Department of Agriculture and Fisheries

User manual

Dual herbicide sprayer

Version 2 November 2017

Queensland Government

CS7169 11/17

This manual was written by Allan Blair and Jack Robertson, extension officers with the Department of Agriculture and Fisheries (DAF).

DAF would like to thank the following growers, who prompted the development of the dual herbicide sprayer and/or participated in field trials:

- Ray Zamora, Riversdale
- Adrian Darveniza, South Johnstone
- Mark Savina, Freshwater
- Peter Verri, Mossman
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- Clint Reynolds, Mossman
- Ross Gangemi, Ingham
- Mark Poggio, Ingham.

The development of the dual herbicide sprayer was funded by the Queensland Government through its Reef Water Quality Program.

For more information on the dual herbicide sprayer, call 13 25 23 or visit www.daf.qld.gov.au.

Contents

About the manual

This manual was developed for canegrowers, contractors, industry support personnel (i.e. productivity services) and other users of dual herbicide sprayers. It describes the steps involved in setting up, calibrating, using and maintaining a sprayer and also includes:

- engineering drawings (Appendix 1)
- Australian Pesticides and Veterinary Medicines Authority (APVMA) permit PER14648 (Appendix 2)
- results of field trials (Appendix 3)
- nozzle selection and output data (Appendix 4)
- an economic analysis (Appendix 5).

It is essential that users read and follow the information in this manual when using the dual herbicide sprayer. The sprayer can only be used under permit PER14648. The Department of Agriculture and Fisheries (DAF) will not be responsible or liable for any damage resulting from equipment/component failure or the improper use of a dual herbicide sprayer.

Background

The dual herbicide sprayer was developed by DAF in response to requests from canegrowers for a simple, inexpensive spray system that could apply glyphosate (Roundup® etc.) to the inter-row and pre-emergent herbicides to the row. Before the sprayer was developed, growers generally had to apply a mix of more expensive cane herbicides over the whole paddock.

In essence, the dual herbicide spray bar is a non-shielded strip sprayer that can direct one herbicide to the inter-row and another to the row (Figure 1). It is constructed by modifying the spray bar of an existing Irvin boom—a low-pressure, low-volume 12 V spray tank is retrofitted to allow two herbicide solutions to be applied simultaneously. In particular, it enables application of knockdown herbicides (such as glyphosate) to be directed into the inter-row via a centre air induction nozzle, while two wing nozzles direct a residual blend into the stool area.

The sprayer is particularly useful for controlling difficult weeds that occur in the inter-row, such as sourgrass (*Paspalum conjugatum*) and guinea grass (*Panicum maximum*). It may also reduce production costs by reducing the amount of newer, more expensive pre-emergent herbicides required to effectively control weeds.

Compared to a conventional Irvin boom, the dual herbicide sprayer enables growers to:

- decrease weed-control costs by using lower cost herbicides in the inter-row
- strategically target weeds
- decrease residuals and improve growers' ability to comply with regulations.

As the dual herbicide sprayer is band-spraying, the amount of residual chemicals being applied is reduced by around half, depending on row width.

A cost–benefit analysis by DAF economists (see Appendix 5) demonstrates that the sprayer can provide herbicide cost savings and can improve the range of options available to growers to better target troublesome weed populations.

Figure 1 DAF staff with the dual herbicide sprayer

When the sprayer is calibrated and used correctly, glyphosate contact with the cane plant is insignificant and does not affect cane growth. The sprayer should be used to apply glyphosate in the inter-row when the **sugarcane canopy is at least 600 mm high** (equivalent to 250 mm to the top visible dewlap).

Replicated trials of the sprayer on cane farms in the Wet Tropics region in 2012–13 showed no significant differences in cane productivity—measured by yield, commercial cane sugar (CCS) and growth—between crops treated with a conventional herbicide sprayer and those that had glyphosate applied to the inter-row using a dual herbicide sprayer (Figure 2). For more information on these trials, see Appendix 3. The data from these trials was used as the basis for the APVMA permit for this equipment.

In the trials, diuron and paraquat mixes were applied to the row through the wing nozzles and glyphosate was applied through the centre air induction nozzle. Ultraviolet tracing showed that the amount of glyphosate deposited on to actively growing sugarcane leaves was minute and insignificant. Growers in the trial program also commented that they achieved better weed control by using glyphosate in the inter-row rather than by conventional diuron herbicide tank mixes. Additionally, they found that in many instances fewer herbicide applications were required to control weeds.

Figure 2 A field trial of the dual herbicide sprayer showing no visible difference between treatments

One of the treatments used only the centre air induction nozzle to apply glyphosate (i.e. did not apply paraquat and diuron through the wing nozzles). The diuron and paraquat mix was applied to the row 20 days after the glyphosate application. This was to remove the weed competition effect in that treatment. As glyphosate is a systemic herbicide, it required this period of time to be taken in to the cane plant from the inter-row application. However, although this treatment did not lead to any significant differences in yield, CCS or growth, paraquat should be applied in the row through the wing nozzles when the glyphosate is applied, particularly in younger cane, to prevent any glyphosate contacting the cane leaves. Many herbicide labels require paraquat to be applied in a mix with pre-emergent herbicides.

Setting up the sprayer

Equipment needed

The main component of the dual herbicide sprayer is the spray bar. The engineering drawings for constructing the spray bar are provided in Appendix 1.

The spray bar (Figure 3) has:

1. a centre air induction nozzle, which delivers glyphosate to the inter-row
2. two wing nozzles, which deliver herbicides that are not toxic to sugarcane plants to the row.

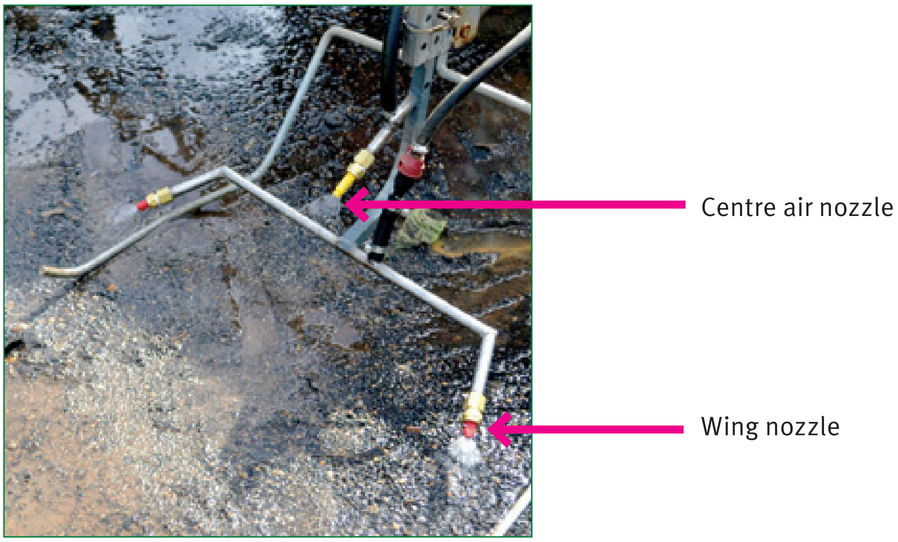


Figure 3 A spray bar showing the centre and wing nozzles

You will need an Irvin-type boom sprayer. This type of sprayer has a parallelogram arrangement attached to the tool bar and tracking legs, which maintain the spray bar at a constant height above the ground.

You will also need a 200 L spray tank and 12 V pump with a minimum of 12 L/min flow at a continuous pressure of 3.0 bar (300 kPa). This would be suitable for a four-row 400–600 L three-point linkage sprayer. The pump specifications will restrict the sprayer to low water volume application rates in the inter-row, which is ideal for glyphosate.

Higher volume pumps are needed for other herbicides that require greater water application volumes. Growers in the trial program achieved this by mounting a 200 L tank on the front of the tractor and purchasing a separate sprayer with a 12 V pump.

Other essential components are:

- a pressure regulator
- a filter (minimum 50 mesh)
- at least 20 m of half-inch (12.7 mm) spray hose
- stainless steel hose clamps
- nozzles (see Appendix 4)
- various half-inch (12.7 mm) tee and elbow fittings
- 8 nozzle filters with ball valves (for a 4-row sprayer)
- 4 diaphragm check valves (for a 4-row sprayer).

Constructing the spray bar

Engineering drawings showing the dimensions of the spray bar are provided in Appendix 1. The design in itself is not complex, but the angles and orientation of the nozzles are critical. Stainless steel of grade 316 is recommended for construction of the spray bar. Lesser grades (e.g. 304) may be used for components that do not carry herbicide. Experience has shown that not all boom sprays are the same, and some bending and final adjustment of the spray bars may be necessary. This is discussed in the steps below.

There are three spray bar designs. They reflect the different row spacings commonly used in sugarcane production in Queensland: 1.4–1.5 m, 1.6–1.7 m and 1.8–2.0 m. The 1.5 m design is also used for dual-row 1.8–2.0 m spacings. The spray bars are designed to spray around 50% in the row and 50% in the inter-row, with 5–10% overlap.

Figure 4 Measuring sprayer width, which can be adjusted to suit row width

Steps in setting up

1. Attach the 12 V sprayer tank and pump to the tractor.
2. Attach the pressure regulator and gauge to the sprayer tank output hose. Allow sufficient hose to attach the regulator to the tractor. Attach a filter to the inlet side of the pressure regulator.
3. Plumb the return hose from the regulator to the 12 V sprayer tank.
4. Attach the dual herbicide spray bar to the legs of the boom sprayer.

5. Attach the diaphragm check valves to the centre nozzle inlet of the spray bar using a short piece of half-inch (12.7 mm) spray hose and clamps. (Ball valve strainers are not generally compatible with the air induction nozzles used in the centre of the sprayer bar.)

6. Using tees and clamps, attach hoses from the pressure regulator to each diaphragm check valve on the centre nozzle. Allow sufficient hose for the boom to fold. In most cases, it is easier to follow the existing hose on the sprayer.

7. Attach the existing spray lines to the wing nozzles' inlet pipe. Quick-fit or quick-release fittings are usually best. There is no need to fit a diaphragm check valve, as 50 mesh nozzle filters with ball shut-off valves are used here. Some low-drift nozzles have a pre-orifice plate that touches the strainer check valve. If this is the case, a separate diaphragm check valve can be fitted to the wing nozzle section of the spray bar or a suitable O ring could be fitted under the cap.

8. Use cable ties to attach delivery hoses to the sprayer frame and boom.

9. Operate the hydraulics and test for spray lines fouling on folding mechanisms. Adjust these if necessary.

10. Fill both the main tank and 12 V sprayer tanks with clean water and flush the system.

11. Insert 80° even fans (or equivalent) in the wing nozzle bodies and an air induction nozzle in the centre nozzle. Check their operation, and check for leaks and blockages. For nozzle selection, see page 8 and the specification tables in Appendix 4.

12. Observe the operation of the spray bar at 1.5–3.0 bar pressure for the wing nozzles and 2.0–4.0 bar pressure for the centre air induction nozzles. On flat ground there should be approximately 50 mm of overlap between the centre and wing nozzles (Figure 5). Final adjustments should be done when the nozzle types and output are decided (see Appendix 4). You can adjust the overlap and relationship between the centre and wing nozzles simply by bending the centre nozzle bracket (Figure 6).

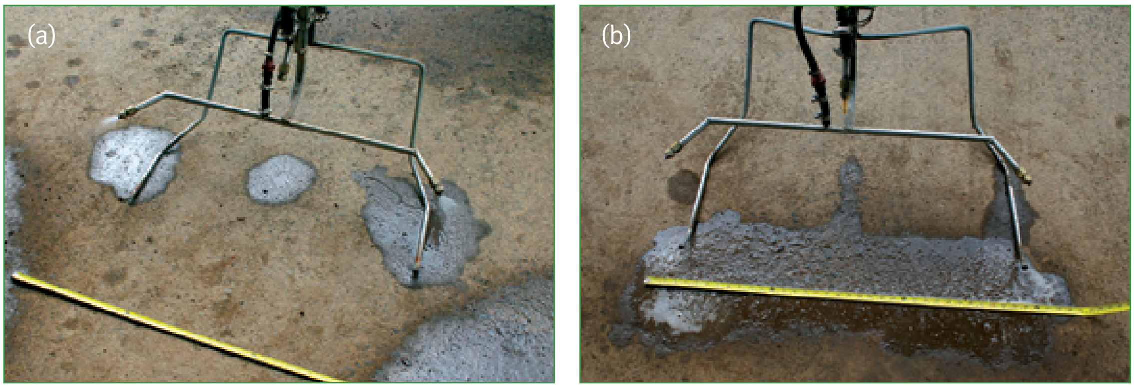


Figure 5 Testing the dual herbicide spray bar for the required 50 mm overlap: (a) spray from wing nozzles only (b) spray from centre nozzle

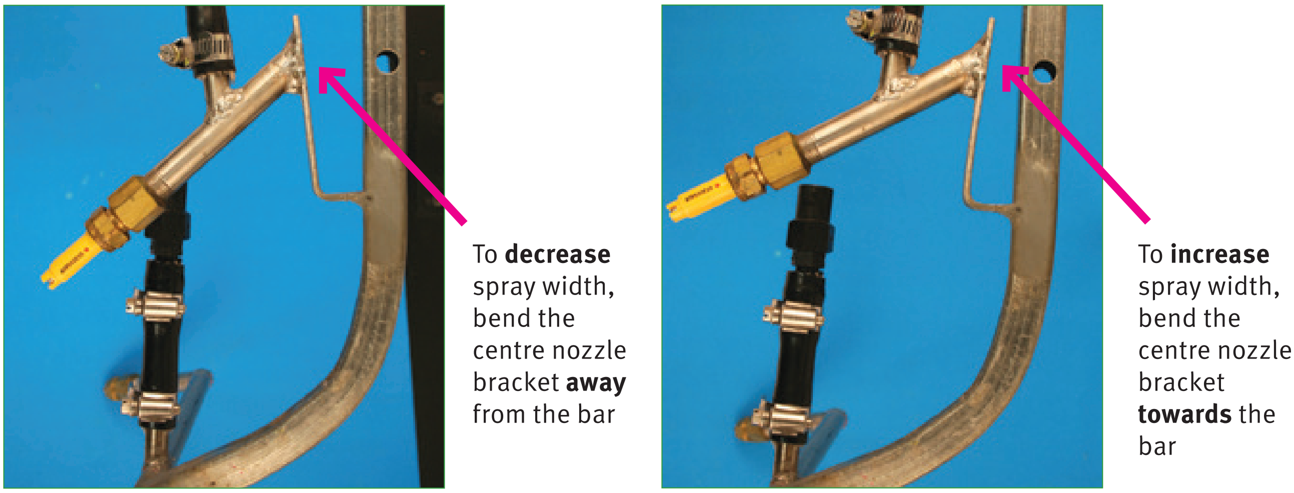


Figure 6 Changing the spray width by adjusting the centre nozzle

13. For high-profile rows in controlled traffic, mound planting and flood irrigation systems, the spray bar may have to travel at a greater height from the inter-row. To achieve this, extend the drag bar shank—usually 150 mm is adequate (Figure 7). You may also need to place an upward deflection on the wing nozzles so they spray at a greater height than for standard beds (Figure 8).

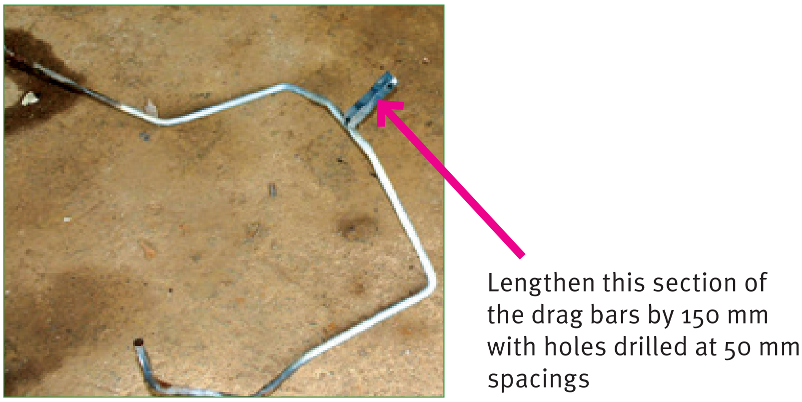


Figure 7 Extending the drag bar shank

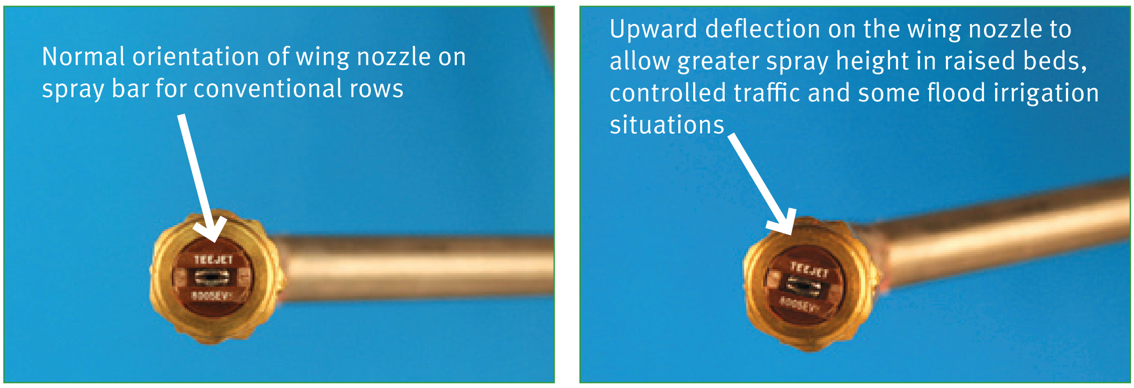


Figure 8 Adjusting the wing nozzle orientation

Nozzle selection

A number of nozzles have been tested for this sprayer, and the tables in Appendix 4 give the theoretical outputs of various combinations. However, actual outputs may vary and therefore should be tested and calibrated as described in the following section.

Wing nozzles

Generally these are 80° even fan-spray nozzles operating at up to 2.0 bar pressure, but there is some flexibility in choice. Other nozzles—such as the Hardi MiniDrift®, Hardi LowDrift®, TeeJet AIXR®, DriftGuard TeeJet® and 95° long air induction nozzles—are also suitable. Growers have suggested that the air induction gallery may clog with dust, but no problems were experienced during the trials, and clogging can be avoided through routine maintenance (see page 11).

It is important to minimise the amount of fine droplets being produced from the wing nozzles. Fine droplets of herbicide containing desiccants like paraquat tend to move into the inter-row and may prevent the uptake of glyphosate by weeds in the inter-row.

Centre nozzle

Centre nozzle selection is critical. It should be an air-induction nozzle of 95–110° angle with at least a very coarse spray quality. Typical nozzles used in the trials were Hardi Injet® and TeeJet AI95EVS®.

Calibration

Terminology

Sprayed area refers to the area that a nozzle or group of nozzles sprays. For single rows, the centre nozzle should spray about half of the crop area and the wing nozzles the remaining half. For double rows, the centre nozzle should spray 40% of the crop area and the wing nozzle 60%. Overlap is taken into account in the nozzle selection and output tables in Appendix 4.

Final calibration and testing

Use the tables in Appendix 4 as a guide for nozzle selection and calibration. Most of the growers who tested the sprayer used a yellow TeeJet AI95 02® air induction nozzle in the centre and either Hardi® or TeeJet® 80° even fans in the wings (Figure 9).

Figure 9 Nozzles assembled on the spray bar

While the aim is to have the centre nozzle spray 50% of the row and the wing nozzles the other 50%, in reality there is a bit of overlap. So in general it is best to set up the sprayer with the centre nozzle at 50% and the wing nozzles at 55%.

Follow the steps below to calibrate the sprayer. Do this before each spraying.

1. Decontaminate the sprayer by flushing it with clean water. If necessary, use tank cleaner as well.

2. Place a large measuring jug under the centre nozzle and another under each of the wing nozzles. Measure the outputs in litres and record the time (in minutes) for these outputs. Divide the outputs by the time and check the results against the tables in Appendix 4 or the nozzle catalogue.

3. Measure how many metres the tractor travels in 1 minute at spraying speed (A).

4. Measure the row width in metres. For single and wide rows, multiply this by 0.5 for the centre nozzle and for the wing nozzles. For double rows, multiply this by 0.4 for the centre nozzle and 0.6 for wing nozzles (B).

5. Multiply A × B for the centre nozzle and for the wing nozzles. This is the **area sprayed in 1 minute** (in square metres).

6. Use the following formula to determine output in litres per hectare. Remember that separate calculations are required for the centre nozzle and wing nozzles.

$$\text{Output (L/ha)} = \frac{\text{total volume sprayed in 1 minute (L)} \times 10\,000}{\text{area sprayed in 1 minute (m}^2\text{)}}$$

You should end up with two numbers:

1. an output in litres per hectare for the centre air induction nozzle
2. an output in litres per hectare for the wing nozzles.

Using flow meters and rate controllers can help in the calibration and fine-tuning of the sprayer. The growers who participated in the trials preferred their own methods of fine-tuning, which included refilling the tanks after spraying a known area and having premeasured strips.

Figure 10 Spray bars set up ready for calibration and testing

Figure 11 Spray bars tested and ready to use

Ultraviolet dyes were used extensively for tracing in the design and development of the sprayer. These products are easy to use by following the instructions on the label. An ultraviolet portable fluorescent lamp costs around $160, and these are commonly available from electrical contractor supply outlets. Ultraviolet dye in pink and yellow can be obtained from paint retailers. Simple vegetable dyes have also been used as an aid in setting up the sprayer.

Using the sprayer

Once it has been set up and calibrated, the dual herbicide sprayer is ready to use on the farm. It can be used in both plant cane and ratoons, but should only be used to apply glyphosate in the inter-row when the cane is at least 600 mm tall (250 mm to the top visible dewlap), due to the risk of glyphosate touching young leaves and adversely affecting growth (Figure 12). However, there are differences in growth habit between sugarcane varieties, so it is critical not to rely just on cane height, age, etc. Always ensure that the glyphosate does not come into contact with any of the living (green) cane leaves.

Ensure canopy height is at least 600 mm from the base of the plant or at least 250 mm to the top visible dewlap

Figure 12 Measuring cane to check height before applying glyphosate to the inter-row

A variety of selective herbicides can be applied through the wing nozzles. These include the commonly used diuron and paraquat mixes and some of the newer chemicals such as isoxaflutole (Balance®) and imazapic (Flame®). Always apply according to instructions.

Glyphosate is recommended for the inter-row, applied through the centre nozzle. Application rates of glyphosate up to 2.85 L/ha active constituent have been tested in inter-row applications. This equates to 5 L/ha of a 570 g/L formulation (e.g. Roundup Attack®) or 6.33 L/ha of a 450 g/L formulation (e.g. Roundup CT®) of glyphosate.

Trials conducted since 2015 have demonstrated that glufosinate ammonium (Basta®) used through the centre nozzle gave excellent control of a variety of weeds. It was particularly effective against young vines and is now registered for sugarcane.

Some growers use paraquat only through the centre nozzle and achieve good weed control in the inter-row. Using either glyphosate or glufosinate ammonium or paraquat will reduce the amount of residual herbicides applied.

Remember to always follow herbicide label instructions.

Maintaining the sprayer

- Flush the spray bar with clean water after use and store it in a dry, safe place.
- Regularly check hoses and fittings for leaks.
- Decontaminate and calibrate the sprayer regularly and follow specific manufacturer's instructions.
- Check nozzles for wear and blockages.
- Clean filters regularly.

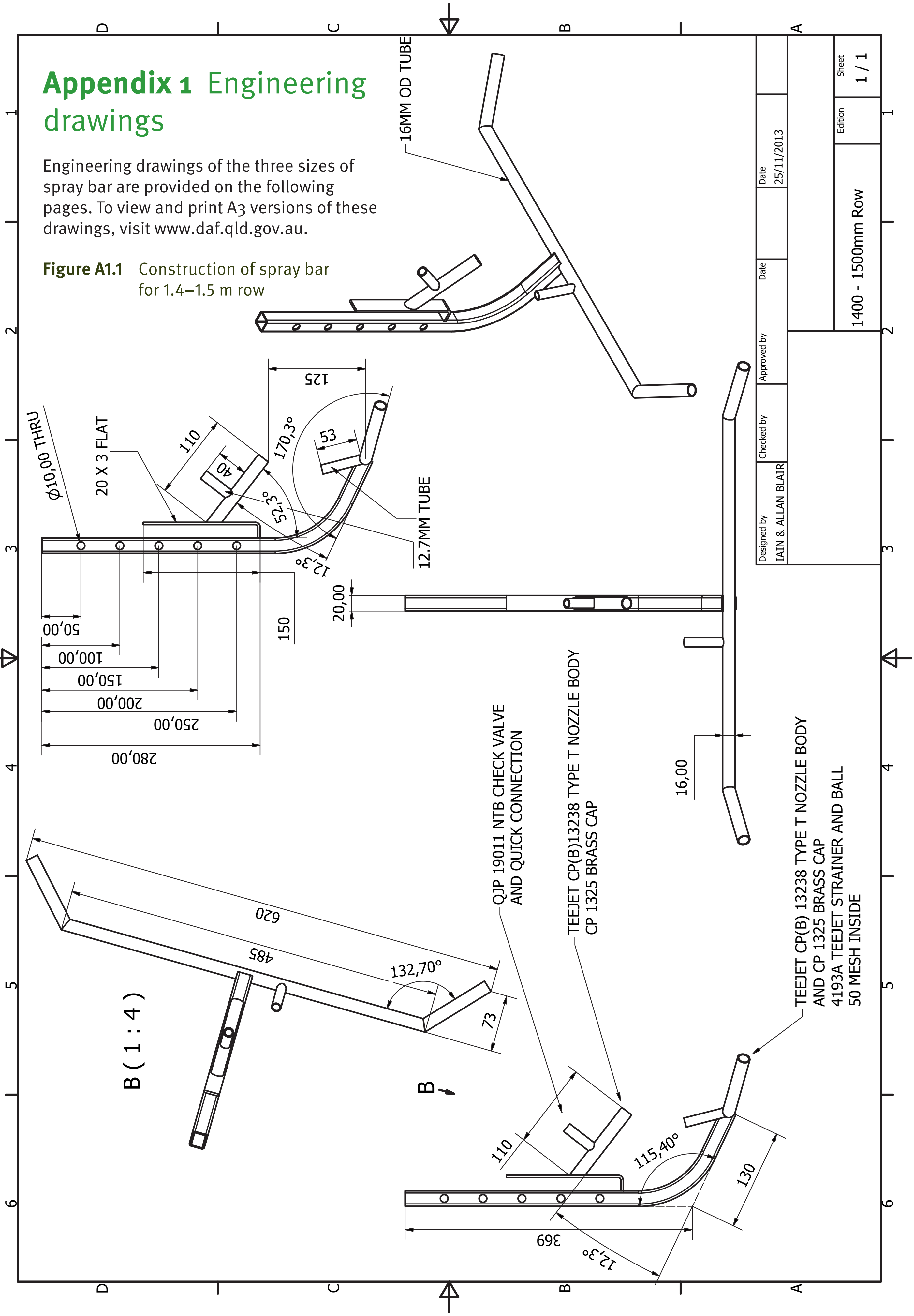
Figure 13 Spray bars being tested after use

Appendices 1–5

Appendix 1 Engineering drawings

Engineering drawings of the three sizes of spray bar are provided on the following pages. To view and print A3 versions of these drawings, visit www.daf.qld.gov.au.

Figure A1.1 Construction of spray bar for 1.4–1.5 m row



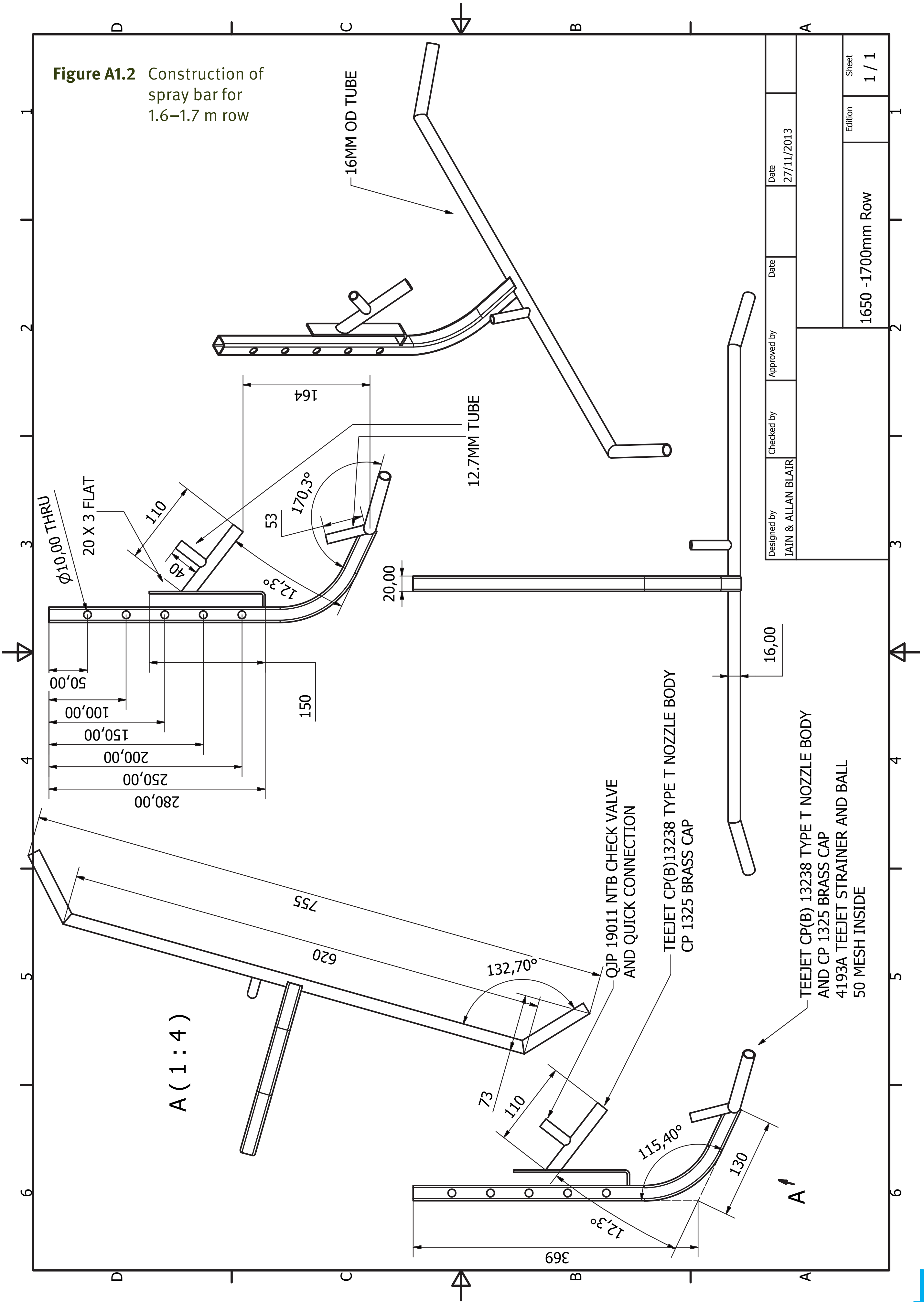
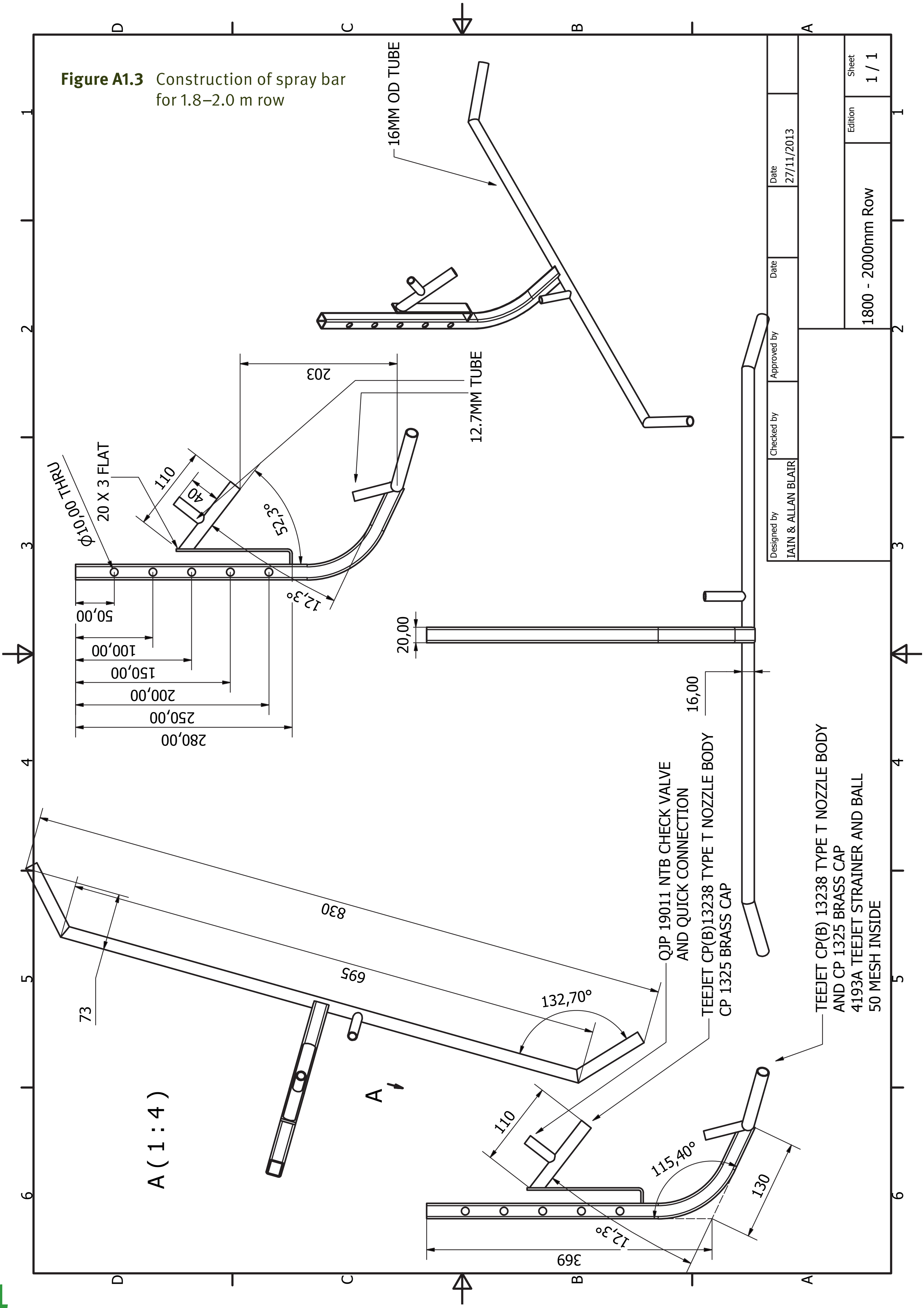


Figure A1.2 Construction of spray bar for 1.6–1.7 m row

Figure A1.3 Construction of spray bar for 1.8–2.0 m row



Appendix 2 Australian Pesticides and Veterinary Medicines Authority permit

Australian Government
Australian Pesticides and Veterinary Medicines Authority

PERMIT TO ALLOW MINOR USE OF AN AGVET CHEMICAL PRODUCT

FOR THE INTER-ROW SPRAYING OF SUGARCANE

PERMIT NUMBER - PER14648

This permit is issued to the Permit Holder in response to an application granted by the APVMA under section 112 of the Agvet Codes of the jurisdictions set out below. This permit allows a person, as stipulated below, to use the product in the manner specified in this permit in the designated jurisdictions. This permit also allows any person to claim that the product can be used in the manner specified in this permit.

Note: Currently authorized label directions have become a restriction on the adoption of new non-shielded spray technologies which allow safe targeted inter-row spraying of weeds in sugarcane. This permit amends currently authorized label directions to remove all references restricting users to specific (shielded or hooded) technologies with an aim to allowing users a choice in adopting the technology that best achieves their required results.

THIS PERMIT IS IN FORCE FROM 20MARCH 2014 TO 30 JUNE 2024

Permit Holder:
DAFF QUEENSLAND
EXPERIMENTAL ROAD
SOUTH JOHNSTONE 4859

Persons who can use the product under this permit:
Persons generally

CONDITIONS OF USE

Product to be used:
Glyphosate Products registered for inter-row spraying of sugarcane
Containing:360 to 570 g/L GLYPHOSATE present as various salts of GLYPHOSATE as their only active constituent.

Directions for Use:

Crop	Pest	Rate
SUGAR CANE inter-row spraying	WEEDS as per label	As per label

Critical Use Comments:
DO NOTallow spray to contact any part of the crop as severe injury may result.

- Apply to weeds growing between crop rows using ground based equipment which has been designedand setup for targeted application.
- Follow retreatment interval and maximum application number as per approved label.

Withholding Period:
Not required when used as directed.

Jurisdiction:
All states

Additional Conditions:
This permit provides for the use of a product in a manner other than specified on the approved label of the product. Unless otherwise stated in this permit, the use of the product must be in accordance with instructions on its label.

Persons who wish to prepare for use and/or use products for the purposes specified in this permit must read, or have read to them, the details and conditions of this permit.

Issued by

Delegated Officer
Version 2: Amended 27 March 2014, change permit holder address and amend critical use comment.

Appendix 3 Results from trials

Replicated trials were undertaken to ensure there were no phytotoxic or yield penalty effects on sugarcane production from applying glyphosate to the inter-row using the dual herbicide sprayer.

The trials included four different treatments.

Treatment 1

This was the control, using a conventional sprayer with paraquat (Gramoxone®) 1.25 L/ha + diuron (Diurex®) 1.00 kg/ha + 2,4-D 1.0 L/ha.

Treatment 2

This used the dual herbicide sprayer set up to spray simultaneously glyphosate (Roundup Attack®) 5.0 L/ha through the centre nozzle and paraquat (Gramoxone®) 1.25 L/ha + diuron (Diurex®) 1.00 kg/ha + 2,4-D 1.0 L/ha through the wing nozzles. A TeeJet® air induction nozzle was used in the centre and TeeJet® DG8005E nozzles in the wings.

Treatment 3

This used the dual herbicide sprayer set up to spray simultaneously glyphosate (Roundup Attack®) 5.0 L/ha through the centre nozzle and paraquat (Gramoxone®) 1.25 L/ha + diuron (Diurex®) 1.00 kg/ha + 2,4-D 1.0 L/ha through the wing nozzles. A Hardi Injet® air inclusion nozzle was used in the centre and TeeJet® DG8005E nozzles in the wings.

Treatment 4

This used the dual herbicide sprayer set up to spray glyphosate (Roundup Attack®) 5.0 L/ha through the centre nozzle followed by paraquat (Gramoxone®) 1.25 L/ha + diuron (Diurex®) 1.00 kg/ha + 2,4-D 1.0 L/ha through the wing nozzles 20 days later. A Hardi Injet® air inclusion nozzle was used in the centre and TeeJet® DG8005E nozzles in the wings.

Findings

Figure A3.1 and Table A3.1 show the results of the trials. There were no significant differences between treatments in terms of yield, commercial cane sugar (CCS), stalk diameter and brix (sugar content).

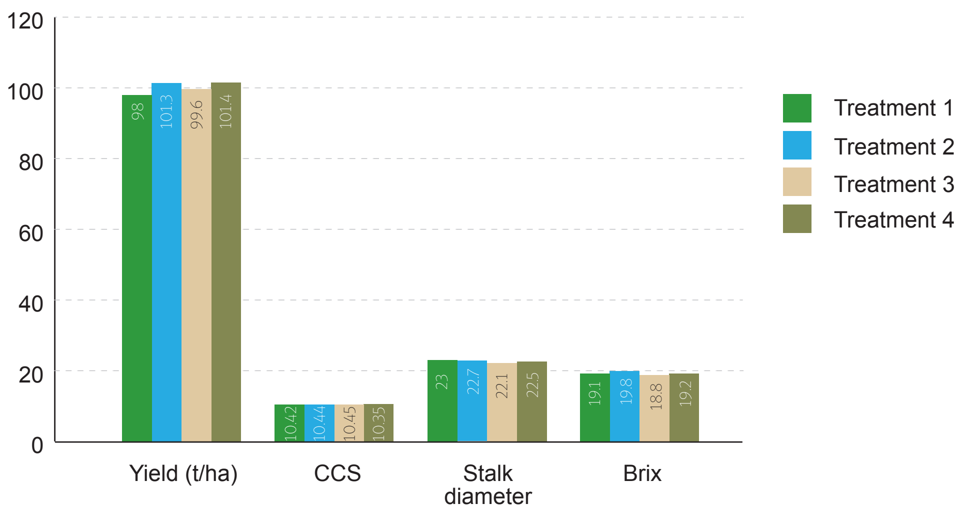


Figure A3.1 Mean results (across all sites) of the dual herbicide sprayer trials

Table A3.1 Statistical measures of trial data

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
p-value	0.072	0.903	0.340	0.551
Standard error of difference	1.19	0.161	0.50	0.72
95% least significant difference	2.83	0.988	1.06	1.57

Appendix 4 Nozzle selection and outputs

Note: Table A4.1 and Table A4.2 show TeeJet® nozzles. Other brands may be substituted, provided the specifications are the same.

This is theoretical data only. Allowances must me made for pressure drop at nozzle and overlap. Data is for 7.5 km/h tractor speed.

Table A4.1 Centre nozzle details and outputs

Pressure (bar)	Nozzle output (L/min)	1.4–1.5 m single rows		1.6–1.7 m single rows		1.8–2.0 m single rows		1.8–2.0 m dual rows	
		Centre nozzle 700–750 mm swathe combined with wing nozzles 700–800 mm swathe		Centre nozzle 800–850 mm swathe combined with wing nozzles 800–900 mm swathe		Centre nozzle 900–1000 mm swathe combined with wing nozzles 900–1050 mm swathe		Centre nozzle 700–800 mm swathe combined with wing nozzles 1000–1200 mm swathe	
		Output (L/ha)		**Output (L/ha)**		**Output (L/ha)**		**Output (L/ha)**	
		Sprayed area	Cane area	Sprayed area	Cane area	Sprayed area	Cane area	Sprayed area	Cane area
TeeJet AI95015EVS									
2.00	0.48	52.94	24.88	46.54	21.87	40.42	19.00	51.20	20.22
3.00	0.59	65.08	30.59	57.21	26.89	49.68	23.35	62.93	24.86
4.00	0.68	75.00	35.25	65.93	30.99	57.26	26.91	72.53	28.65
TeeJet AI9502EVS									
2.00	0.65	71.70	33.70	63.02	29.62	54.74	25.73	69.33	27.38
3.00	0.79	87.14	40.95	76.60	36.00	66.53	31.27	84.26	33.28
4.00	0.91	100.37	47.18	88.23	41.47	76.63	36.02	97.06	38.34
TeeJet AI95025EVS									
2.00	0.81	89.34	41.99	78.54	36.91	66.47	31.24	86.39	34.13
3.00	0.99	109.20	51.32	95.99	45.12	83.37	39.18	105.59	41.71
4.00	1.14	125.74	59.10	110.53	51.95	96.00	45.12	121.59	48.03
TeeJet AI9503EVS									
2.00	0.96	105.89	49.77	93.08	43.75	80.84	38.00	102.39	40.45
3.00	1.18	130.15	61.17	114.41	53.77	99.37	46.70	125.86	49.71
4.00	1.36	150.01	70.50	131.87	61.98	114.53	53.83	145.06	57.30

Table A4.2 Wing nozzle details and outputs

Pressure (bar)	Nozzle output (L/min)	1.4–1.5 m single rows		1.6–1.7 m single rows		1.8–2.0 m single rows		1.8–2.0 m dual rows	
		Centre nozzle swath 700–750 mm swathe combined with wing nozzle 700–800 mm swathe		Centre nozzle 800–850 mm swathe combined with wing nozzles 800–900 mm swathe		Centre nozzle 900–1000 mm swathe combined with wing nozzles 900–1050 mm swathe		Centre nozzle 700–800 mm swathe combined with wing nozzle 1000–1200 mm swathe	
		Output (L/ha)		**Output (L/ha)**		**Output (L/ha)**		**Output (L/ha)**	
		Sprayed area	Cane area	Sprayed area	Cane area	Sprayed area	Cane area	Sprayed area	Cane area
TeeJet DG8004E									
2.00	1.29	258.00	144.48	235.86	132.08	211.71	120.68	179.49	102.31
2.50	1.44	288.00	161.28	263.29	147.44	236.33	134.71	200.36	114.21
3.00	1.58	316.00	176.96	288.89	161.78	259.31	147.81	219.84	125.31
TeeJet DG8005									
2.00	1.61	322.00	180.32	294.37	164.85	264.23	150.61	224.02	127.69
2.50	1.80	360.00	201.60	329.11	184.30	295.42	168.39	250.45	142.76
3.00	1.97	394.00	220.64	360.19	201.71	323.32	184.29	274.11	156.24

Appendix 5 Economic summary

The dual herbicide sprayer was developed to reduce dependency on photosystem II inhibiting (PSII) herbicides by enabling growers to use knockdown herbicides instead. This report was prepared by economists within the Department of Agriculture and Fisheries to examine the economic viability of the sprayer.

The dual herbicide sprayer

The dual herbicide sprayer is constructed by modifying the spray bar of an existing Irvin boom—a low-pressure, low-volume 12 V spray tank is retrofitted to allow two herbicide solutions to be applied simultaneously (Figure A5.1). A centre air induction nozzle enables application of knockdown herbicides (such as glyphosate) to be directed into the inter-row, while two wing nozzles direct a residual blend into the stool area (Figure A5.2).

Figure A5.1 The dual herbicide sprayer ready for use

Compared to a conventional Irvin boom, the dual herbicide sprayer enables growers to:

- decrease weed-control costs by using lower cost herbicides in the inter-row
- strategically target weeds
- decrease residuals and improve growers' ability to comply with regulations.

Figure A5.2 Dyes showing how the centre and wing nozzles allow the application of two herbicides

As the dual herbicide sprayer is band-spraying, the amount of residual chemicals being applied is around half that used with conventional spraying, depending on row width (see Figure A5.3). On farms with wider row spacings, a greater proportion of the paddock area is sprayed with knockdowns only.

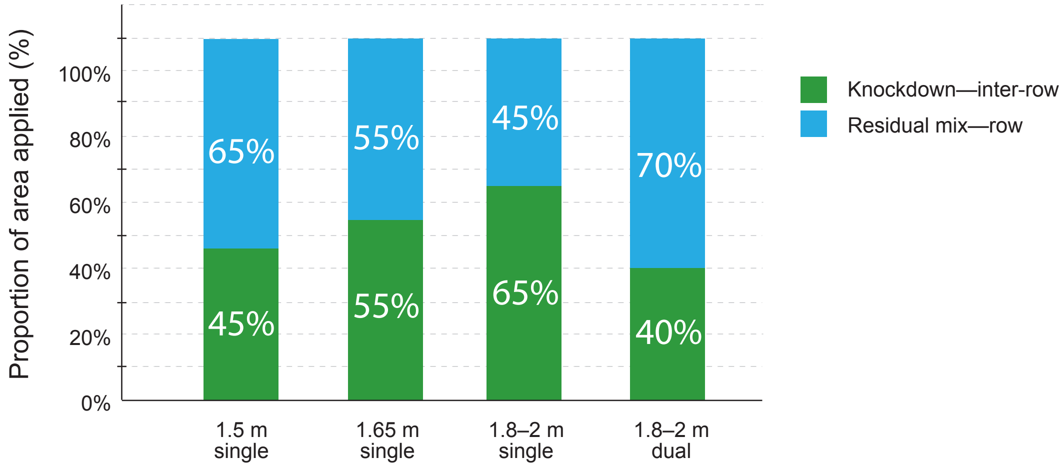


Figure A5.3 Proportions of paddock sprayed with residual and knockdown herbicides when using the dual herbicide sprayer

Economic analysis

The objective of the economic analysis was to investigate two questions:

1. What are the herbicide cost savings from using the dual herbicide sprayer instead of a conventional Irvin boom?
2. Based on these savings, how long will it take to recoup the initial investment?

Herbicide costs

Table A5.1 shows the herbicide usage and costs for a spray blend popular for weed control in ratoon cane. More specifically, it presents the usage and costs when spraying with a standard Irvin boom and compares them with the usage and costs when spraying with the dual herbicide sprayer. Both cases are for a cane farm with 1.8 m row spacing. The dual herbicide sprayer substitutes the spraying of hexazinone (Bobcat®) and paraquat (Gramoxone®) onto the inter-rows with glyphosate (Roundup Attack®), which decreases herbicide costs per hectare from $27.50 to less than $19.00 (by $8.50 or around one-third). This saving includes the reduced amount of wetting agent such as alcohol alkoxylate (BS 1000®) required.

Table A5.1 Usage and cost[1] of herbicides

Herbicide	Usage (kg/ha or L/ha)		Costs ($/ha)	
	Irvin boom	Dual herbicide sprayer	Irvin boom	Dual herbicide sprayer
Hexazinone	0.9	0.4	17.70	7.90
Paraquat	1.5	0.7	8.50	3.80
Alcohol alkoxylate	0.2	0.1	1.30	0.60
Glyphosate	––	1.0	––	6.60
Total			**27.50**	**18.90**

[1] Costs are based on 2017 herbicide prices.

Payback period

The cost to modify a conventional 4-row Irvin boom[2] to the dual herbicide sprayer is between $1200 and $1600[3] if a low-pressure, low-volume 12 V spray tank is already fitted, or between $2500 and $3000 if both the spray bar and tank are required.

Table A5.2 shows the period required to recoup the modification costs under several scenarios. Each scenario assumes there is one spraying per year. For example, when $3000 is invested to modify the Irvin boom and 200 hectares is sprayed per year, costs are recouped within 2 years.

Table A5.2 Payback period (discounted[4]) for the dual herbicide sprayer

Annual usage of dual herbicide sprayer (ha)	Annual cost savings ($)	Payback period (years)			
		Modification costs			
		$1200	$1600	$2500	$3000
40	340	4.2	5.9	10.7	14.2
70	596	2.2	3.1	5.1	6.4
100	851	1.5	2.1	3.4	4.2
150	1276	1.0	1.4	2.2	2.7
200	1702	0.7	1.0	1.6	1.9
300	2552	0.5	0.7	1.0	1.3
500	4254	0.3	0.4	0.6	0.7

Alternative herbicide blends

Farmers may need to target different weeds, so Table A5.3 shows the herbicide cost savings for a number of different spray combinations. For example, growers might need to apply isoxaflutole (Balance®) or imazapic (Flame®) instead of hexazinone, while glyphosate might be switched for glufosinate ammonium (Basta®)[5] or paraquat in the inter-row.

Using isoxaflutole instead of hexazinone at 0.15 kg/ha provides similar savings when using the dual herbicide sprayer. In this case, herbicide costs per hectare are $9 lower than those for spraying with a conventional Irvin boom.

Table A5.3 Herbicide cost savings using the dual herbicide sprayer ($/ha)

		Residual blends		
		Hexazinone	Isoxaflutole	Imazapic
Knockdowns	Glyphosate	8.50	9.20	3.30
	Paraquat	8.70	9.50	3.60
	Glufosinate ammonium	−2.40	−1.70	−7.60

The correct equipment operating procedures must be followed when using the dual herbicide sprayer. If they are not, minor yield losses may make the investment economically unacceptable.

[2] New 4-row Irvin boom sprayers generally cost between $12 000 and $20 000, depending on options and suppliers.

[3] At least two companies (Irvin Farm and Ian Ritchie Pty Ltd) can carry out the required modifications to the Irvin boom.

[4] A discount rate of 7% was used for the analysis.

[5] Trials since 2016 have shown that glufosinate ammonium works particularly well on inter-row weeds containing a high vine population

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