

**Evaluation of Shear Express Wool Harvester during  
Commissioning and Field Trials**

for

**Australian Wool Innovation Limited**

**Authors:**

Graeme Pleasance  
Allen White

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## Executive Summary <sup>(#)</sup>

The Shear Express Wool Harvester provides an opportunity to both improve the work environment of shearers and the quality of sheep shearing. However, the machine has not successfully passed its field trial milestone as trial results did not meet design expectations and targets.

The lower productivity and consequent higher cost of operation make it uncompetitive with conventional shearing and the potential add-on benefits that the system may offer some woolgrowers does not bridge the gap. To make it competitive, productivity would need to increase by 50% above that achieved in the trials. The shortfall is so large that extension of the current trial is not warranted.

Possible specialised applications for the existing machine are by the super fine wool woolgrowers or stud breeders who may be willing to pay a premium for the superior shearing and ancillary services offered by the Shear Express Wool Harvester.

The Shear Express Wool Harvester does have some features which could be of potential value to the industry and could be incorporated into other portable shearing systems.

Evaluation of the Shear Express Wool Harvester (SEWH) <sup>(2)</sup> has taken place over a 10 week period following construction when some 10,000 sheep have been harvested during field trials. Continuous improvement has occurred during this period and optimisation of its operation to improve throughput will be an ongoing task as operator skills and technique develop to cope with varying sheep characteristics. Two definitive field trials were carried out, the first on lambs at the MMBW farm at Werribee <sup>(4)</sup> and the second on Merinos on John Tomson's property at Condah near Hamilton. <sup>(5)</sup>

This report evaluates the performance of the SEWH and provides an estimate of the rate that would need to be charged to the woolgrower for a viable business. Comparisons are made with conventional shearing <sup>(9,10)</sup> and the original design objectives. <sup>(2)</sup>

### Throughput

The following Table shows the throughput measured and projected for SEWH in comparison with that measured with conventional shearing in split trials.

	<b>Active Lambs Sheep per hour</b>	<b>Merinos Sheep per hour</b>
Target <sup>(2)</sup>	N/A	120-135
Achieved Daily Average <sup>(4,5)</sup>	81	70
Average of Quickest 50 sheep per Day <sup>(4,5)</sup>	99	81
Conventional – 6 Shearers <sup>(5)</sup>	Est (180-200)	150
Projection <sup>(9)</sup>	100-110	80-85

<sup>#</sup> Numbers in brackets refer to the section of report where details are available

The rate achieved on any one day will depend on sheep type, wool condition and operator skills/ experience on the machine. The nature of serial processing with little station to station interaction is that the cycle times depend on the slowest station. The critical station was found to vary during the day<sup>(5)</sup> with operator (skills and performance), sheep behaviour and machine performance. The projections given above are based on an analysis of the elements of the operation<sup>(9)</sup> and assume that the operation will become more balanced between stations and the man-machine interface will improve with experience.

The actual performance and projections fall well short of the design target even though the design targets were based on prototype evaluation. Active shearing time is only 50% of cycle time compared with the target of 61%. Conventional shearers spend approximately 80% of the time shearing. Shearing time with SEWH takes some 50% longer than conventional shearing.<sup>(9)</sup> For the target to be reached, it would require shearing to begin immediately the sheep was incremented to a station and shearing time to be reduced by 10-20%. This is not feasible with the current machine design. It is therefore concluded that extension of the trials to further refine operation does not have the potential to make a significant enough improvement and is not warranted.

### **Shearing Quality<sup>(7)</sup>**

The shearing quality of the SEWH, as compared with conventional shearing in the split trials, was superior in every respect. When scored using competition standards, Shear Express scored less than half the penalty points of the conventional shearers, had fewer skin cuts and, of the skin pieces produced, recovered more from the fleece. This is attributed to the presentation of sheep in a near perfect position for shearing every time, coupled with the need for the operator to concentrate on removing the wool from a section of the animal and the absence of the physical demands required for traditional shearing.

### **Wool Quality<sup>(7)</sup>**

A subjective appraisal of the wools from conventional shearing and by SEWH during the split trials suggests similar cents/kg greasy being applied to the main fleece lines. This trial reveals the principle differences being high skirting ratios in the conventional system (which could be addressed by changing staffing ratios), less second cuts, less locks and the separation of table locks in the shear express system (which could have been carried out in the conventional system). There is little visual difference in the fleece wools.

The wool lines produced by SEWH in the split trials were estimated to be of greater value than that produced by conventional shearing by in the order of \$0.70 per sheep. This was due to a higher portion of fleeces with lower proportion of pieces and locks produced with SEWH. The higher rate of throughput in the conventional shed would have contributed to the higher pieces but better presentation of the fleece for skirting in the SEWH was an advantage. It is not known if all of this premium would remain at similar throughputs.

After test results for fibre diameter, yield, lengths and strengths are obtained it will be possible to provide more factual data for comparison between wool from the two systems.

### **HR Issues<sup>(8)</sup>**

The perception is that the OH&S environment is improved in the SEWH. Posture has greatly improved and given that 30% of shearing WorkCover claims in Victoria are related to back injuries, this should assist in reducing premiums. However, other issues need to be monitored and managed carefully. The experts in this area warn of Occupational Overuse syndrome caused by repetitive tasks. This can be managed by rotation of people albeit with some penalty in output as they settle into the rhythm of the new station. Also careful management of the man/machine interface is required. Specific issues are the noise and vibration from the generator which can impact on performance and impact injuries from kicking sheep with leg restraints attached to their legs. A number of cuts and bruises occurred during the trials due to kicking sheep.

A key issue in performance is the need to generate a teamwork environment in a serial process using shearers who are trained and motivated by financial incentives in a parallel or individual process. With minimal dynamic sharing of workload between stations the throughput will always depend on the slowest station. This in turn depends on a host of human factors that govern performance. Variations in output at a station (time to restrain and shear a sheep), allowing for varying sheep shearability, can typically change by 60% over a day. Whilst applying the lessons learnt on production lines elsewhere could no doubt improve the situation, there is always going to be variation due to the well being of the operators or new trainees coming onto the team that is accentuated in SEWH compared to conventional shearing.

Staffing numbers of 14 to run the machine for 10hrs per day have not been demonstrated at this stage and there is some question as to the capacity to maintain the throughput rate demonstrated over 8 hours with this level of staffing.

### **Machine Costs<sup>(12)</sup> and Operation<sup>(6)</sup>**

Invetech has recently estimated the cost of building an additional machine to the same design as the existing one at \$1.4M. Cost escalation from the original estimate of \$0.47M is due primarily to the requirement for a B-Double trailer, inclusion of the overhead conveyor system and added complexity of the manipulators.

The machine was designed to overcome the unreliable characteristics of the previous prototype with availability of greater than 97.5%. Following initial teething problems not unusual for a prototype of this type, some of which are yet to be finally fixed, the machine had 88% availability during the split trials. The main source of lost time is due to the overhead conveyor and broken suspension wires with occasional conveyor belt rips. With proposed changes to the wire thickness and provided the retention on the Harvesting Team of a suitable skilled technical person (mechanic with electrician and control skills) to identify and address faults, it is believed availability will achieve 95%. Invetech was currently offering high level support as part of Commissioning.

### **Business Evaluation<sup>(10)</sup>**

The current estimate of average throughput based on the trials to date and assuming further improvement with experience is 800 sheep per day. This is well below the minimum rate of 1200 sheep per day for 200 days per year stated by Chain Shear in its original submission for funding (Reference 3). The following table gives the breakdown of costs that would make up the charge to the woolgrower in Year 1 for the 200 days per year scenario.

<b>Average Sheep Throughput / 10hr day</b>	<b>800</b>	<b>1,000</b>	<b>1,200</b>	<b>CS 1,200<sup>a</sup></b>
Operation Costs - \$/Sheep	5.12	4.14	3.50	3.16
Corporate Costs - \$/Sheep	0.51	0.41	0.34	0.34
Capital Cost - \$/Sheep	1.28	1.03	0.86	0.19
Operator (Risk) Margin - \$/Sheep	0.93	0.75	0.63	0.86
<b>Total Charge - \$/sheep</b>	<b>7.83</b>	<b>6.33</b>	<b>5.33</b>	<b>4.55</b>

<sup>a</sup> Derived from Chain-Shear estimate (Reference 3) escalated by 3 years CPI

Labour costs comprise some 56% of the operating costs. Capital costs 16%.

The current shearing rates for conventional shearing is \$4.50 -\$4.75. Chain Shear stated in its submission that the throughput needed to exceed 1,200 sheep per day for its proposition to be viable. The current evaluation supports that claim.

A premium of \$0.70 per sheep could apply for wool quality. Additional benefits claimed for the woolgrower (no shearing shed, in shed fibre measurement, drafting and drenching) of around a maximum of \$0.80-\$1.00 per sheep are considered to be grower specific. With overall benefits at \$0.70-\$1.70 per sheep, there is no evidence at this stage that these would add sufficient premium to justify the margin required to bridge the \$3 gap between SEWH and conventional shearing.

### **Options** <sup>(12)</sup>

Options have been considered to improve the cost effectiveness of the current Harvester. Reducing capital cost does not bridge the gap (capital cost for 800 sheep per hour is \$1.28 or 16% of charge to the woolgrower). The most beneficial area is productivity either by increasing throughput or decreasing labour. To achieve a throughput of 1,200 sheep per day would require eliminating the current time taken to restrain and release the sheep (automatic connection of leg clamps to the manipulators and positioning the manipulators ready for shearing operating in a short time interval) and reducing shearing time by 10-20%. This is not considered practical.

The current machine with no capital recovery might find application in specialty areas that have a use for the features of the machine. For example stud breeders who require close integration of the analysis of the removed fleece with drafting and culling or super fine wool producers who may require reduction in second cuts and superior classing/ separation of the wool. However, specialised markets are unlikely to allow efficient, on going, utilisation of the machine

### **Conclusion** <sup>(13)</sup>

The performance of the Shear Express Wool Harvester falls short of design expectations by a significant margin. The resultant price an operator would need to charge woolgrowers to ensure his viability is well above the market rate for conventional shearing. The add-on services offered by Shear Express would not be required by all clients and do not make up the shortfall. Neither extension of the existing trials nor development of further machines can be justified based on the projected throughput and business model. However the existing unit charged out with no element for capital recovery may be of interest to some markets that have need of the unique features that the machine offers.

The Shear Express Wool Harvester does have some features which could be of potential value to the industry including:

- The touch activated hand pieces.
- The fleece spreading conveyor delivering fleeces to the wool table.
- Good separation of the clip to minimise contamination.
- An innovative option for lifting and inverting sheep.
- Presentation of sheep in a near perfect position for shearing every time.
- A fleece logging system that could have broad application.
- Control sheep unloader with options to feed an auto draft conveyor with potential for animal husbandry activities.

Many of these items could not be justified in a wool shed used once a year, but have a possible place in portable high utilisation systems similar to the Shear Express Wool Harvester.



Reproduced from Reference 1

## Shear Express Wool Harvester

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