Preventing resistance in sheep lice

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Resistance can be defined as a genetic change in response to exposure to a pesticide that enables lice to survive doses that would normally kill all lice. Continued use of the same chemical or chemical group allows the resistant lice to survive, breed and increase in numbers until they make up the majority of the population.

Theoretically, resistance can develop to any group of chemicals. Historically, in Australia, resistance in sheep lice has been mainly a problem with chemicals applied as backline treatments, but it can also affect chemicals applied by showering or dipping. For example, resistance was found overseas to organochlorine chemicals applied by dipping and showering, and resistance to synthetic pyrethroid (SP) backliners in Australia also compromised the effectiveness of SP dips.

In Australia, resistance has been found to three main chemical groups:

Synthetic pyrethroids (SPs)

Resistance to SPs was detected in the mid to late 1980s and is now widespread.

Insect growth regulators (IGRs)

Resistance to the insect growth regulator (IGR) pesticides diflubenzuron and triflumuron has been confirmed and has been shown to be responsible for lice control breakdowns in at least some instances. As diflubenzuron and triflumuron have the same mode of action, if resistance is present to one, then it will also be present to the other. The current extent of this resistance is unknown.

Organophosphates (OPs)

One strain of lice with reduced susceptibility to organophosphates has been reported, but resistance is thought to be rare.

It is important to note that although resistance often gets blamed for lice control breakdowns, the majority of breakdowns result from under-dosing, poor application or reinfestation; not resistance. When a treatment failure occurs, it is essential to carefully review your application method, ensure that all sheep were treated and to check that new lousy sheep have not entered the property before deciding that resistance is the problem.

Why resistance is important

Taking steps to prevent or slow the spread of resistance helps to control costs by avoiding control breakdowns and the need for extra treatments. Extra treatments also increase the level of residues in the wool.

Sometimes, when resistance is present, treatment suppresses lice, but does not completely eradicate them. These suppressed infestations are difficult to detect and increase the chance of lice spreading between flocks, particularly on purchased or agisted sheep. The upsurge in lice prevalence around Australia in the late 1980s and early 1990s was associated with the spread of resistance to SP lousicides and the upsurge in lice in the 2000s was probably associated with IGR resistance.

Preserving the efficacy of currently available compounds is also important as the costs of developing and registering new products continues to increase. New groups of lousicides are almost always more expensive than their predecessors, in turn increasing production costs for woolgrowers.

How resistance develops

Within any population of lice there will be some able to withstand higher concentrations of insecticide than others. If lice are exposed to concentrations of insecticide that do not kill all of them, for example by under-dosing or poor application method, the more resistant individuals survive and breed, gradually increasing the level of resistance in the population.

Sometimes a genotype or mutation with high-level resistance develops enabling lice that carry it to survive properly applied chemical treatments. With continued use of the same chemical group, these more resistant individuals have a selective advantage and come to predominate in the population.

If resistance develops to one insecticide in a chemical group, it generally also applies to others in the same group. Changing to a different product in the same group is unlikely to give better results. The more often products from the same chemical group are used, the more likely that resistance will develop.

Know your chemical group

Knowing which chemical **group** your lice control products belong to is critical to resistance management—the group is the class of chemical to which the particular active ingredient belongs. Table 1 gives a list of the different chemical groups and some products that belong to them. For a full listing of flystrike and lice products, consult the LiceBoss Products Tool.

Remember that treatments to prevent flystrike also expose any lice present to chemicals. It is important to use products from different chemical groups when treating for flystrike and lice in the same year and to consider flystrike chemicals when determining a resistance management plan. Fortunately, the two main chemicals used for flystrike control, cyromazine and dicyclanil, do not have any effect against lice and will not contribute to selection for resistance in lice.

Avoiding resistance

Resistance is most likely to develop when lice are exposed to sub-lethal concentrations of pesticide and when products from the same chemical group are used repeatedly. Fortunately, many of the practices that help prevent resistance occurring are the same as for good lice control. If lice can be eliminated from a property and the property kept lice-free so that treatment is not necessary, there will be no selection for resistance.

To avoid exposing lice to sub-lethal concentrations of chemical, the following precautions should be taken:

Make sure the dose rate is correct

With backliners, the wrong dose rate often results from underestimating the weight of the heaviest sheep in the mob or using an applicator gun that is delivering the wrong dose. It is important to weigh the heaviest sheep in the mob to determine the right dose rate and to check that the applicator gun is delivering the correct dose.

With dips or showers, under-dosing can occur if the volume of the dip sump is underestimated or the mixing rate is wrong. With products that strip (see LiceBoss note: Plunge and cage dipping), if the dip is not reinforced and topped up according to the label instructions the concentration may fall below the concentration required to kill all lice. This is especially likely to occur near the end of the mob and instructions for dipping out should be followed carefully.

Apply chemicals strictly according to label directions

To eradicate lice it is critical that effective levels of chemical are applied all over the sheep's body. Poor application technique can leave areas of sub-lethal chemical in the fleece where lice that are more

resistant can breed. The dilution rate indicated on product labels must be used. Increasing the dip concentration cannot counteract substandard application and should not be considered. Similarly, nothing other than a bacteriostat (a product that is used in some circumstances to inhibit the breeding of bacteria in the dip) should be mixed with registered products in a dip. Combining two or more products in a dip in an attempt to control lice that are resistant to one of the products makes no sense, is unnecessarily expensive, is likely to leave excessive residues in wool and must not occur.

With backline products, the backline strip must be applied exactly as described on the product label. For most products, this is right down the middle of the back and all of the way from poll to rump. If application is uneven or only part of the way along the backline, this can leave areas of low pesticide concentration where the more resistant lice can survive.

If shower dips are not functioning properly or if the sheep are not left in the dip for long enough and are not properly wet to the skin, there can be areas with no chemical or with only low levels of chemical where more resistant lice can survive and breed. Similarly, if sheep are not wet properly in plunge dips, areas of low chemical concentration can remain where lice that are more resistant can survive.

Don't expose treated sheep to untreated lousy sheep

Untreated sheep in a mob will provide a source of ongoing infestation. While there are still protective levels of chemical on the treated sheep this will not be important as any lice that transfer will be killed. However, as chemicals break down on the treated sheep, lice that are more resistant will be able to transfer and survive to breed a more resistant population. In addition, sub-lethal amounts of synthetic pyrethroids can rub onto untreated sheep that are running with treated sheep and may contribute to resistance development.

Therefore, it is critical to eliminate sources of lice:

- Ensure clean musters and that all sheep on the property are treated.
- Keep strays out of the mob.
- Quarantine newly purchased sheep.
- Avoid split shearings or at least keep mobs shorn at different times separate from each other.
- Avoid treating ewes with lambs at foot (unless the lambs are also treated) or pregnant ewes within 6 weeks of lambing.

Check the LiceBoss note: Sheep lice—biosecurity can prevent introduction, for information to assist in developing a lice biosecurity program to prevent new infestations.

Strategic use of chemicals to minimise selection for resistance

Where chemical treatments are required, there are some other rules that can be followed to minimise the likelihood of resistance.

Rotate products from different chemical groups

Use chemicals from different chemical **groups** (Table 2) for consecutive treatments. Treating repeatedly with chemical from the same chemical group (even if it is a different active ingredient) exerts heavy pressure for the selection of resistance. Remember that there may be a number of different chemicals within a group; changing to another one of these within a group will not help to avoid resistance.

Consider flystrike chemicals

Treatment for flystrike exposes any lice present to chemical. Likewise, lice treatments can also select for resistance in sheep blowflies. If possible, use chemicals from different chemical groups for controlling lice and flystrike in the same year. The names of flystrike control products containing cyromazine and dicyclanil, which don't affect lice, are listed in the LiceBoss Products Tool.

Avoid using long wool treatments where possible

Long wool treatments do not eradicate lice and may allow the more resistant ones to survive and breed. Consult the LiceBoss Long Wool Tool to help determine if a long wool treatment is likely to be economically worthwhile before using a long wool product.

Where a long wool treatment has been used, ensure that a chemical from a different group is used after the next shearing

As long wool treatments don't eradicate lice, all sheep will need to be treated again, after their next shearing. Using a chemical from a different group maximises the chance of killing any resistant lice left alive by the long wool treatment.

What to do if resistance is suspected

- If you think that resistance may have caused a control break down, carry out a complete review of your lice control program, including the treatment method used and the biosecurity program. The Treatments Tool and Short Wool Tool in LiceBoss Tools can assist with this.
- If no other reason for the breakdown can be found, then resistance is a possibility.
- If a long wool treatment is being contemplated, consult the LiceBoss Long Wool Tool to determine whether it is economically justified and which chemicals can be used.
- If applying a long wool treatment, use a product from a different chemical group to the last treatment used on this mob.
- If a long wool treatment is used, it will not eradicate lice; all sheep will need to be treated after their next shearing. Use a chemical from a different group for the post-shearing treatment.
- If problems continue to arise and no reason can be identified, seek professional advice.

Table 1: Flystrike control products and their effect against lice

Chemical / Group	Products	Effect against lice
Cyromazine	Many	No
Dicyclanil	CLiK; CLiKZin	No
Dicyclanil + Diflubenzuron	Magik; CLiK Plus	Yes
Synthetic pyrethroid	Vanquish	Yes
Spinosyn	Extinosad	Yes
Macrocyclic lactone	Paramax; Blowfly and lice jetting fluid; Zinjet; Jet Away	Yes

Table 2: Chemical groups and products registered for lice control in Australia

Chemical group	Chemical actives	Products	Resistance detected
Organophosphates	Diazinon Temephos	Eureka Gold; Southern Cross Gold Assassin; Wham	Low level and rare
Synthetic pyrethroids	Deltamethrin Cypermethrin Alpha-cypermethrin	Clout-S Outflank; Spurt; Cypercare; Cypermethrin 25 Vanquish	Widespread to all
Insect growth regulators	Diflubenzuron Triflumuron	Magnum; Fleececare; Strike; Magik; CLiK Plus; Stampede; Crusader; Duodip Zapp; Triffik; Exilice; Virbac IGR Pouron; Cannon; Command; Triflumuron 25	Yes Yes
Spinosyns	Spinosyns	Extinosad	No
Neonicotinoid	Imidacloprid	Avenge	No
Macrocylic lactone	Abamectin Ivermectin	Maverick Paramax; Blowfly and lice jetting fluid; Zinjet; Jet Away	No
Other	Magnesium fluorosilicate, rotenone and sulphur	Flockmaster MkII	No

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