producer, each veterinarian may need to educate their client as to the epidemiology of BVDV, as well as the relative costs and benefits of embarking on a control program. Systematically managing BVDV is both cost effective and profitable for most dairy producers. However, failure to maintain a control program can put producers in a vulnerable position, as a proportion of their accumulated production benefits could be lost.

BVDV control centres around controlling PI animals. Testing and removing all PI animals from the entire population, every calf every born into the system, and any introductions to the herd, as well as vaccinating the entire breeding population

annually will manage BVDV effectively, arguably even profitably, however, blanket approaches to BVDV management can be unnecessarily expensive. The BVDV status of individual dairies can vary significantly over time. By measuring their individual client's herd's BVDV status, veterinarians can tailor each program to invest in BVDV control that is both cost effective and profitable for each of their clients.

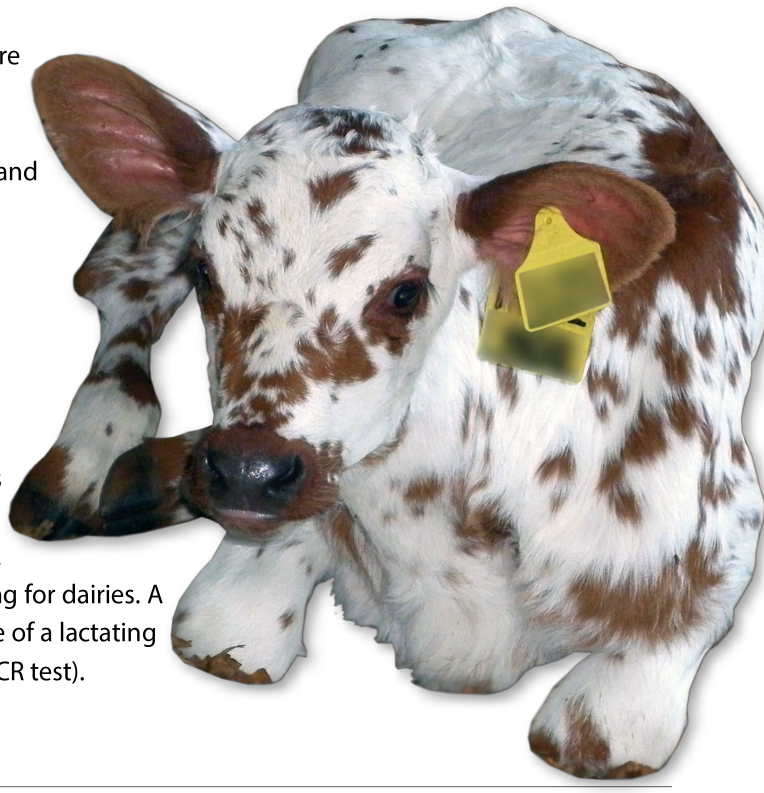
Veterinarians can begin establishing a BVDV herd risk profile for each client's dairy by defining and managing the immune status of the milking population, and then that of their pregnant replacement heifer populations. Once completed, the status of every new group of replacement heifers can be monitored and addressed appropriately prior to mating. The management practice of removing calves from the milking population shortly after birth greatly simplifies the process of controlling BVDV on individual dairies. If replacement heifers are reared in isolation from other pregnant stock until such time as they are presented for mating, the process of maintaining surveillance for BVDV freedom becomes quite simple. If all PI animals are removed from the population, if all animals without evidence of prior immunity are vaccinated, and if each new group of replacement females are ensured to be reasonably immune and PI free prior to their first mating, the disease will be systematically managed. Further, by measuring the level of immunity and then appropriately managing each new group of heifer replacements prior to mating, the dairy farmer and their veterinarian will not only be protecting their investment, but will be able to continually measure the success of their interventions. All that will remain is to maintain reasonably simple common sense biosecurity practices.

CONTROLLING BVDV

To systematically manage and even eradicate BVDV at the herd level, PI animals must be actively managed. The process of eradicating BVDV from individual dairies is relatively straightforward, the tests available are excellent, and once the virus has been eradicated from a property, ongoing surveillance is both simple and inexpensive.

The three main steps of control process for BVDV in dairies are:

1. Identify at "risk management" groups and provide them with immunity
2. Clear PI animals from the population
3. Ensure annually that all replacement animals are both PI free and immune prior to their first joining



There are four general management groups to consider and manage separately on dairies:

1. The lactating population
2. The pregnant heifer population
3. The unmated replacement heifer population
4. All other stock including bulls

Defining the immune and PI status of the milking population is an excellent place to start when investigating a dairy's BVDV status. Access to commingled milk from the vat, or Bulk Tank Milk (BTM) sample, greatly simplifies BVDV testing and monitoring for dairies. A BTM sample can be used to estimate the BVDV immune response of a lactating population (antibody test) or to screen for the presence of a PI (PCR test).

BULK TANK MILK ANTIBODY TEST

Analysing a bulk tank milk sample for antibodies to BVDV provides an estimate of the entire milking population's BVDV immune status, guiding vaccination or testing programs and providing a benchmark for further monitoring. The results are reported as a sample to positive ratio, or s/p ratio. Essentially, the level of antibody from the BTM sample is compared to a "known positive" sample. The higher the BTM sample's antibody level compared to the positive, the higher the s/p ratio, and therefore the greater the level of measurable antibody in the sample provided. Because a BTM Antibody Test is an estimate of the milking population's immune response, it is not imperative that all animals contribute to the sample. Either high s/p ratios, or significant changes in s/p ratio should be triggers for further veterinary investigation or intervention. Timing of BTM sampling should take into consideration recent management practices such as vaccination or changes in the composition of the lactating population.

The BTM Antibody Test is used to identify "at risk" milking populations. "At risk" could either mean lacking immunity, or potentially harboring a PI. Samples need to be collected from a well agitated bulk tank into a small container including preservative, can be frozen, and then dispatched to the lab for analysis. Depending upon the s/p ratio of the sample, management practices can be tailored to suit the findings.

BTM ANTIBODY UNDER 0.25

If the BTM Antibody Test s/p result is less than 0.25, few if any of the lactating animals have immunity to BVDV, a lactating PI is not present, unless a PI has been recently introduced, and the herd may even be entirely BVDV free. Strong consideration could be given to blanket vaccination of the entire milking herd.

BTM ANTIBODY BETWEEN 0.25 AND 0.75

If the BTM Antibody Test s/p result is between 0.25 and 0.75 it is unlikely that a PI exists within the lactating population and only some of the contributing animals possess immunity to BVDV. The proportion of animals immune to BVDV could be further estimated by randomly collecting blood or milk samples from 5% or more of the milking herd. If the proportion of immune animals is found to be unacceptably low, vaccination of the entire lactating population could be considered. Some lactational subgroups, reared together prior to coming into milk, could collectively lack immunity to BVDV, whilst other subgroups may have been exposed to the virus. Collecting a random 5% or a minimum of 6 individual blood or milk samples from each lactational subgroup could assist producers and their veterinarians to further focus their vaccination program.

BTM ANTIBODY OVER 0.75

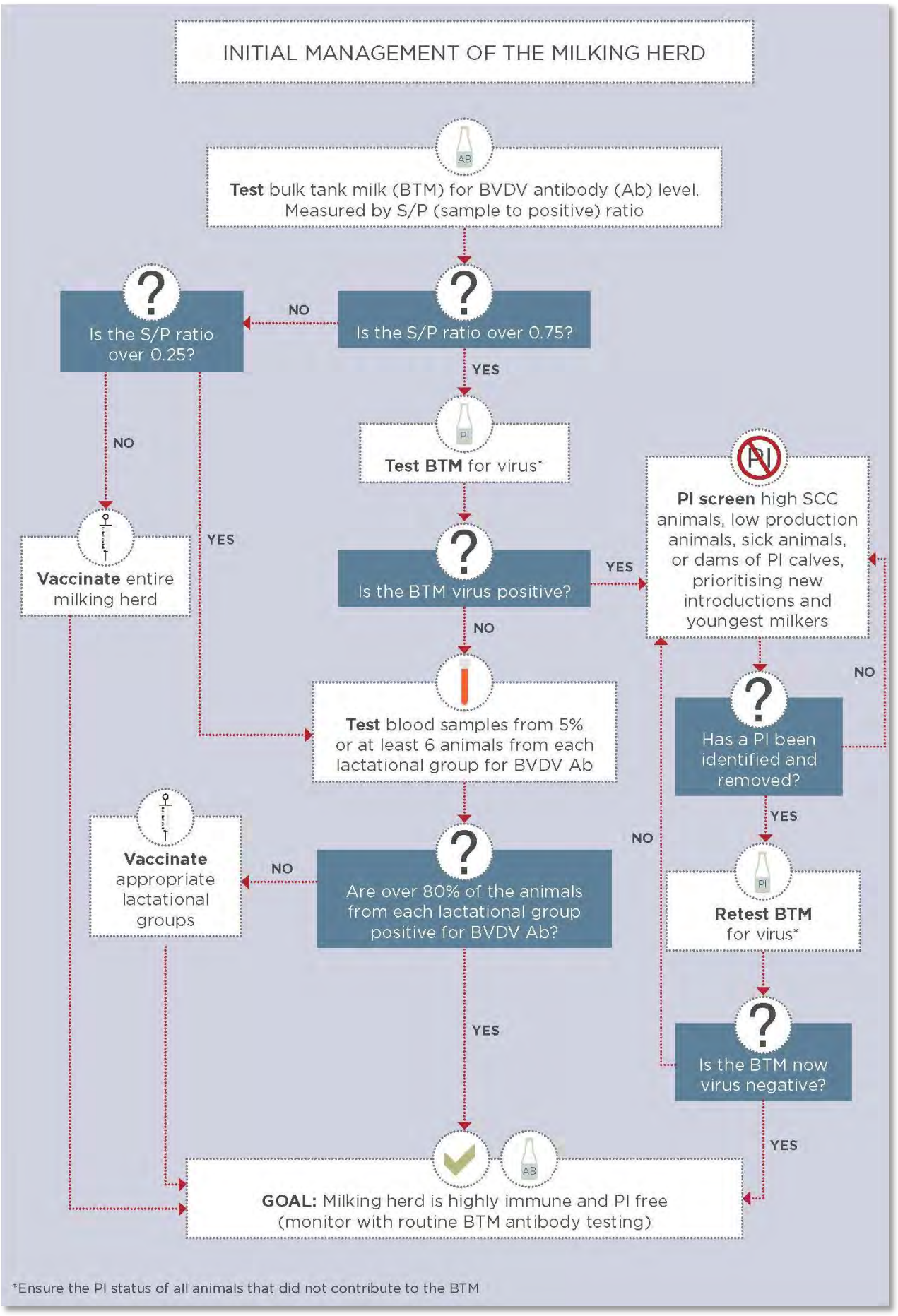
If the BTM Antibody Test s/p result is above 0.75, a lactating PI may exist within the lactating herd. The same sample submitted for antibody testing can be tested by PCR for the presence of milk from a PI animal.

BULK TANK MILK PCR TEST

The presence of milk from a PI can be detected with extreme sensitivity by PCR from a BTM sample. When measuring BTM samples by PCR, it is important to ensure that all animals of unknown PI status that did not contribute to the vat sample are accounted for and tested separately. If the BTM PCR sample is positive, either a lactating PI has contributed to the sample, or less commonly, a proportion of the lactating population has been recently exposed to the virus. Collecting a follow up BTM sample for PCR analysis will usually confirm the presence of a PI.

If the BTM PCR result is negative, the milking herd's immune status may require further investigation, as some lactational subgroups may benefit from vaccination. If the BTM PCR is positive, a PI likely exists within the lactating population, in order to control BVDV on the dairy she must be identified and removed. If one or more lactating PI's are found, it can be assumed that the remainder of the milking population is reasonably immune.

Directly testing an entire population of lactating animals to identify PI animals could often be an unnecessarily expensive option. PI animals tend to produce less milk, have higher somatic cell counts, and have poor health outcomes. Additionally, lactating PI animals tend to be in their first or sometimes second lactation, as most PI's are culled or die over time. By screening for PI's targeting low production cows, high SCC cows, sick cows, or the dams of any known PI animals, a PI or PIs can often be found without having to test the entire milking population. Emphasis could also be placed on younger parities to further narrow the scope of the search. If a PI is found and removed the BTM PCR test can be repeated. If the BTM PCR test is negative and all animals not contributing to the vat are accounted for, the lactating cows can be considered both immune and PI free. If the sample remains positive, more individual cow testing will be required. Regardless, once free, the milking herd can be maintained by screening all herd additions prior to joining or coming into milk.


INITIAL MANAGEMENT OF THE MILKING HERD
Test bulk tank milk (BTM) for BVDV antibody (Ab) level. Measured by S/P (sample to positive) ratio
Is the S/P ratio over 0.75?
NO
Is the S/P ratio over 0.25?
YES
NO
Test BTM for virus*
Vaccinate entire milking herd
YES
Is the BTM virus positive?
YES
PI screen high SCC animals, low production animals, sick animals, or dams of PI calves, prioritising new introductions and youngest milkers
NO
Test blood samples from 5% or at least 6 animals from each lactational group for BVDV Ab
NO
Has a PI been identified and removed?
YES
Vaccinate appropriate lactational groups
NO
Are over 80% of the animals from each lactational group positive for BVDV Ab?
NO
Retest BTM for virus*
YES
Is the BTM now virus negative?
YES
GOAL: Milking herd is highly immune and PI free (monitor with routine BTM antibody testing)
*Ensure the PI status of all animals that did not contribute to the BTM

THE ROLE OF VACCINATION IN THE MANAGEMENT OF BVDV

Pestigard is currently Australia's only licensed BVDV vaccine, requiring two priming doses, administered from four weeks to six months apart followed by annual boosters. Whilst vaccination should reduce the cost of BVDV, vaccination **will not** prevent the production of all PI calves, **will not** change the status of PI animals already in the herd, and will provide **limited** protection to young calves due to maternal antibody interference. Animals immune to BVDV will receive limited additional benefit from vaccination. In most instances, the strategic use of the vaccine is more cost effective than blanket vaccination.

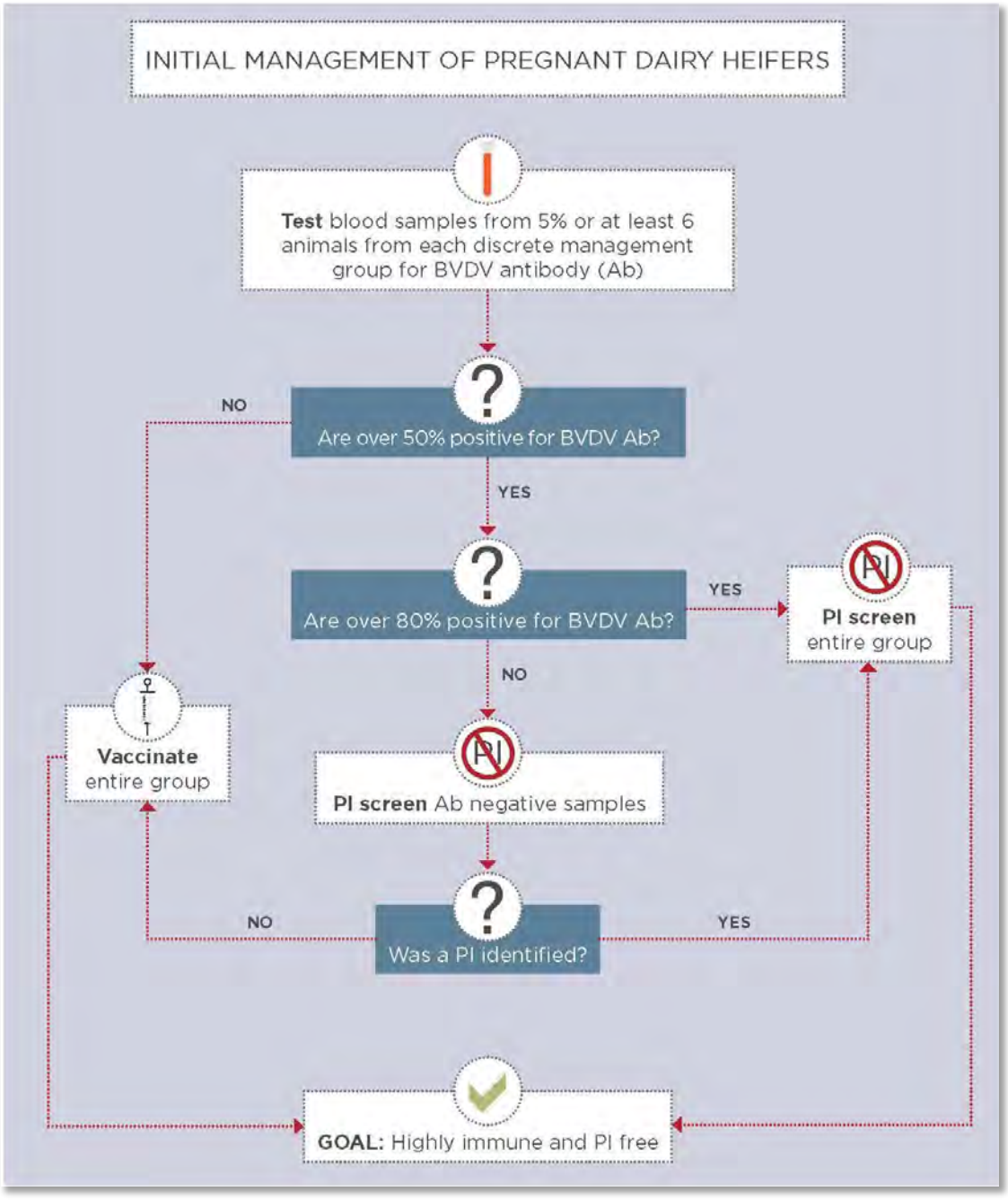
Providing immunity to animals without prior exposure to BVDV will improve each animal's individual risk as well as the overall biosecurity of the dairy. Vaccinated animals are less likely to produce PI calves should they be inadvertently exposed to a PI or sufficient BVDV virus either from a transiently infected animal or contaminated equipment.

The primary goal of a dairy herd wishing to strategically manage the immune status to BVDV via vaccination is to ensure that each existing stable reproducing management group is reasonably immune and that every new group of replacement heifers is reasonably immune prior to mating. Vaccination thresholds will vary from producer to producer and from veterinarian to veterinarian based on appetite for risk, however vaccinating any management groups with a sero-prevalence below 80% is a reasonable policy.

Maintaining a routine BTM Antibody Test is a good means of monitoring the milking population's immune status. BTM results must be interpreted in the context of other management factors, especially vaccination. If the BTM result changes significantly, investigation is always warranted.

PREGNANT HEIFER MANAGEMENT

Once the milking herd is confirmed to be PI free, the producer's goal should be to ensure that each new group of replacement heifers is both PI free and immune prior to coming into milk. In the first production year of the control program, any pregnant heifers will need to be screened directly. Testing individual blood samples for antibodies to BVDV is a good method to screen stable groups of unvaccinated pregnant replacement heifers. If they have been vaccinated, their results will need to be interpreted in light of their vaccination history. Most BVDV antibody tests available in Australia can be interpreted to discern evidence of natural exposure from vaccination. If a subsample of 5% or a minimum of 6 pregnant heifers are found to be highly immune to BVDV, every pregnant heifer will need to be directly tested and any PI's removed prior to joining the milking herd. If instead they are found to lack immunity to BVDV, it is unlikely that a PI is among them, however, they should be vaccinated prior to joining the milking herd. If the milking herd and the pregnant heifers are found to both be highly immune, the replacement heifers could alternatively be allowed to come into milk, allowing them to be screened with the rest of the milking herd via a BTM PCR test.



REPLACEMENT HEIFER MANAGEMENT AND HERD MONITORING

Once both the immune status of the pregnant heifers and the milking herd have been described and addressed, each new group of replacement heifers must be assured to be both PI free and immune prior to being joined. Some producers prefer to test all retained calves at or near birth and to vaccinate them prior to breeding. Rather than testing all calves, blood testing replacement heifers prior to mating may be financially advantageous. Once weaned and commingled for at least two months, and at a minimum of eight months of age, blood testing a random 5% or a minimum of six replacement heifers for antibodies to BVDV will usually clearly indicate either a need to test the entire group of replacement heifers for PI's or to vaccinate them.

Highly immune groups of heifers (over 80% immune) should be tested to identify any potential PI's and would gain limited benefit from vaccination. By ear notching the management tags of animals from groups proven highly immune, they can be easily identified and excluded from future booster vaccinations.

Groups of animals with little or no evidence of immunity (less than 50% immune) would benefit from enrolment in a vaccination program. Their immune status indicates that a PI animal is very unlikely to exist within the group, hence testing them individually for PI's would be unnecessary.

Occasionally, heifer screening may result in mixed serology (between 50% and 80% immune), for which there are four scenarios:

1. The heifers without immunity to BVDV are persistently infected. (PI present)
2. Some heifers were exposed prior to commingling. (No PI)
3. One or more of the heifers is a PI. (PI present)
4. Exposure from outside of the group. (No PI)

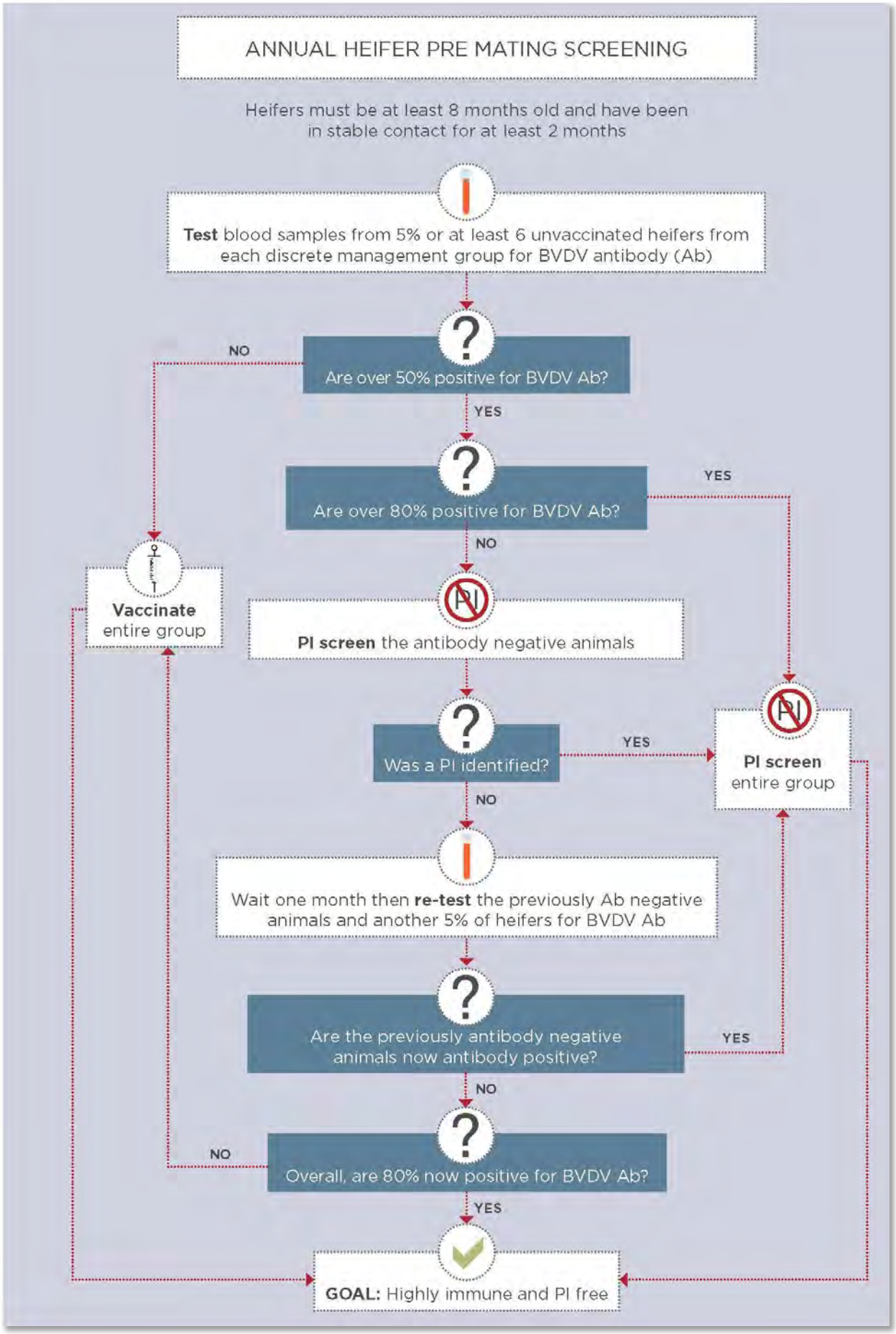
The first scenario can be confirmed by testing the antibody negative blood samples for PI status. If a PI is found, the entire group of heifers should be tested to ensure that none are PI's.

To discern the second scenario from the third and fourth scenarios, producers and their veterinarian could wait one month, then collect blood samples from the previously antibody negative animals, as well as an additional 5% or another 6 random heifers.

If the previously antibody negative animals remain antibody negative, it can be assumed that the existing immunity is from historic exposure, such as exposure from a culled or deceased heifer no longer present within the mob. The management group could then either be vaccinated or monitored depending on the final calculated immune status, made more significant by the additional antibody testing.

If some of the previously antibody negative animals have become antibody positive, then ongoing exposure is occurring indicating that either a PI exists within the mob, or the mob is undergoing outside exposure, regardless it is a sound decision to screen the entire group for the presence of any PI heifers. If no PI is found, effort should be given to identifying the source of ongoing infection.

Some dairies continually add weaned calves to groups of replacement heifers. If older heifers from the group are screened for antibodies to BVDV every three months, once at least eight months old, and at least three months prior to joining, a pattern will develop. If all of the animals are consistently PI free, the pattern will consistently result in seronegative animals. However, should a PI join the group, within a couple of weeks of its joining the population, animals will begin to develop antibodies to BVDV. Should some of the animals tested be found to possess antibodies to BVDV, it will be a simple matter of PI testing all of the newest heifers that joined the group to isolate the source of infection.


ANNUAL HEIFER PRE MATING SCREENING
Heifers must be at least 8 months old and have been in stable contact for at least 2 months
Test blood samples from 5% or at least 6 unvaccinated heifers from each discrete management group for BVDV antibody (Ab)
Are over 50% positive for BVDV Ab?
NO
YES
Are over 80% positive for BVDV Ab?
YES
NO
Vaccinate entire group
PI screen the antibody negative animals
Was a PI identified?
YES
PI screen entire group
NO
Wait one month then re-test the previously Ab negative animals and another 5% of heifers for BVDV Ab
Are the previously antibody negative animals now antibody positive?
YES
NO
Overall, are 80% now positive for BVDV Ab?
NO
YES
GOAL: Highly immune and PI free

REPLACEMENT HEIFER MANAGEMENT AND HERD MONITORING

(continued)

Many Australian dairy producers rear their heifers off farm, often with other cattle of unknown BVD status, representing a biosecurity risk. Dairy producers who rear heifers off site need to ensure that heifers are PI tested prior to agistment. Heifer rearing facilities should have a biosecurity plan (including that all cattle on the property are confirmed PI free) to ensure BVD risk is minimised.

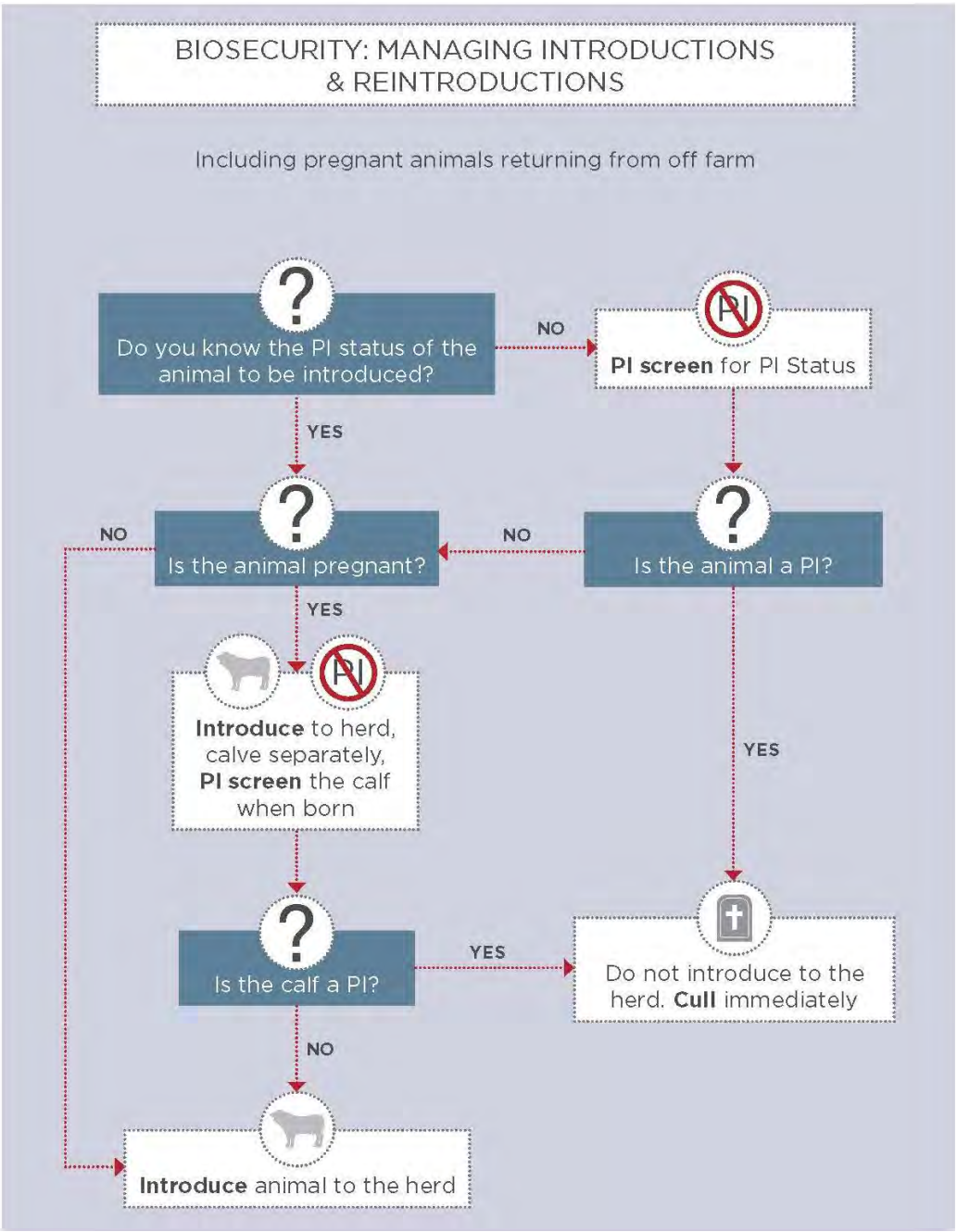
Once the milking population and the pregnant heifers have been vaccinated if appropriate, any PI animals removed, and each new replacement heifer group is both immune to BVDV and PI free at mating, the entire production system is less likely to produce any PI progeny. When consistently implemented, PI calves will cease being produced and the new replacement heifers will render negative antibody results when screened prior to mating. However, if the replacement heifers are found to continue to demonstrate premating immunity to BVDV, further investigation as to the source of PI exposure is warranted.

Following successful clearance of the lactating population, and once replacement heifers are consistently BVDV antibody negative when screened prior to mating, it can be assumed that the dairy is BVDV free. The focus should remain on maintaining simple biosecurity practices and ongoing heifer pre-mating surveillance. Biosecurity focuses on reducing exposure of animals in early to mid gestation to outside animals or management groups of unknown BVDV status. All introduced animals should be screened to ensure that they are not Persistently Infected and if pregnant, their progeny should be screened as soon as possible after birth. The unborn progeny of pregnant animals agisted off farm, shown, or exposed to management groups of unknown status would also warrant screening at birth. Should a PI be unwittingly produced and retained as a replacement it will be identified when screened pre-breeding.

Most properties with incomplete biosecurity should strongly consider maintaining vaccination programs including annual boosters. Dairy producers with excellent biosecurity may eventually consider ceasing vaccination as part of their systematic control strategy. Regardless of their decision, it is imperative that they continue to monitor the immune status of their replacement heifers pre-mating. Should they decide to cease vaccinating, it is prudent to begin with older parities first, those with sound vaccination histories. If the replacement heifers then begin to demonstrate evidence of exposure, it would be clear that the dairy's biosecurity is insufficient to warrant ceasing vaccinating and the owner may decide to re-enroll the management groups that had not been receiving booster vaccinations.

Bulk Tank Milk Antibody monitoring provides an excellent monitoring tool. If the BTM antibody level increases unexpectedly, it warrants investigation. Performed quarterly, prior to annual booster vaccination, or after other key management practices is a sound investment.

The cost of BVDV varies from year to year on individual dairies and from dairy to dairy. Regardless, if a group of animals become exposed to the virus at an inopportune time, the outcome can be financially devastating. BVDV is complicated but predictable and the tools that exist to manage it are highly accurate. Measuring the immune status of BVDV within herds allows veterinarians and their producers to manage the disease. Managing BVDV protects their investment, provides flexibility, and drives profitability. Leaving BVDV to chance is risky business.


BIOSECURITY: MANAGING INTRODUCTIONS & REINTRODUCTIONS
Including pregnant animals returning from off farm
Do you know the PI status of the animal to be introduced?
NO
PI screen for PI Status
YES
Is the animal pregnant?
NO
Is the animal a PI?
NO
YES
Introduce to herd, calve separately, PI screen the calf when born
YES
Is the calf a PI?
YES
Do not introduce to the herd. Cull immediately
NO
Introduce animal to the herd

BVDV

Bovine Viral Diarrhoea Virus

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