

**SRA Grower Group Innovation Project  
Final Report**



Sugar Research  
Australia

Research Funding Unit

## The Mantis – developing an innovative, high flotation, affordable high rise spray unit

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## **Executive Summary:**

Weed control on the steep slopes of Innisfail is difficult with current machinery. Top heavy, clutch driven highrise sprayers are unable to operate under these conditions resulting in poor weed management strategies for our farms. We set about to develop a machine that would greatly improve operator safety, eliminate the need for aerial application of herbicides as well as cut the amount of residual herbicide used in our weed management strategies.

Growers formed a group to discuss the problem of highrise spraying on steep terrain. After consultation with an engineer, many farm visits and group meetings, a concept was developed for a highrise sprayer carrying all the weight of the drive and tanks down low and having four wheels for increased stability. After conducting a feasibility study of highrise sprayers and many more group discussions, the final Mantis sprayer was developed and constructed.

As a result of the extensive grower-engineer consultations, group members now have a better appreciation of engineering and safety responsibilities involved when constructing an item of agricultural machinery. Growers also have a better understanding of the time commitment required when developing and implementing an innovative farm practice change compared to purchasing an implement off the factory floor.

Results from trials between the conventional and innovative machines have been severely hampered due to unseasonal lack of weed growth and then Tropical Cyclone Ita. Trials to compare weed control using both machines have been unable to be established. As a result, extensive consultation with industry extension staff have identified that herbicide mixtures used in a trial would not have varied between the innovative and conventional machine; it is the machine itself that would have varied and as a conventional machine is not able to access the steep or wetter blocks that can be accessed with the Mantis sprayer an aerial application would have been used.

The Mantis sprayer has enabled us to develop weed management strategies for steep and wetter blocks that involve timelier weed control operations using knockdown herbicides rather than residuals leading to improved long term weed control over the entire crop cycle.

By designing a high floatation, extremely stable and affordable spraying machine that can operate across all terrain, our objectives of improved weed control, reduced residual herbicide usage; increased crop yield and improved operator safety have been achieved.

**Background:**

Highrise sprayers have developed over the years from old technology and farmer engineering. These implements are over engineered, top heavy, expensive and extremely unsafe. Our intent was to design a high floatation, extremely stable and affordable spraying machine.

In some areas farmers are not able to use highrise tractors due to unsuitable terrain and safety concerns; they therefore rely on expensive aerial application of herbicides for weed control. As timeliness of weed control is an important part of the farming system and past BSES trials have shown that poor weed control can lead to 25-30% crop yield loss. Development of a more robust and safe spray unit will increase grower's ability to control weeds at the right time, also allowing for greater use of knockdown herbicides rather than reliance on residual herbicides for weed control.

**Objectives:**

This project aimed to

- design and develop an innovative spray rig that was able to spray in areas not accessible by current machines, and increase operator safety due to increased machine stability
- improve weed control in all crop classes through
  - increased timeliness of weed control
  - increased applicator safety
  - increased machinery affordability
- reduce usage of residual herbicides for long term weed control and cut herbicide rates by improving timing of herbicide applications. An innovative spray unit with a twin tank directed sprayer allows more knockdown herbicides for weed control with different blocks sprayed with different herbicide mixtures based on crop stage, weed presence and pressure. We estimate a reduction in diuron usage from around 2kg/ha to at least 0.6kg/ha or less with this machine.
- increase crop yields through better weed control. Weed competition trials conducted by BSES have shown yield losses of 25-30%.

By simply designing a machine that can operate across all terrain, our objectives of improved weed control, reduced residual herbicide usage and increased crop yield were achieved.

**Methodology:**

1. Engage an engineer to develop an innovative highrise sprayer.
2. Group discussions and farm visits to further develop the concept of a highrise self-propelled sprayer that had increased stability and safety for hilly terrain, increased floatation for swampy areas and increased affordability
3. A feasibility report on the possibility of constructing such a highrise sprayer with these added features.
4. Design a highrise sprayer with the following features
  - a. Current machines have high centre of gravity, unstable in steep situations
  - b. Air cab will reduce exposure to chemical spray
  - c. Air cab to reduce noise and sun exposure

- d. Removal of clutch driven transmission to prevent movement while no operator in seat
- e. All-wheel drive to improve manoeuvrability during tight cornering
- f. Power management drive system to improve fuel consumption
5. Engage a boilermaker to undertake construction of the highrise sprayer as per engineers specifications
6. Commission the machine to ensure it has increased stability and safety features across various terrains.
7. Communicate the engineering outcomes to industry through publications and field days.
8. Conduct an economic cost of operation between the innovative highrise and conventional spraying options.

### **Results and Outputs:**

The original concept for the Mantis sprayer was for a purpose built machine that differs from current machines by carrying all the weight of the drive and tanks down low and having four wheels for increased stability. The two central wheels are the drive wheels and the outside two are for stability only. Current machines use all three wheels as drive wheels which is how this machine will work on unstable terrain. This machine will then be constructed of lighter materials increasing floatation and affordability.

### CONCEPT SKETCH 1



After much discussion and debate, a feasibility report was carried out taking into consideration

- traditional high rise sprayers for cane and other crops
- the gradient of farmland where this machine will be used
- machine specifications

This resulted in two more concept sketches before the final design was developed. A copy of the feasibility report is attached to this report (High Rise Cane Sprayer Feasibility Report 4<sup>th</sup> March 2013)

Due to unseasonal lack of weed growth and then Tropical Cyclone Ita, we were unable to carry out weed control trials compared to a conventional sprayer. We have since spoken with industry experts and the herbicide mixtures that would have been used in a trial would not have varied between the innovative and conventional machines; it is the machine itself

that would have varied and a conventional machine is not able to access the steep or wetter blocks that can be accessed with the Mantis sprayer and aerial application would have been used.

A conventional highrise sprayer costs between \$135,000 and \$175,000 depending on individual requirements. Our machine has hydraulically adjustable wheels to match different row spacings, as well as a hydraulically adjustable boom to spray different crop stages. It also has a lower centre of gravity and is a safer machine to operate at a cost of \$140,000.

Operating costs between this and a conventional machine would be similar whereas the area covered when spraying with a conventional machine in hilly country is half what can be covered when spraying on flat terrain. This machine has been designed to operate at a consistent spraying speed regardless of the terrain. Below is a comparison table of the different costs involved for spraying as well as the amount of hectares sprayed per hour.

#### Cost of Spraying

	<b>Conventional Highrise</b>	<b>Mantis Highrise</b>	<b>Aerial Application with fixed wing</b>	<b>Aerial Application with helicopter</b>
<b>Cost per hectare</b>	\$47.50	\$47.50*	\$35	\$49

\*this cost does not take into consideration the extra time taken to spray this hectare

#### Hectares Sprayed per Hour

	<b>Flat Terrain (ha)</b>	<b>Steep Slopes (ha)</b>
<b>Conventional Highrise</b>	6	3
<b>Mantis Highrise</b>	6	6

Aerial application does not allow targeting of specific weeds within blocks and there are minimum areas required before the contractor can be engaged.

#### **Intellectual Property and Confidentiality:**

We are investigating a patent on the Mantis sprayer and until such had been determined, we do not intend to publish any detail on the hydraulic components and set up of this machine.

#### **Capacity Building:**

As a result of this project, the group has a good appreciation of engineering and safety responsibilities involved when constructing a piece of agricultural machinery. They also better understand the time commitment required when developing and implementing an innovative farming system compared to purchasing an implement off the factory floor. This has been a good learning exercise for all involved.

**Environmental and Social Impacts:**

Improving timing of herbicide applications allows us to reduce our usage of residual herbicides for long term weed control and cut residual herbicide rates. This unit allows for better access to blocks improving timeliness of herbicide applications for weed control and a twin tank directed sprayer will also allow more knockdown herbicides for weed control with different blocks sprayed with different herbicide mixtures based on crop stage, weed presence and pressure. We have estimated that we will reduce our diuron usage from around 2kg/ha to at least 0.6kg/ha or less with this machine.

Aerial spraying particularly near communities is becoming less and less acceptable. This machine has eliminated the need for aerial application due to better weed management throughout the crop cycle.

Grower safety has also been greatly improved. The increased stability in the design of this machine with weight carried low prevents roll over, particularly in steep terrain. The design also ensures the boom remains horizontal over uneven terrain.

**Outcomes:**

Our original intention was to build a very cheap two wheel over row cane sprayer. After engaging an engineer and conducting a feasibility study on our concept and requirements, a totally different outcome was developed. It was decided to build a three wheel machine that reduced complexity of manufacture and cost. This three wheel machine had all the components fitted close to ground level resulting in increased stability of the machine.

Weed control strategies will be improved with an immediate reduction in herbicide costs to the growers through reducing the amount of residual herbicide used for weed control. This machine will allow timelier weed control operations using knockdown herbicides rather than residuals leading to improved long term weed control over the entire crop cycle.

**Communication and Adoption of Outputs:**

The Mantis sprayer was featured as part of the 2014 GIVE Conference field tours. There was lots of positive feedback and questioning as a result of the brief presentation by the group members and engineer.

**Publications:**

As the project is only just completed and spraying season is a long way off, we have not put the Mantis in any publications but it was featured on the 2014 GIVE Conference field tour.

**Acknowledgements:**

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**Photos:**

Mantis sprayer ready for operation



Mantis sprayer on display at 2014 GIVE Conference in Innisfail



