BUREAU OF SUGAR EXPERIMENT STATIONS
QUEENSLAND, AUSTRALIA

FINAL REPORT
SRDC PROJECT BS66S
DEVELOPMENT OF A CANE HARVESTER CABIN FOR OPERATOR EFFICIENCY

by

R G Dick

SD94009

Principal Supervisor: Mr R G Dick
BSES
PO Box 651
BUNDABERG Q 4670
Phone (071) 59 3228

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SUMMARY

This report describes the successful development of a futuristic, state-of-the-art, ergonomic cabin which has been engineered to provide the harvester operator with great comfort and operating ease (Plate 1).

All-round visibility from the harvester has been improved. Modified controls have been designed and installed and the location for controls altered for ease of operation. This equipment includes proportional and direct electric over hydraulic controls, a multi-function hand piece, conventional cable controls and foot controls. Refined cabin mounts have been fitted and double glazed rear windows and sound proofing material installed. Many other smaller modifications have been made to the cabin. During testing of the harvester by contractors during the 1993 season many favourable comments were received. Positive feedback from these operators has resulted in Austoft Industries Ltd constructing five ergonomic harvesters for the 1994 season.

The new, improved cabin is designed for greater efficiency, improved standards of work, less loss of cane and increased profitability for the sugar industry.

1.0 INTRODUCTION

Since the advent of mechanical harvesters there has been continuing input by manufacturers and researchers to evaluate and modify these machines (Dick, 1986). Most of this input focussed on improving the cleaning systems and machine throughput. Although these technological improvements resulted in significant advances in machine design, their potential is not fully realised, unless the driver is operating at maximum efficiency.

Limited visibility and cabin layout make it difficult for an operator to concentrate attention on all key areas and thus minimise cane loss. The layout of the 16 controls in a 1993 production harvester cabin is complex. Many of the controls require two or more adjustments or continuous adjustment during harvesting. Improvements using ergonomic principles were required to increase operator efficiency and machine productivity.

Operator stress has increased in recent years with the gradual increase in cane harvester group sizes, longer working hours and the advent of green cane harvesting which further reduces visibility. This increased operator stress, partly due to poor cabin design, resulted in many operators leaving the industry. Replacements require extensive training and this further adds to costs and inefficient harvesting. With an improvement in cabin design, operator stress would be reduced and there would also be a reduction in the need for operator training and experience.

2.0 OBJECTIVES

The overall objective of the project was to improve operator productivity and comfort through the ergonomic design of the cabin. Attention was focused on four main aspects:

! To improve visibility, from the seated position, of key working parts of the harvester and hence minimise cane loss from the machine.

In some conditions with standard production machines, the harvester operator needs to stand and lean forward to be able to see and adjust the height of the points at the bottom of the crop dividers to ensure all lodged stalks are gathered. However, this necessitates the operator's hands being out of reach of the controls, and whole stalks of cane can be left ungathered on the ground.

! To improve the ease of operating these controls by introducing multi-function controls and by repositioning controls.

At present, the operator's hands are required in at least four positions simultaneously; namely, to steer, adjust traction, lift the basecutter and to turn the elevator on and off. Visibility would be improved if the size of the control rack was reduced and more use was made of foot-operated controls.

! To install and evaluate suitable closed circuit monitors/sensors and/or visual indicators as a means of assisting the operator to correctly adjust the machine.

There is a need for constant, instantaneous feedback on the filling of the cane transporter and on basecutter height setting. This could be provided by closed-circuit monitors focussed on the transporter and the row harvested.

! To reposition selected indicators from the instrument panel and incorporate the successfully developed Cane Loss Monitor.

The main instrument panel is presently positioned above the operator's head whilst a number of gauges restrict visibility at a lower level.

3.0 RESEARCH NEED

In the design of the standard 1993 production harvester cabin it was recognised that visibility could be improved and hence the floating side walls and basecutter could be set correctly. This would help in reducing cane loss. Losses from these sources have been measured as high as 10% in lodged green cane. For each 1% loss there is an industry cost of approximately $10m. Dirt intake by the harvester would be reduced if the floating side walls and the basecutter could be accurately positioned. Dirt in the cane supply is estimated to contribute from 65 to 90 4/t to maintenance costs in sugar mills.
With the industry cost of harvesting the crop each year being approximately $120m, developments to improve the harvesting operation are continuously required. Harvesting

costs rise as a result of capital and operating costs increasing. Improved efficiency of harvest is one method of restraining these cost increases.

4.0 ACTIVITY ANALYSIS

At the commencement of the project a series of operator analyses was conducted. Two video cameras were used simultaneously during in-field investigations.

One video camera was used to take views from a position above and to the left of the driver's head, showing the hand movements associated with operation of the controls as well as the head and body movements of the operator. The other video camera was used to record the general harvesting operation including the movement of the haulout vehicles, the topper, the elevator and the discharge flap. The general harvesting operation of the following machines was recorded.

1. A 1987 Austoft 7000 working in short burnt cane.
2. A 1991 experimental Austoft 7700 machine running on rubber tacks, working in fairly short burnt cane in medium length rows, adjacent to power lines at one headland.
3. A new 7000 machine which was being prepared for the harvest, featuring a modified instrument panel and a number of owner modifications.
4. A 1989 Austoft 7000 working in long rows of green cane.
5. A 1989 Austoft 7000 working in very short rows of burnt cane.
6. A Toft 6000 Series 4 working on medium length rows in tall burnt cane and featuring a pedal-operated traction control.

A preliminary analysis of the operator's movements for these machines is shown in Appendix I - Figures 1 to 4.

The analysis showed that the right hand was principally involved in making adjustments to the elevator flap and the height of the topper. The left hand was principally occupied in steering the machine but there were a number of switching on and off operations being performed at headlands, by the left hand also. The feet were only used for slewing the elevator at headlands.

From a visibility point of view, the operators were principally interested in being able to keep the machine on line and to be sure of the relationship between the elevator and the haulout vehicle, as well as the angle of the elevator flap. Positioning the elevator and adjusting the bin flap required the operators to turn their heads to view the discharge through the rear window. This checking activity became particularly intense when the bin was almost full and the flap adjustments also become more frequent.

Several operators had fitted spacers beneath the seat in order to increase the height of the operator in the seated position and several had added footrests to accommodate this change in seat height. An elevated forward position of the seat appeared to be favoured both from a control operation viewpoint and from a visibility viewpoint.

In summary, the Activity Analysis identified a number of design shortcomings which resulted in some recommendations and cabin refinements being made.

5.0 PRELIMINARY RECOMMENDATIONS

As a result of the activity analysis, consideration was given to the following points.

5.1 Foot controls

To reduce the number of occasions on which multiple hand controls need to be operated in a very short space of time, greater utilisation of the operator's feet was considered important. The elevator slew and brakes were proposed to be operated by the left foot and possibly the horn also. The traction control was proposed to be operated by the right foot and be presented in a form similar to an accelerator pedal or the forward-reverse type of pedal used on ride-on lawnmowers.

5.2 Hand controls

As the throttle is only adjusted when starting and stopping, it was recommended that it should be moved away from its central location. The bin flap and topper height adjustment controls, being more frequently used, were recommended to be repositioned closer to the centre, but still in a manner suitable for operation by the right hand. It was suggested the remaining controls could probably remain in essentially the same general arrangement as they were, but with increased spacing and identifying knobs and or lengths.

5.3 Gauges

Following removal of the traction and throttle controls from the steering console area, additional space would be made available in that region for the fitment of important gauges including the basecutter and chopper pressures.

5.4 Rear vision

With the absence of rear vision mirrors, operators had to turn their head and shoulders through an angle of approximately 130 degrees. Typically they looked through the rear window rather than the glass door when monitoring either the position of the bin flap or the filling of the bin. During the final filling of a bin this undesirable turning action occurred frequently.

It was then proposed that a pair of suitably shaped convex mirrors would provide an adequate view of the haulout bin and the discharge of the elevator. Following some preliminary tests, it was believed that small mirrors placed on the windscreen immediately in front of the driver may have fulfilled this function.

6.0 CABIN REFINEMENTS

Following the series of operator analyses, the cabin on the BSES Austoft 7000 harvester at Bundaberg was modified to incorporate electric over hydraulic controls, a foot control for traction, and a slanted windscreen and raised seat for improved visibility. Instrument panels were relocated for easier viewing and large, slightly convex, rear vision mirrors were also included with many other features. The electric over hydraulic controls were fitted to a right-hand joystick lever to allow control of basecutter height, topper height and throw direction, bin flap position, secondary hood slew, left and right croplifter settings and elevator on/off operation.

Closed-circuit cameras and monitors were also evaluated as an aid for filling of bins during harvesting and for observing the quality of basecutter cut. Double-glazed rear windows were fitted and sound-proofing added. The original steering-wheel was kept in the machine, whilst the entry ladders were lengthened.

6.1 Ergonomic considerations

To improve visibility and reduce neck strain resulting from turning and looking up at the discharging elevator, the designed sitting position for the operator was altered. The cabin, the forward section of the floor and the seat were each raised 100, 200 and 100 mm, respectively. In addition, the seat was also located 160 mm further forward. This repositioning resulted in the head of the sitting operator being in a similar position to where it was when the operator was standing prior to the cabin alterations outlined above. Once the seated position was determined and the zones of comfort and reach (Appendix II - Figures 1 to 3) identified in accordance with the Australian Standard, hand and foot controls were positioned.

In the neutral position, the feet were located 600 mm apart and 650 mm/450 mm forward of/below the hip. The hands were located 550 mm apart, with the left hand 250 mm/200 mm forward of/above the hip and the right hand 350 mm/100 mm forward of/above the hip.

6.2 Operator's seat

Features of the seat selected for the operator include:

- 100 mm vertical suspension stroke
- manual adjustment for driver weight
- low frequency vibration isolation characteristics
- anatomically shaped
- seat height and tilt adjustment
- backrest angle adjustment
- fore and aft adjustment of 160 mm
- turntable giving 90° movement to the right and 45° movement to the left
- adjustable pivoting armrests

! adjustable head-rest

6.3 Windscreen and rear windows

To further improve operator visibility, the windscreen was extended vertically upwards by 50 mm and downwards to the top of the topper support. In addition to increasing the area of the single glass, the top of the screen was tilted outwards. This ensured a good distance was achieved between it and the operator's eye. With the screen on a greater slope, less dust builds up on the screen and the operator is able to view the ground more clearly closer to the machine than previously. Enlarged glass panels were also fitted to the side of the cabin.

Following removal of the single rear window, the roof was structurally supported directly behind the operator. This enabled the thinning of the upper section of the door catch columns, thus reducing the degree of impaired direct rear vision. Below the bottom edge of the windscreen the cabin was extended forward slightly to ensure the operator's feet were in the ergonomic comfort zone.

6.4 Instrument panel

Following the repositioning of the seat and altering the windscreen's slope, the instruments were relocated to achieve the optimum distance of 700 mm between them and the operator's eye. This distance, stipulated by the Australian Standard, identifies the preferred instrument panel location (Appendix II - Figure 4).

Two narrow, vertical instrument panels were designed, constructed and fitted into each of the front corners of the cabin as shown in Plate 1. Reading from the top, down the right hand instrument panel of gauges, the displays are:

- tachometer

- oil pressure
- water temperature
- oil temperature

- voltage
- fuel level
- engine hours

Six warning lights are fitted in the middle of the panel to provide an early warning to the operator of any imminent malfunction. These lights cover the following functions:

water temperature	!	!	hydraulic oil level
air cleaner	!	!	hydraulic filter pressure
transmission neutral	!	!	transmission filter pressure

The placement of these lights in the centre divides the instrument panel enabling faster reading of the gauges.

Reading from the top, down the left hand instrument panel of gauges, the displays show oil pressures in the following circuits.

- secondary extractor
- primary extractor
- choppers
- roller train
- basecutter

The Cane Loss Monitor was placed most centrally as it provides a digital display of the four key driving parameters including:

- cane loss
- basecutter speed
- fan speed
- ground speed

The collection of switches previously located together with the instruments above the operator's head was left in the overhead position after being regrouped. Such switches include:

- ignition
- air-conditioning
- headlights
- tail-lights
- top and rear flashing lights

A bin counter was also installed in the cabin.

6.5 Foot controls

A right-foot operated, traction control was successfully fitted in the harvester cabin. A simple fore and aft rocking action gently takes the harvester from forward to reverse operation. The elevator slew buttons were fitted to either side of the left-foot rest. These two refinements ensure limited movement is required by the operator's feet as they are now located in an ergonomically favoured position. For full forward traction a small modification to the pedal was required.

6.6 Electric over hydraulic controls and associated switches

To enable optimum positioning and grouping of controls, a number of controls governing machine motor and actuator functions were converted to electric over hydraulic controls. The standard control rack was replaced with a series of directional solenoid valves (Appendix III) to control the operation of the left and right crop dividers, bin flap and elevator lift and slew. Two proportional solenoid valves were selected for controlling the basecutter and topper height. The flow divider circuit for these valves together with the bin flap/hood slew circuit is shown in Figures 1 and 2 - Appendix IV.

A unique multi-function control handle was constructed to give single-handed proportional control of basecutter and topper height and direct control of bin flap, left and right crop dividers, topper throw, elevator stop/start and horn. A small support group of switches is located to the right of the operator and together with the multi-function control, gives the operator a sense of safety and a feeling of being in control. This panel incorporates switches regulating the following functions:

- feed train forward/reverse with separate off switch
- bin flap to hood slew converting switch for multi-function handle control
- elevator raise/lower
- primary extractor
- secondary extractor

Conventional cable controls that engage the following functions were left unchanged and are to be operated by the left hand:

- high/low speed
- elevator in/out of gear
- side knives, left and right

6.7 Closed-circuit monitors and mirrors

The usefulness of closed-circuit monitors was assessed whilst experimenting with camera position in an endeavour to present easily interpreted images to the operator. The equipment used was a monochrome vehicle camera with a wide angle lens (Appendix III). The image on the monitor was kept clear through the utilisation of an air compressor providing an air blast to the camera lens freeing it of any dust build up. However, the image displayed on the monitor of the bin filling operation, captured by cameras fitted to the top rear corners of the cabin, gave a poor 3-D effect.

The display always appeared on the left-hand side of the operator, where the single monitor was mounted, and as a result created operator confusion when bins were filled on the right-hand side. Due to this and the poor 3-D effect produced, the system was not recommended for use in Austoft Industries Ltd production machines.

With a camera mounted under the elevator's turntable, the view of the cut stubble was particularly good up to 4 km/h. A better view, less affected by higher forward speeds, was attained by locating the camera higher, just below the outlet of the primary extractor.

Large, slightly convex mirrors mounted both inside and outside the cabin gave a better view of the bin filling operation and greatly minimised the amount of head turning previously undertaken by the operator. Ideally, mirrors should be slightly convex and the convexity should have a radius of at least 1 m. The mirrors fitted are specified in Appendix III.

6.8 Noise control

Prior to the fitment of additional sound-proofing materials to the cabin, the sound level was recorded at the operator's ear position. An average level of 92.6 dB was recorded following acoustical measurements taken in accordance with AS2012.2-1990.

The five classes of noise and vibration control methods were focussed on and included:

- structural modification
- structural damping
- absorption
- use of barriers
- vibration isolation

6.8.1 Structural modification

Extra plates were added in an endeavour to minimise the transmission of noise through the rear wall of the cabin. This involved fitting double steel plates behind the operator's head immediately forward of the engine compartment, thereby increasing the mass of the panel and structural damping material was used to increase the attenuation. This was achieved without increasing the stiffness of the panel which would have increased the noise.

6.8.2 Structural damping

This noise control method relies on dissipating vibrational energy in the structure before it builds up and radiates as sound. Steel has so little internal damping that its resonant behaviour often makes it an effective sound radiator. An expanding foam liquid was injected under pressure into all rolled hollow structural steel sections in the back wall of the cabin and into the space between the double steel plates behind the operator's head.

The majority of the non-window section of the back wall, the area below the glass in the doors, and the floor was then covered with damping sheets of thermoplastic alloy. This sheeting, stuck directly to the steel, is an extremely weight and thickness effective dampening material.

6.8.3 Absorption

Sound is reflected from sound barriers. Hard surfaces within confined spaces reflect sound so that noise levels increase. Sound absorption materials reduce the degree of reflection.

The full wall and door area of the cabin covered by the thermoplastic alloy was then covered with 25 mm thick acoustical foam, faced with perforated vinyl. The majority of the cabin's ceiling was also lined with this material. The perforated vinyl, combined with the controlled flow resistance of the acoustic foam, maximises the critical mid-frequency sound absorption. There is also excellent absorption of high frequency sound with this product.

6.8.4 Use of barriers

To reduce the transmission of airborne sound, sound barrier materials are used. Sound barrier materials allow only a small percentage of the sound incident on the material to pass through by reflecting sound back towards the source. They therefore reduce the noise level between the source and receiver.

Acoustical measurements taken with a standard cabin indicated the fibreglass roof of the cabin only reduced engine noise from 101 dB to 93.9 dB. It was therefore decided to secure a sheet of barrier/absorption material in the roof of the cabin.

Other barrier modifications included the double glazing of the two rear windows, with a 40 mm air gap, and the insertion of a small quantity of silica gel between the glass in each window to ensure there was no fogging. Also improved quality door handles were fitted and door corners reshaped to ensure an improved seal was attained.

The floor area, covered with structural damping material, was also covered with the standard `rough surface' matting as used by Austoft Industries Ltd. Closed-cell foam was fixed to the underside of this matting.

6.8.5 Vibration isolation

This method reduces the transmission of vibrational energy from one system to another. On the standard Austoft harvester, polyester polyurethane isolation mounts were used. Following recent developments, a new elastomeric material was made available in the form of polyether polyurethane. Polyether polyurethane isolation mounts having different load ratings for fitment to the front and rear of the cabin were sourced and fitted to provide excellent vibration isolation.

6.8.6 Cabin noise level

With the cabin interior sound insulated and dampened and independent isolation mounts fitted, the sound level at the operator's ear position was reduced by an impressive 12.4 dB to 80.2 dB. This was recorded with a Bruel and Kjaer dBA sound level meter, type 2232, when engine was running at full speed with all of the hydraulics engaged. This is a major improvement in operator comfort and workplace safety.

7.0 OPERATOR SURVEY

During the 1993 season a survey of eight operators, who had driven the BSES Austoft 7000 fitted with the new ergonomic cabin, was undertaken. In general, operators commented positively on improvements relating to:

- general control layout
- general visibility
- noise level
- harvesting efficiency
- the ease of operation
- the ease of turning
- arm comfort
- leg comfort

A summary of the results of the cabin evaluation appears in Appendix V.

All operators saw the majority of changes as positive improvements with individuals commenting that:

- the smaller back corner columns provided greatly improved visibility;
- the location of the elevator stop/start switch was excellent;
- they were less stressed after operating the ergonomic machine;
- the Cane Loss Monitor is a good driving aid;
- more time was needed to evaluate the foot control, or that it needed some refinement, or conversion to a dual pedal, or sideways operation, or a compact hand control;
- linkages in the Sunstrand transmission could be adjusted to improve the foot control;
- a larger rocker could be used for slewing the elevator;
- more leg space was required for operating the topper height control;
- the main forward/rewind switch should be well defined, close to the operator and be linked to an on/off switch;
- that switches for the crop dividers/topper throw could be kept close to the operator but separate from the multi-function handpiece;
- indicator lights should be fitted;
- windscreen protection bars should be fitted;
- oil pressure and temperature and water temperature gauges could be located immediately in front of the operator;
- the wiper should have a double arm, be fitted with 1 200 mm long blades and park at side of screen;
- the steering-wheel could be smaller;
- the B/C height indicator could be centrally located;
- a full glass is required at the back of the cabin.

The majority of the above suggestions were addressed following the survey to further improve the cabin design.

8.0 CONCLUSION

The successful development of the ergonomic cabin together with positive feedback from the operators who tested the machine resulted in Austoft Industries Ltd constructing five ergonomic cabins for harvesters for the 1994 season (Plate 2). It is anticipated that the new, improved cabin will result in greater operator comfort, improved standards of work, less loss of cane and increased profitability for the sugar industry.

All formulated concepts have been considered by the manufacturers, with the majority adopted. In production machines the manufacturer is keen to have the traction control automatically lock as it passes through neutral. As a result, the traction control for the 1994 ergonomic machines will be adjusted by the left hand which also controls the steering. The more expensive proportional controls regulating basecutter and topper height have been replaced with cheaper directional controls with which operators are content. The switches fitted to the multi-function control have been grouped with the small support group of switches (refer 6.6) and have been located on an extension of the right arm rest very close to the basecutter/topper height control. The use of vacuum fluorescent digital displays is proposed for consideration by Austoft Industries Ltd in future instrument panel design.

Further research and development using sensor and control technology in harvesting and transport of product is proposed to be undertaken by BSES in the future.

9.0 INTELLECTUAL PROPERTY

As Austoft Industries Ltd were part of the project team and as details relating to the cabin's development have been published in the press, no Intellectual Property claim is laid.

10.0 TECHNICAL SUMMARY

A new, ergonomic cane harvester cabin has been developed that offers improved visibility, control layout and sound insulation. The operator has been positioned in accordance with the Australian Standard relating to ergonomic zones of comfort and reach. A unique multi-function hand piece fitted to a twin axis proportional remote control governs the operation of a series of directional valves, and a twin spool proportional valve. These valves control the operation of basecutter and topper heights, the bin flap and crop divider positions, the throw of the topper and the stopping and starting of the elevator. A range of noise control products was used after considering structural modification, structural damping, absorption, use of barriers and vibration isolation. The range included thermoplastic alloy damping, acoustical foam, barrier/absorption material and isolation mounts. Further details on these and other major new equipment fitted are listed in Appendix III.

11.0 PUBLICATIONS

Numerous television and newspaper releases have been made to cover all canegrowing districts. A paper is proposed to be presented at the 1995 ASSCT Conference in Bundaberg.

12.0 ACKNOWLEDGMENTS

Close cooperation of operators, Austoft Industries Ltd, Frank Grigg and Associates and Mr Ross Miller, an auto-electrician in Bundaberg, is gratefully acknowledged.

In addition to the principal supervisor the research and development team comprised Messrs M Baker and D Spargo, Austoft Industries Ltd, Dr F W Grigg, Frank Grigg and Associates Pty Ltd, Dr D F Radcliffe, The University of Queensland, and Messrs D R Ridge and L S Poulsen, BSES.

13.0 REFERENCE

Dick, R G (1986) Cane harvesting research - past, present and future. Proc. Int. Soc. Sugar Cane Technol., 19:159-167.

APPENDIX I

ACTIVITY ANALYSES

APPENDIX II

ERGONOMIC ZONES OF COMFORT AND REACH

APPENDIX III

MAJOR NEW EQUIPMENT FITTED

ELECTRIC OVER HYDRAULIC CONTROLS

7 Hägglunds Denison 4DO1 directional solenoid valves for operating:

- left crop divider
- right crop divider
- bin flap
- elevator lift
- hood slew

1 Hägglunds Denison 3DO2 directional solenoid valve for adjusting the topper's throw from left to right.

1 Danfoss PVG32 (twin spool) proportional solenoid valve for operating:

- basecutter height
- topper height

1 Danfoss PVRE twin axis electrical remote control lever for operation of PVG32 valve.

1 Southcott Engineering DFE20 directional valve for switching the elevator on and off.

1 multi-function handpiece fitted to PVRE control lever.

NOISE CONTROL MATERIALS

Thermoplastic alloy damping:	E-A-R ISODAMP SD40-ALPSA
Acoustical foam:	Decibar VAF/HR-25
Barrier/absorption material:	Decibar FLVF-532
Floor matting underlay:	Decibar EVAF-10 closed cell foam
Isolation mounts:	2 - Barry Controls SR 22003-11 for rear of cabin
	2 - Barry Controls Sr 22003-13 for front of cabin

OPERATOR'S SEAT

KAB 303 seat

CLOSED-CIRCUIT MONITOR AND MIRRORS

Camera:	Austral Security CCD monochrome vehicle camera
Lens:	Cosmicar 6 mm wide angle
Monitor:	Javelin 225 mm monitor
Air Compressor:	Mini Delco electric
Mirrors:	M P O'Rourke convex mirrors #DI-12 (155 mm x 305 mm)

APPENDIX IV

FLOW DIVIDER CIRCUIT AND

BIN FLAP/HOOD SLEW CIRCUIT

FLOW DIVIDER CIRCUIT

1. Pump - existing
2. Flow divider - existing
3. Directional valve - existing
4. Directional valve - Southcott Engineering - DFE20/3A-18ES-Y-24VDC
5. Motors - existing
6. Directional valve - Hägglunds-Denison - 3DO2.34.201.03.02.00A1.GOQ327
7. Motor - existing
8. Priority valve - existing
9. Directional valves - (5 required) - Hägglunds-Denison - 4DO1.35.201.03.02.00A1. GOQ327
10. Directional valve - Danfoss - PVG32 157H189 (2 spool)
11. Control - Danfoss - proportional joystick 155B4276

BIN FLAP/HOOD SLEW

1. Directional valve - refer item 9 above
2. Directional valve - refer item 9 above
3. Cylinder - bin flap - existing
4. Motor - hood slew - existing
5. Directional valve - refer item 9 above

APPENDIX V

SUMMARY OF CABIN EVALUATION RESULTS

Subject	Modification		
	better	no difference	worse
General control layout	8		
General visibility	8		
Noise level	7	1	
Harvesting efficiency	7	1	
Ease of operation	7	1	
Ease of turning	6	2	
Arm comfort	7	1	
Leg comfort	6	2	
Viewing elevator operating	8		
Viewing transporter	8		
Viewing crop dividers	7	1	
Viewing gauges	8		
Instrument layout - left	8		
Instrument layout - above	3	5	
Instrument layout - right	8		
CLM driving aid	5	3	
Larger windscreen	8		
Larger side glass	5	3	
Rear windows	8		
Seat design	6	2	
Seat height	6	2	
Seat access	8		
Cabin height	8		
Sloping windscreen	8		
Wiper location	6	2	
Washer operation	1	7	
Adjustable steering-wheel	8		
Steering-wheel knob	5	3	
Control rack (left hand)	2	6	
Brakes	0	8	
Elevator slew	6	1	1
Foot traction	5	1	2
Joystick (right hand)	8		
Basecutter height control	8		

Subject	Modification		
	better	no difference	worse
Topper height control	8		
Bin flap operation	8		
Crop divider operation	8		
Topper throw control	8		
Elevator stop/start	8		
Horn	7	1	
Throttle	7	1	
Forward/rewind switch	5	2	1
Ladders	5	3	
Door stops	8		
Door catches	8		