Automatic jetting races

The information below is based extensively on the reports prepared by the late Mr Roger Lund and Mr Peter Kelly formerly of the NSW Department of Primary Industries Agricultural Engineering Research Unit, ARC Trangie.

Effective jetting requires wetting the sheep to skin level in those areas most likely to be affected by flystrike i.e. from the poll, over the shoulders, down the backline, over the rump and around the breech and pizzle. Wetting to skin level is required for maximum length of protection. Automatic jetting races (AJRs) are an alternative to the spray-on backlines and the much slower practice of hand jetting. Being quicker than hand jetting, they allow more timely jetting operations. However, AJRs tend to use more chemical than hand jetting. AJRs are not recommended for lice treatments.

Work conducted by NSW DPI at theTrangie Agricultural Research Centre in 1988 and by the Kondinin Group in 1991 demonstrated that AJRs were less effective than hand jetting. Anecdotal field evidence from farmers and advisers suggested that AJRs could be made more effective and labour efficient, and a number of farmers had modified existing AJRs to improve their performance. As well, observation of working AJRs suggested that many operators were exposed to excessive pesticide spray drift. Many manufacturers have incorporated the recommended modifications described in this note into their current designs however, plenty early model machines remain.

One way to minimise the amount of pesticide that remains on the wool at shearing is to improve the machinery used to apply the pesticide, so that flystrike is controlled effectively and repeat treatment is not necessary.

AJR research

The principal aim of the research was to establish the plumbing design, flow characteristics, droplet form and nozzle type, size and location required to achieve maximum protection against flystrike.

To achieve this the research concentrated on:

- investigating how different AJR configurations affected wetting of sheep; and
- improving the plumbing design and components of intermittent jetting systems (those that are actuated by the sheep passing through the race).

General principles

The work showed that to achieve effective jetting of sheep and protection against flystrike, a number of key principles need to be followed when selecting and operating an AJR. Each of the components tested had an effect on the operation of the system and had a significant effect on wetting sheep where pesticide is required - at skin level along the back line, down the sides and under the belly.

Specific design features (see diagrams)

Plumbing size

The major effect of increased plumbing size was to decrease pressure losses. This in turn reduced pump power requirements to achieve the same pressure and flow output. The decrease in pressure settling time with larger plumbing was a significant advantage.

Valve type

A quick acting gate valve showed several advantages over the others tested, including lower pressure losses on partial opening and a shorter reaction time. The settling time was not affected by valve type or opening.

Nozzles

The jet of fluid from solid stream nozzles gave significantly better penetration of the fleece than the dispersed stream produced by flat fan or solid cone nozzles. Solid stream nozzles also produced fewer small droplets, reducing the OH&S risk to operators.

Nozzle size had little effect on fleece penetration, but larger nozzles applied a greater volume of fluid.

Spray bar orientation

Top: When the two top spray bars ran in the direction of travel, wetting was significantly better than with any of the other top bar arrangements. This suggests that greater efficacy is achieved where there is multiple wetting, i.e. where the fleece is wetted in the same place a number of times. Results favoured a short longitudinal arrangement with five nozzles per bar.

Bottom: Best wetting was achieved with a bottom spray bar arrangement that consisted of three nozzles across the direction of travel, angled forward at 30° off the vertical.

Spray bar height
Positioning of the top spray bar nozzles such that they combed the wool proved no better than when the nozzles were 150 mm above the fleece. However these two heights gave better wetting than a third position 300 mm above the fleece.

This result further supports the argument for solid stream nozzles. The spray pattern from solid stream nozzles tended to break up at a distance away from the nozzle, particularly at higher pressure settings, giving a similar stream characteristic to that of the cone and flat fan nozzles.

Flow rates
Both top and bottom flow rates affected application efficacy. The number of nozzles per top spray bar should be five in preference to three and larger size nozzles preferred over smaller ones.

Spray pressure
Spray pressure has two effects on the spray stream; it determines flow rate and affects the characteristics of the spray stream. The pressure should be high enough to achieve the required flow rate but not so high as to break up the solid stream. Spray pressures above 450 kPa were significantly better at wetting sheep than those below 450 kPa. However, increased pressure caused increased spray scatter.

The pump
Pump size is specified by its pressure / volume characteristics. Five to six litres of jetting fluid, applied at a pressure 450 kPa or greater, is required to adequately wet sheep carrying more than eight months wool. To achieve this a pump slightly bigger than the conventional "5 hp fire fighter" is required. Sheep in shorter wool require less jetting fluid, so a smaller pump may suffice. (Check pump specifications: For jetting, volume is more important than high pressure.)

Sheep flow
The speed that sheep pass through an AJR had a significant effect on wetting, irrespective of any mechanical features of the AJR configuration. For adequate wetting, it is important that sheep speed is controlled to less than 1 sheep per second. This influences the design of both the AJR and adjacent entrance and exit races.

As sheep speed is an important factor in jetting performance, and sheep behaviour

through jetting races was known to be an issue, an extensive review of the literature on sheep yard design was undertaken. This suggested that the entrance and exit races adjacent to the AJR have a key impact on sheep flow, spacing and speed. General recommendations with respect to sheep flow through an AJR are:

- at the approach to the AJR, sheep should move around a corner to achieve separation ie; around a bugle or curved lead up race
- the AJR should be as free from clutter as possible
- the AJR and lead up race should have solid sides
- the exit race should encourage sheep to run through the AJR , with a floor that will reduce the problem of sheep baulking at excess water
- the AJR and adjacent entrance and exit races should be a similar colour, shape and material.

Best practice design specifications

The design features detailed above were incorporated into a modified AJR (see figure) and tested at NSW DPI's Trangie Agricultural Research Centre. AJRs with the design features/specifications listed below can be expected to perform well.

Recommendations for AJR design and operation.

Design feature	**Recommended specification**
Number of top spray bars	2
Number of nozzles per top bar	5
Top bar orientation	In line with direction of sheep movement, 100 mm apart
Top nozzle size	Solid stream (4.8 mm (3/16") diam.)
Top nozzle direction	Straight down, angled in
Top bar height above sheep	150 mm maximum
Number of bottom bars	1
Number of nozzles per bottom bar	3
Bottom nozzles size	Solid stream (4.8 mm (3/16") diam.)

Bottom bar arrangement	Across the line of sheep movement
Bottom bar angle	30° forward
Sheep speed	Less than 1 sheep per second
Manifold and Valve size	40 mm diam.
Hoses and spray bars	25 mm diam.
Pressure cylinder volume	No larger than 2.5 L
Valve type	Quick acting gate or butterfly valve
Operating pressure at nozzles	450 kPa
Pump specification	6 L/s at 550 kPa. (8 hp)

Some manufacturers have made other minor alterations to the spray bar configurations, with apparent success eg. two longitudinal and one across top spray bar arrangement with nine nozzles. Two bottom spray bars, one to target the pizzle and the other to target the crutch, also appears to work well. A further modification could be the addition of a number of shut-off valves on the various spray bars such that jetting can be targeted onto a specific fly susceptible area of the sheep rather than all areas. This change would reduce the volume of jetting fluid used and hence reduce pesticide residues in the wool.

The AJR sides should be solid to direct the sheep's view of where to go. The AJR should not look like a narrow tunnel nor should it appear cluttered. Although a parallel-sided race is the tried and proven design, a'V' configuration may reduce the tunnel effect. Top spray bars may add to the creation of the tunnel effect.

The floor of the race can also cause problems. A metal floor may make enough noise to cause the sheep to baulk. Wood or even polyurethane may be a better material. For continuity of sheep flow, the entrance and exit races should be a similar colour, shape and material to the AJR. Flaps and hock bars are unnecessary and constitute 'junk' in the race. The AJR should ideally have a north / south orientation to throw constant shadows.

Intermittent machines tend to clutter the race with triggering mechanisms causing a visual blockage. To reduce baulking, the actuating device could be clear of the sheep's direct view and relatively inconspicuous.

Constant flow machines incorporate the same spraybar configuration and are less cluttered, but without some form of sump they waste an excessive amount of jetting fluid. The inclusion of a drainage area, filter, sump and recirculation pump are an additional complication and cost, add uncertainty about the concentration of pesticide applied, and increase the risk of infection.

Setting up

When using an AJR, a number of adjustments and checks need to be made as the first few sheep are jetted:

- On an intermittent machine, adjust the triggering arms such that the sheep fully open the on/off valve yet not so tight as to jam the animal. If the adjustment is too loose jetting may be less than optimal. For mobs comprising sheep of different sizes it will be worthwhile to draft the mob into groups of similarly sized sheep.

- Adjust the longitudinal spray bars as close as practical to the sheep's back with the sprays hitting evenly each side of the midline.

- After the first few sheep are jetted, check that the areas targeted for treatment are wet. Use an indelible pencil. If there are still dry areas the triggering mechanism may be too loose and/or the pump pressure may need to be increased. Jetting fluid dripping from the rib-line of the sheep is an indication of good jetting.

- If there is excessive wastage of jetting fluid, the pump pressure may need to be reduced, ie. throttle the pump back.

Occupational health and safety

Larger solid stream spray nozzles operating at lower pressures produce less spray drift. This significantly reduces the human health risk of pesticide exposure. Operators should however still take reasonable precautions against pesticide exposure. Product label directions must be followed. Full-length cotton overalls, gum boots, gloves and a washable hat are recommended. A good sheep flow through the race is important. An operator standing near the entrance to the AJR, pushing sheep through, will invariably become heavily exposed to pesticide.

Pesticide residue ramifications

Compared with traditional AJRs, designs incorporating the improvements detailed above increase both the total amount of pesticide retained in the wool and the amount

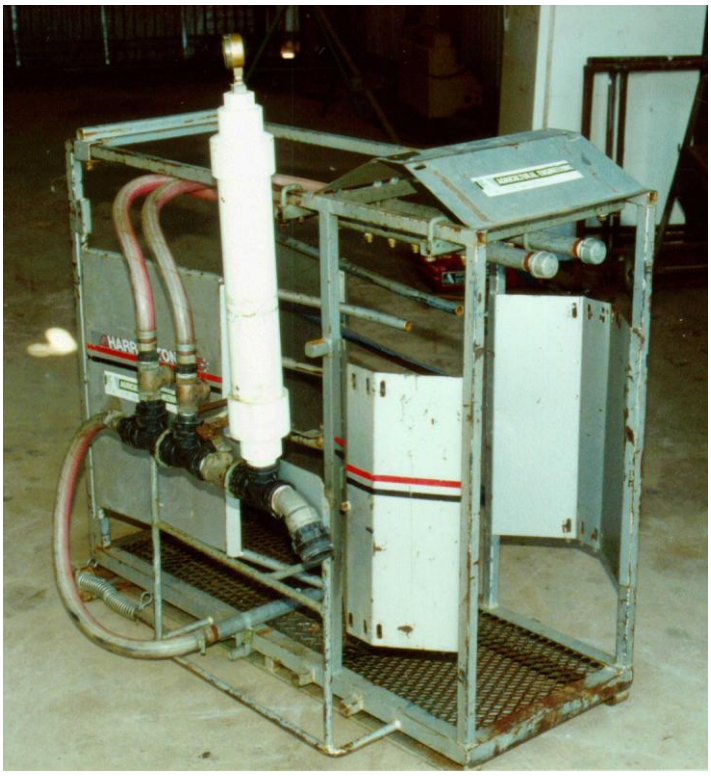
of pesticide deposited at skin level. With the greater emphasis now on producing low residue wool, it is important to ensure that adoption of these modifications does not lead to a greater residue problem. In this regard, the type of chemical used and the time of treatment in relation to shearing have a major effect on ability to meet residue targets.

A NSW DPI trial compared the residue burden in wool shorn from sheep treated four months previously by:

- hand jetting
- a traditional AJR; and
- an AJR designed as outlined above.

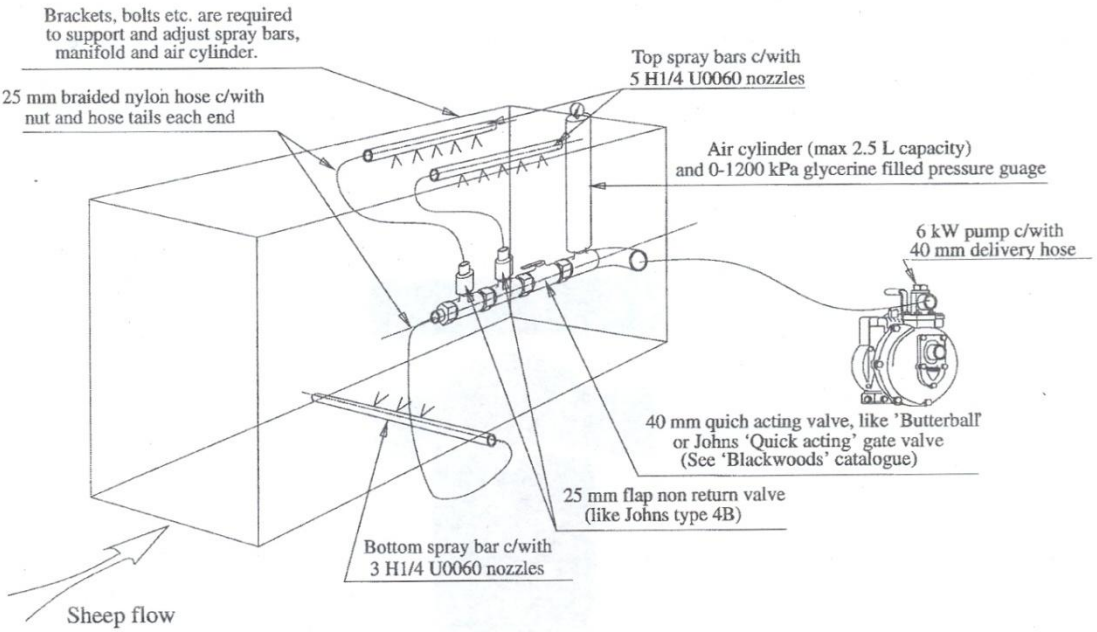
Results showed that on average hand jetting applied 3.1 litres of fluid per sheep. The traditional AJR delivered 1.7 litres per sheep and the modified AJR 4.5 litres per sheep. Hand jetting left significantly higher residues than the modified AJR, which in turn left more residues than the traditional AJR. This was because pesticide applied deep into the fleece, close to the skin, broke down more slowly than pesticide deposited near the wool tip.

The research also showed that the modified AJR, although more efficient than the traditional AJR, was less efficient than hand jetting at delivering pesticide to the preferred sites on the sheep.

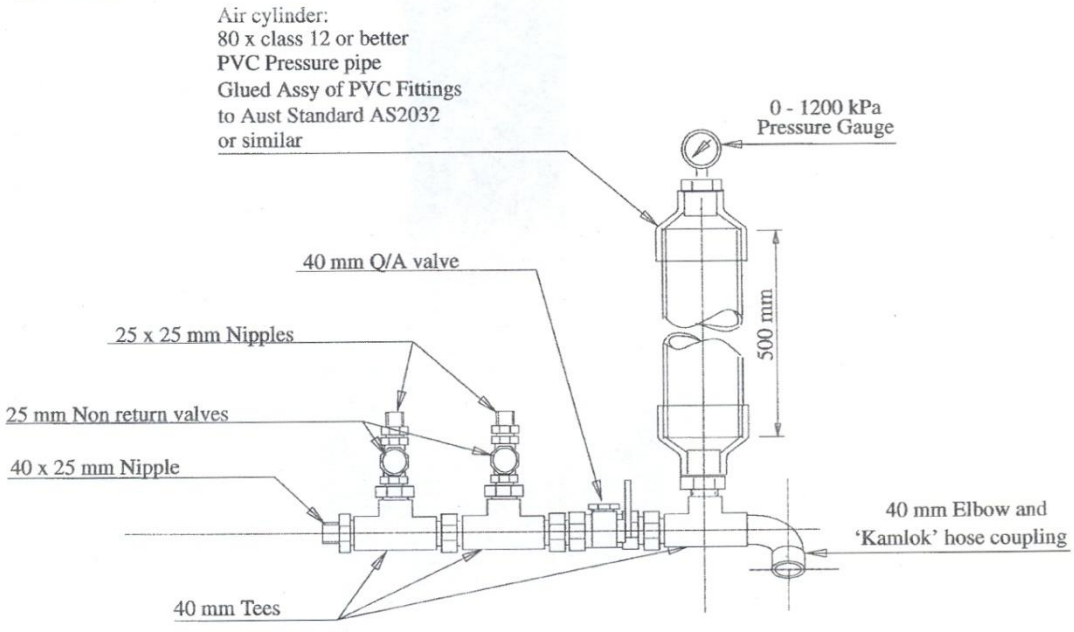


Trangie automated jetting race

GENERAL ARRANGEMENT

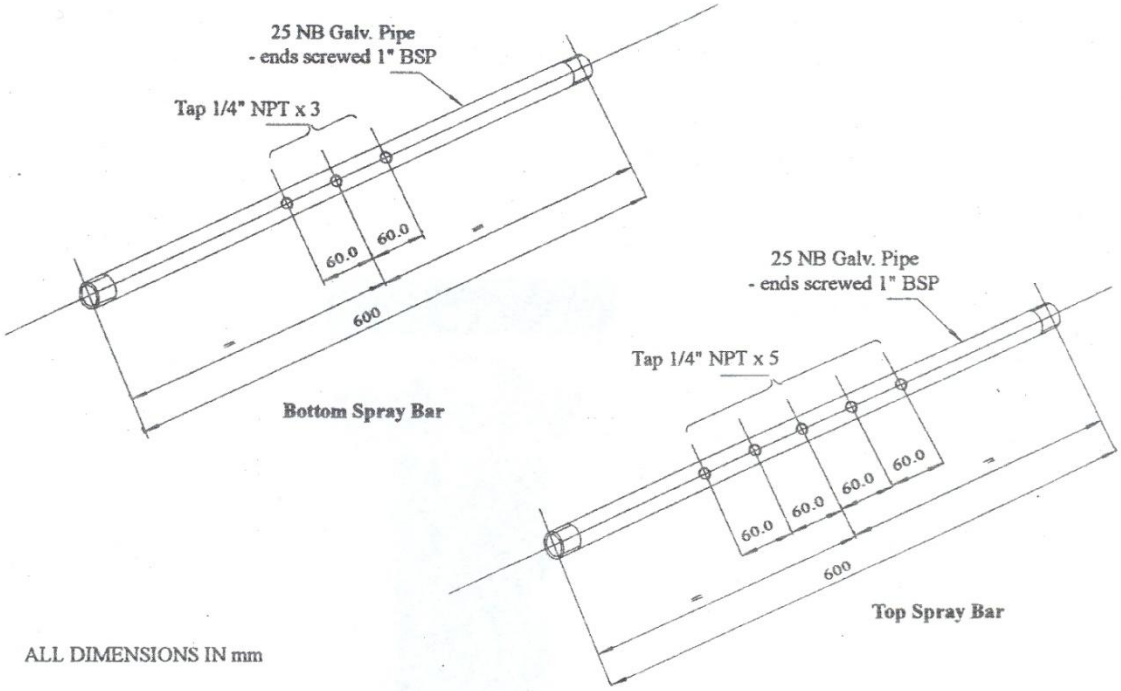


FITTINGS



Hint: Use rigid PVC/Polythene/Brass fittings where possible to avoid corrosion problems.

SPRAY BARS



ALL DIMENSIONS IN mm

NOZZLES*

Nozzle No.	Pipe Conn. NPT Male	Oriface Diam. Nom. Inches	Capacity L/s (litres per second) at kPa (kilopascals)				
			211 kPa	281 kPa	422 kPa	562 kPa	703 kPa
H¼U0040	¼	5/32	0.22	0.24	0.30	0.34	0.38
H¼U0050	¼	11/64	0.26	0.30	0.37	0.43	0.48
H¼U0060	¼	3/16	0.31	0.36	0.44	0.51	0.57
H¼U0070	¼	13/64	0.37	0.42	0.52	0.60	0.67
H¼U0080	¼	7/32	0.42	0.48	0.59	0.68	0.76

Table: Spraying Systems Australia Pty Ltd.