INTERIM REPORT ON McCONNEL STAGE II CANE HARVESTER

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Abstract

The initial testing of the McConnel Stage II, including modifications, is discussed. As this was a pre-production prototype the tests were conducted to determine the weak points and to make various modifications to improve the efficiency and reliability of the machine.

Introduction

The South African Sugar Industry is predominantly orientated towards whole stick harvesting and is likely to remain so for several years. Furthermore, there is a significant advantage, in at least 50% of the area under cane, in cutting the cane green (unburnt) and leaving a trash blanket on the ground.

Whilst it is noted that Australia, for instance, now cuts 99% of its cane with chopper harvesters, and there is a growing trend towards this system in other parts of the world, it is not a system which could be introduced into most of the South African area at this stage, the principal reasons for this being:–

1. Topography which is often rather steep.
2. Desirability of having a trash blanket. (Chopper harvesters usually operate in burnt cane as output in green cane is poor).
3. Distance from the mill and delays between cutting and milling, leading to deterioration of the chopped cane.
4. Availability and cost of labour. (It is still cheaper to hand cut cane, and in most areas there is, at present, adequate labour).
5. Non-convertibility of most mills to accept chopped cane.
6. Transportation systems geared for whole stalk cane.

It can be expected that manual labour will become scarcer and more expensive as the years pass, and the gap between the cost of harvesting sugarcane manually and mechanically will close as in many instances, it has already done. It is fitting therefore that thought should be given to mechanising the cutting and handling of green cane.

The McConnel Stage I cane cutter is already fairly well known. This machine is able to cut both green and burnt cane, whether recumbent or upright, at a rate which is attractive to the larger-than-average grower. Although hand recovery of the cane from the "sausage" (swath) left by the machine is necessary, this operation results in approximately a 50% saving in labour by comparison with straight manual cutting.

McConnel realised that, as labour became even scarcer, there would be a need for a machine which would handle the cane from the sausage, detop and detrash it and load it. The loading part of the operation has not yet been satisfactorily achieved, but a machine has been designed which tops and detrashes the cane and places it in approximately ½ ton bundles, ready for mechanical loading. It has been called the McConnel Stage II and has been described by Hudson *et al*[1].

The subsidy Committee of the South African Association considered that such a machine would be to the benefit of the South African Sugar Industry and bought a pre-production prototype as part of a joint agreement between SASA and McConnel, to develop the machine for South African conditions. The machine reached South Africa in May 1976 and, for the rest of the 1976/77 season, underwent extensive testing and development by the Experiment Station and McConnel.

The Stage II machine is used as the second part of a cane harvesting system in which the original Stage I machine is used to base cut the cane into a sausage but not to remove the tops. The Stage II (see Fig. 1) picks the sausage up tops first, feeds it onto a toothed conveyer which then moves it onto two rubber coated accelerating drums which throw the cane sticks into a rear-mounted bin. The acceleration of the sticks causes the tops and trash to be bent and/or stripped away from the stalk and they are caught up in cleaning drums (also acting as fans) which are rotating in the opposite direction to the hurlers. The tops and trash are then drawn off from the cane sticks (see Fig. 2). When a bundle of about 500 kg has accumulated, it is dropped by lowering the bin door. A more detailed description of the machine and its principles has been provided by Hudson *et al*[1].

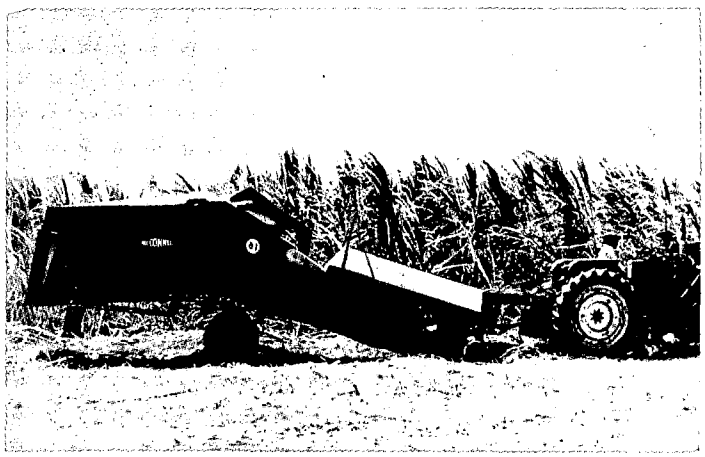

FIGURE 1 McConnel Stage II in action before modification.

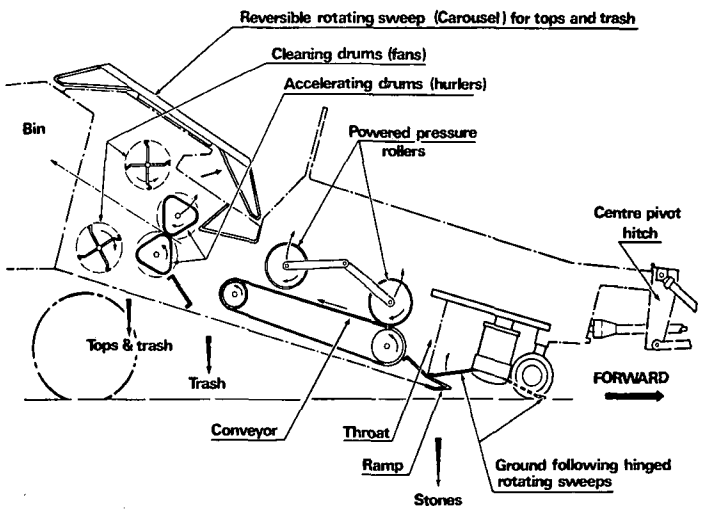

FIGURE 2 Details of operation and design of McConnel Stage II before modification.

Development objectives

The following objectives were originally set for 1976/77 :

1. To achieve satisfactory general performance at acceptable trash levels (7% average extraneous matter).
2. To achieve satisfactory performance in different varieties and under different conditions.

3. To reduce cost by elimination of components.
4. To achieve satisfactory output rates in green cane (20 tons/h).
5. To discover slope limitations and other working restrictions.
6. To study the effect of adopting a 2 wheel hitch.
7. To establish yield limitation in single and 2-row working.
8. To investigate single pass working.
9. To investigate alternative loading systems.

Field test conditions

Testing was done at the SASA farm at La Mercy. On the first block to be cut slopes varied up to 14%. The variety was 20 month old N55/805, at 1,37 m spacing, in sandy soil, on a flat culture, and yielding between 80 and 110 tons/ha. The cane was fairly recumbent. The second block was 24 month old N55/805 yielding 110 tons/ha in similar conditions but with a greater percentage of recumbent cane. The third block was NCo 376 at 1,8 m spacing and 19 month old plant cane on side slopes of no more than 3%. The first and second blocks were cut two rows at a time while the third block was cut in single rows.

Field testing experience

During the preliminary setting up and adjustments of the machine it was found that the safety shear pin was too weak and a larger pin was fitted. During this phase a Ford 5 000 tractor was used for both Stage I and Stage II machines; this required constant coupling and de-coupling.

The following problems occurred immediately:

1. Bundles did not fall readily from the bin.
2. Continuous jamming in the cleaning section was caused by poor metering.
3. Bundles were not clean, containing about 10% extraneous matter (tops, trash, etc.).
4. Tractor stability was rather poor on account of lack of traction.
5. Tractor power appeared to be deficient.

Early modifications and adjustments

1. *Bin*

An hydraulic ram was fitted to the rear door and the shape was altered by adding 500 mm of 4 mm plate to the bottom of the door to act as part of the floor. The floor was shortened by 500 mm. This arrangement assisted in pulling the cane outwards as the door opened, and the shortened floor took up a steeper angle which helped the cane to leave the bin more rapidly.

The addition of the ram necessitated the fitting of a modified (bin floor) control valve to enable both floor and door to operate from one control lever. The control valve enabled the door to be held open without retaining pressure on the lever.

2. *Metering*

This is the term used when referring to the evenness of flow of material through the hurlers. The ideal condition would be for the cane to be passed between the hurlers in layers one canestick deep.

After numerous trials it was found that the conveyor required toothed flights at 300 mm intervals to be fitted. (A 50 mm section of plate in front of the conveyor had to be cut away to make space for the teeth). It was also necessary to increase the speed of the conveyor by changing the driving and driven pulleys of the conveyor to a 1 to 1 ratio (100 mm vee-pulleys were used). A shield was welded beneath the conveyor to prevent trash and other material being picked up from the ground under the machine.

Various experiments were made with the pressure rollers above the conveyor. Eventually the rollers were removed and replaced by a series of hinged pressure trays which had vee shaped leading edges to spread the cane on the conveyor (see Fig. 5).

3. *Stability*

The hitching of the Stage II was altered to exclude the use of its own hydraulic rams for lifting. Instead, the tractor's hydraulic oil was fed through the controls to operate the raising of the machine by means of the tractor lift arms. This gave weight transference and vastly improved traction, but reduced steering ability because of the front wheels lifting.

4. *Power loss*

To compensate for a lack of power the engine revs were increased from 1 700 rpm to 2 000 rpm. It was later found that this improved overall machine performance and it is recommended that the machine should always be run at this speed.

5. *Hurlers*

The original smooth rubbers of the hurlers allowed too much slippage, especially in the wet. Rough rubber was tried but this wore out after only 100 tons and again did not work very well in the wet. A tyre company was approached to vulcanise a truck tyre tread onto the original hurler rubbers (see Fig. 3) and this proved to be a major breakthrough for the future of the machine. Extremely efficient hurling was achieved in wet and dry conditions and the life of the rubbers became acceptable. On account of the increased loading on the hurler rubbers additional locating pegs had to be fitted to the hurler drums. The shafts of the hurler drums snapped and these were strengthened by repairing them with considerably tougher steel.

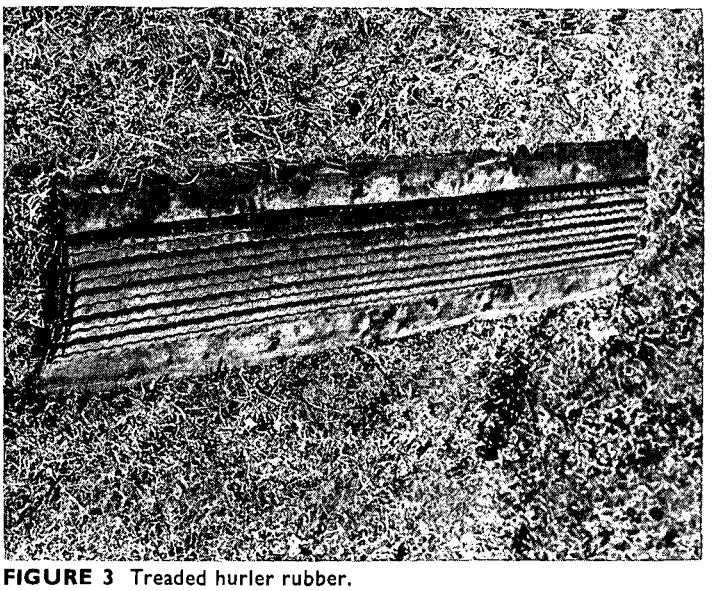

FIGURE 3 Treaded hurler rubber.

6. *Fans*

The original fan shafts broke and these were also strengthened by repairing them with a stronger steel. The working edges of the fan were found to be weak so they were also strengthened.

Major Modifications

1. *Centre pivot hitch*

A significant improvement in the traction and steering of the unit was achieved by the adoption of a 2-wheel hitch. (see Fig.

4). The idea of the hitch was to dispense with the tractor front wheels and their steering function. Steering with the new hitch was achieved by articulating the machine about the hitch pivot point referred to above.

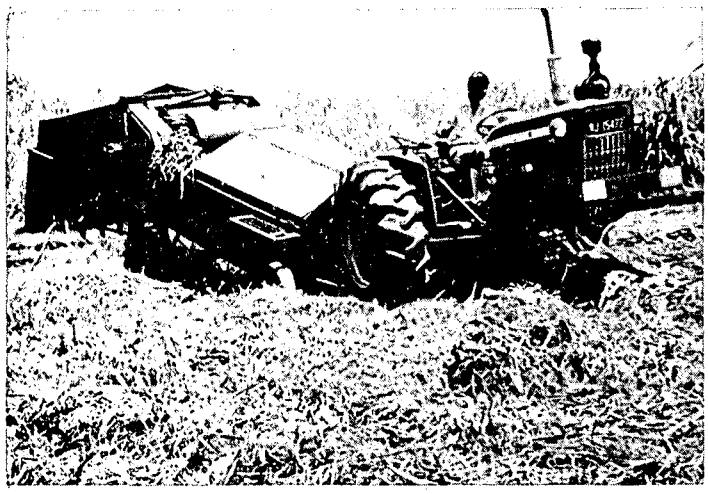

FIGURE 4 Articulated McConnel Stage II with recycling shroud.

As the standard centre pivot hitch had been designed for 4-wheeled tractors it was found to be too weak for articulated operation. Considerable strengthening was done and the problems encounterd were diminished but, for two-wheeled operation, it would be necessary for the centre pivot hitch to be redesigned for lasting strength.

2. *Power steering*

The Ford 5 000 steering was modified for the 2-wheel hitch; a new control valve was fitted to the steering column and the pump relief valve had to be increased to its maximum setting of 12 400 kPa, which is still a little too low, at least 13 790 kPa being needed for maximum efficiency.

3. *Bin*

Inspection showed stress cracks to the bin "picture frame" (the frame which supports the bin). The beam had become banana shaped and the pivot holes were elongated. This beam was replaced by a rectangular, hollow section beam (50 x 100 mm with 6 mm walls) with integral pivot (20 mm in diameter).

4. *Recycling shroud*

A shroud was manufactured to replace the carousel, to deflect all materials downwards. (See Fig. 4). For efficient operation of this shroud it was found necessary to lower the bottom hurler by 50 mm to encourage tops and trash to be deflected to the bottom fan, which proved to be a most successful adjustment.

5. *Fan shroud*

The lower fan shroud was louvred to create a better air flow and so draw the tops and trash downward. This led to a further improvement in the cleanliness of the bundles.

Performance

During the major part of the testing programme it had been found that the cane did not clean well when picked up on the same day as cutting, it being preferable to do so two days later. As a result of the latest adjustments it is now possible to pick up immediately after cutting, with no appreciable drop in performance.

Over the entire testing programme numerous bundle analyses were made to determine the results of various modifications. A total of 60 bundles were analysed from 2 100 tons harvested over the test period and the overall averages were as follows :—

Average tops in bundle	= 2,26%
Average trash in bundle	= 2,47%
Average trash under bundle	= 1,37%
Average total extraneous matter	= 6,10%
Average cane left between bundles	= 6,60%

The first 11 bundles were compared with the final 11 bundles to establish the extent of the improvements and the table below gives the comparison.

		First 11	Final 11
Average tops in bundle	=	4,47%	1,24%
Average trash in bundle	=	4,33%	1,35%
Average trash under bundle	=	2,18%	0,35%
Average total extraneous matter	=	10,98%	2,94%
Average cane left between bundles	=	11,39%	3,55%

From the above figures it is clear that the machine is now able to do the job of cleaning most satisfactorily.

As a result of improved reliability, an output figure of nearly 16 t/h (tons per hour) was obtained towards the end of the test period. This may not appear to be very good, but it must be pointed out that, for test purposes, a constant engine speed and gear were used, giving a constant forward motion irrespective of the density of the sausage. The result was that, where the cane yield was high, very good output results could be achieved (estimated at 26 t/h).

Considering that the last 418 tons of cane harvested had an average yield of 80 t/ha, the output of nearly 16 t/h, is acceptable, and it is expected that the average output would be in excess of 20 t/h during commercial operation in cane yielding at 100 t/ha.

Conclusion

Before further extensive tests, it would be rather rash to say that Stage II, in its present form, is now a viable commercial machine, ready for full scale production, although the results obtained have been very promising.

During the coming season it is planned to replace the carousel and top fan with a powerful centrifugal air blower to improve the cleaning effect (see Fig. 5). There is a feeling of confidence that, with this modification, future testing will be a mere formality in proving that the McConnel Stage II will, in fact, deliver whole stalk greencane in bundles at a rate of 20 tons/h, and with total trash content of less than 7%.

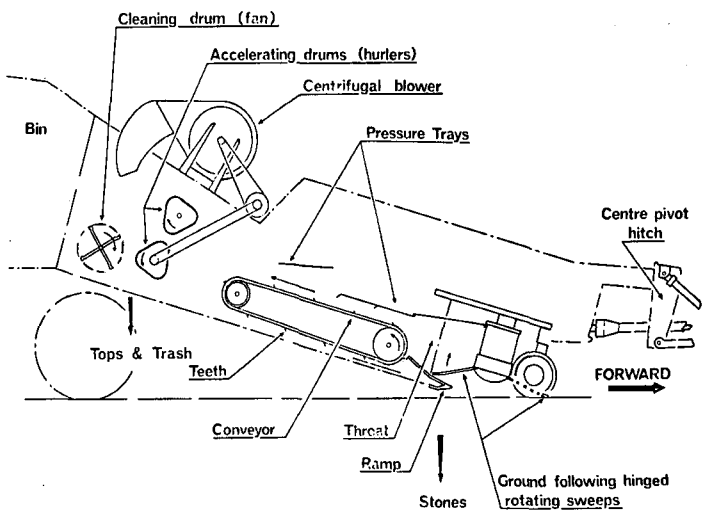

FIGURE 5 Modified version of McConnel Stage II.

REFERENCES

1. Hudson, J. G., Boycott, C. A. and Scott, D. A. (1976). A system for whole stick cane harvesting: the McConnel "Stage 2" Machine. SASTA Proc **50**, 6-11.