BSES CANE HARVESTING STUDIES, 1977

- PRELIMINARY REPORT

December, 1977

Introduction

The sugar cane industry in Queensland has maintained its prosperity by successful mechanization of harvesting and other farm operations. Farm machinery purchases now represent a significant investment decision. The most expensive item is the cane harvester. The current order of cost of harvesters is as follows : -

Tractor mounted harvester (eg Toft Mizzi)	$40 000
Small over the row harvester (eg MF102, Toft 4000)	$60 000
Large over the row harvester. (eg MF205, Toft 6000)	$80 000
Imported Green Cane Harvester (eg Claas 1400)	$110 000

With this level of investment it is essential that harvesters satisfy industry requirements. These are : -

* total harvest - cane left in the field by the harvester should be minimized (current levels vary from 3 to 10 tonnes per hectare);

* harvest costs - machines should be capable of handling different harvest conditions, including lodged cane, with reliability and economy;

* mill efficiency - millers require a minimum of extraneous matter in the cane supply and continuity in wet weather; and

* sugar quality - machines should cut billets of suitable length and quality (in terms of damage) to avoid bacterial infection.

These factors have an important impact on the income of both the farmer and miller and the current BSES research programme is aimed at evaluating and improving efficiency in all these areas.

Current BSES Research

The problems of wet weather harvesting in 1973 and 1975 prompted the appointment of specialized agricultural engineering staff

to investigate harvesting procedures. The Agricultural Engineers are based at Tully Sugar Experiment Station which is ideally suited for the investigation of wet weather problems.

In 1976 extension staff assisted the engineers in a series of case studies of harvesters and haul-out equipment. These were designed specifically to assess performance in wet weather and have been continued this year in the absence of wet harvest conditions in 1976. This programme is aimed at evaluating both the performance of equipment and the effect of compaction on the subsequent crop.

The preliminary case studies have led to more detailed investigation of high flotation haul-out equipment such as tracked and rubber tyred tippers and elevator bins. From an economic viewpoint this equipment will be required to operate satisfactorily both in wet and dry years and these studies will not be complete until wet harvest conditions are experienced.

The main emphasis in this year's programme has been in the assessment of harvester performance, particularly quality of the cane supply from different harvesters. This year several new harvester models have been released.

The range of new machines appearing on the Australian Market in 1977 was : -

Toft 4000, Toft 6000, Massey Ferguson 205, Claas 1400

Some of these machines were advertised with green cane harvesting capabilities and some had options for dual row planting.

The performance of all models has been evaluated in green and burnt cane. Green cane harvesting is now an accepted practice by some farmers in North Queensland, particularly in showery conditions. A full evaluation of harvester performance and other aspects of green cane harvesting is essential in view of the growing interest in it.

Green cane harvesting studies, this year, have included monitoring of beetle borer populations where trash has been left in the field and evaluation of methods of disposal of the trash blanket.

Harvester Evaluation Programme

The aims of the harvester evaluation programme in 1977 were : -

(1) to assess the efficiency of the cutting, chopping and cleaning mechanisms of new machines under a range of crop conditions;

(2) to examine the quality of the cane supply in terms of billet quality, billet length and extraneous matter;

(3) to quantify the millable cane losses in the harvest operation and the causes of such losses;

(4) to compare the performance of machines in green and burnt cane; and

(5) to note other characteristics of the machine including reliability, driver comfort, etc.

It is intended that this data will be distributed to all concerned to encourage continual upgrading of the harvesters, and aim at improving sugar quality for the industry.

Machines Tested

The table below sets out the machines tested in relation to the number of new machines operating in the various mill areas in the Northern region.

BSES HARVESTER TEST PROGRAMME 1977

MACHINE	Toft 4000		Toft 6000		MF 205		Claas 1400	
Mill Area	New Machines	Machines Tested	New Machines	Machines Tested	New Machines	Machines Tested	New Machines	Machines Tested
Mossman					1	-		
Hambledon	5	1xG & B			2		1	
Mulgrave	2		1	1xG & B			2	1xG & B
Babinda	2	1xG & B	1				1	1xG & B
Goondi			1	1xG & B				
Mourilyan			1					
South Johnstone	1		1		2	1xG & B		
Tully			2	1 x DR	5	1x DR 2xG & B		
Victoria	3		2	1 x B	2			
Macknade	3	1 x B	1		1			
Number of Tests								
Green & Burnt		2		2		3		3
Burnt Only		1		1		-		
Dual Row				1		1		

G & B = Green and Burnt cane test
B = Burnt cane test only
DR = Dual Row test (Burnt cane)

Testing Procedures

A standard record sheet was drawn up for recording data from each test. Appendix A shows the detailed record sheet. Briefly the sheet includes the following : -

* date, time and place of test
* harvester specification
* crop and field conditions
* pour rate calculations
* billet length and quality analysis
* extraneous matter analysis
* millable cane left in the field
* visual assessment of performance
* notes on modifications
* comments on reliability

Trials were carried out in normal operating conditions. Sites and machines were selected in consultation with harvester company agents, cane inspectors, farmers and operators. The tests were especially designed to minimize disturbance of the normal harvest operation.

A speedo dynamometer was attached to the harvester to achieve uniform speeds.

Cane samples were collected by means of a chute attached to the bin trailer. Five samples were collected at each of three speeds in green and burnt cane.

Millable cane left in the field was collected from three plots at each speed.

During the test, the performance of various components was assessed visually and comments on reliability and performance were obtained from operators.

At the conclusion of the test samples were taken to the laboratory for analysis.

The catagories into which samples were divided are presented on pages 5 and 7 of the record sheet presented in Appendix A.

Mill c.c.s. figures were collected for a comparison of green versus burnt rakes for each test.

Results of Harvester Testing Programme

The programme was completed in November and results are now being analysed.

The general performance of harvesters under test has been discussed directly with the manufacturer's research and development engineers and any problems in operation have been brought to their attention.

Detailed results of tests will be made available initially to the industry Harvesting Review Committee and maybe discussed at BSES seminars and conferences such as QSSCT in early 1978.

The lack of consistent industry standards on billet quality (especially billet length) makes it difficult to define good quality billets.

Uniform testing procedures for billet quality and extraneous matter would assist mills in getting the message on cane quality back to manufacturers.

It appears that Australian harvesters have some green cane capability in erect cane. Further development is necessary for them to handle green cane economically, especially in lodged conditions.

Higher c.c.s. figures from mill tests of green cane have been recorded but more detailed studies are required for accurate assessment.

Green Cane Harvesting - Agronomic Studies

Following the industry group study tour overseas early this year, it was recommended that several important agronomic studies be carried out. These include investigations to determine whether there will be a beetle borer problem if green cane harvesting becomes widespread and to evaluate methods of disposal of trash and tops after harvesting.

BSES agronomists have established three trials in the Tully-Innisfail area, four in the Mulgrave area, and two in the Babinda area this year to investigate these problems. In ratoon crops, three methods of disposal of the green cane trash mat are being compared : -

* burning the trash using a running fire before cultivating normally;
* ploughing in the trash; and
* leaving an undisturbed trash blanket without cultivating.

Several implements have been used for trash incorporation, for example, a coulter-ripper combination, ratoon discs, a rotary hoe and a spade cultivator (Agritill). The rotary hoe fitted with long blades and the spade cultivator have both given effective trash disposal.

In the trash blanket treatments, fertilizer has been trickled onto the surface or drilled in beside the row after raking away the trash using a side delivery rake.

Early crop growth shows that all methods of trash disposal are satisfactory. In this year's dry conditions the trash blanket treatments have produced better early growth in some districts but further work in a wet year will be necessary to evaluate fully the effect of conserving trash.

Investigation of possible beetle borer problems will be a longer term project as it may take time for borer populations to build up. Preliminary observations were carried out prior to harvest this year in normal cane, standover cane and cane with a trash blanket left after harvest in 1976. Borer activity was greatest in rat damaged standover cane and minor damage also occurred where the trash blanket was left. Further observations will be carried out in 1977 on farms in the Mulgrave, Babinda, Innisfail and Tully districts. To date it appears that most farmers are burning the trash blanket after harvest and there will be only isolated patches where trash is left and borers have the opportunity to build up.

The studies of ratooning methods and borer populations will be continued for several seasons so that climatic influences can be thoroughly evaluated.

Appreciation

The BSES gratefully acknowledges the assistance and co-operation of farmers, harvester operators and their crew, cane inspectors, milling staff, manufacturers and their agents in the research associated with these programmes.

BUREAU OF SUGAR EXPERIMENT STATIONS

HARVESTER EVALUATION

RECORD SHEET

Grower : _____ Test No.: _____

Location : _____ Date : _____

Mill Area : _____

Type of Trial : ☐ Green ☐ Burnt ☐ Dual Row

HARVESTER MAKE:

☐ Claas ☐ MF205 ☐ Joe Mizzi

☐ Toft 4000 ☐ Toft 6000 (Dual Row) ☐ MF205 (Dual Row)

Year of Manufacture: _____

Harvester specification obtained: ☐ Yes ☐ No

List options on specifications:

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

TYRES:

	Drive	Steering
Size	_____	_____
Ballast	_____ kg	_____ kg
Distance between centres	_____ cm	_____ cm

Harvester group size _____ tonnes Tonnes/day _____

Harvester operator:
☐ Grower ☐ Grower employee
☐ Grower contractor ☐ Grower contractor employee
☐ Non-grower contractor ☐ Non-grower contractor employee

Experience:
☐ Years cutting ☐ Months - test machine

HAULOUTS:

Type: _____ Number: _____ Capacity: _____

TRIAL AREA DESCRIPTION:

Block No. _____ Variety: _____

Crop class: ☐ Pl., ☐ 1R, ☐ 2R, ☐ 3R ☐ OR, ☐ Standover

Yield estimate: _____ Tonnes/ha. Row spacing: _____ cm

Soil texture: ☐ Sandy ☐ Clay loam ☐ Sandy Loam
☐ Clay ☐ Loam ☐ Peaty

Soil type: _____

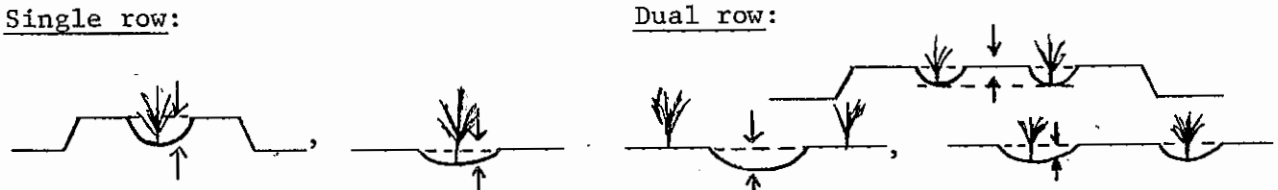
GRADE THE FOLLOWING:

☐ Consistency of yield within trial area (Consistent 1 - High variable 5).
☐ Burn (Very good 1 - Very poor 4, Green 5)
☐ Lodging (Erect 1 - Totally lodged 5)
☐ Suckers (Nil 1 - Prolific 5)
☐ Dead cane (Nil 1 - Prolific 5)
☐ Stones in trial area (Nil 1 - Many 5)
☐ Stool turnout (Nil 1 - Prolific 5)

If plant cane, is there a depression around stool? ☐ Yes ☐ No

If yes, indicate profile:

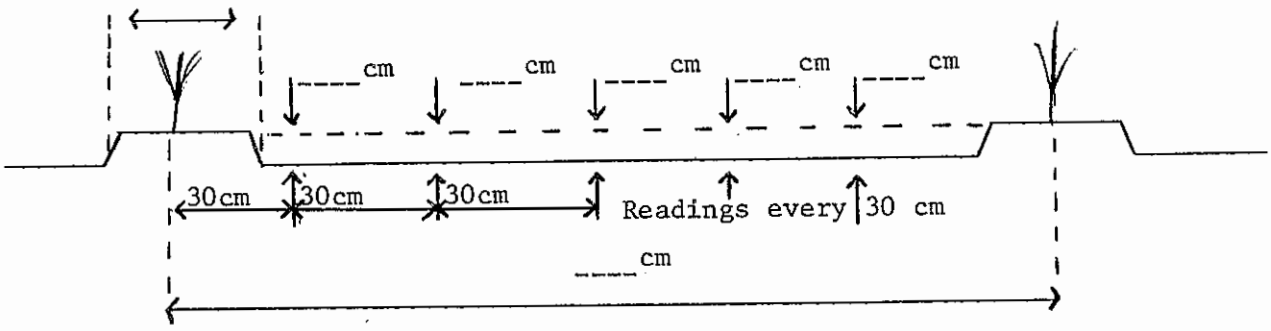
Single row: Dual row:



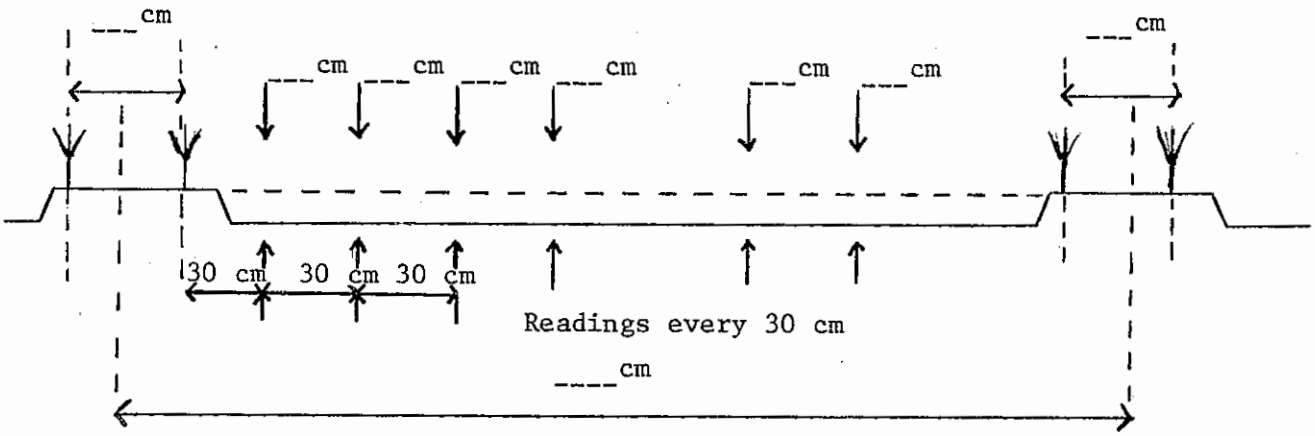
Record depth of depression: _____cm.

MEAN SURFACE PROFILE: (Mean taken from 10 individual readings.)

Single row:



Dual row:



COMMENCEMENT TIME OF TEST:

Early morning test _____ a.m.

Late morning/Early afternoon test _____ a.m. / p.m.

SOIL MOISTURE:

☐ Dry

☐ Moist/Wet - ☐ Grade (Slightly moist, 1 - Very wet, 5)

Test No.: _____ Time of Day: _____

HARVESTER POUR RATE AND GROUND SPEED ANALYSIS:

Is test side or rear delivery? _____

	Normal operating speed						Other speed					
Bin No.												
Bin capacity (tonnes)												
Nett time to fill bin (minutes)												
Mill bin weight (tonnes)												
Pour rate (tonnes/hr)												
Mean pour rate (tonnes/hr)												
Distance to fill a bin (metres)												
Ground speed (km/hr)												
Mean ground speed (km/hr)												

Test No.: _____ Time of Day: _____

BILLET QUALITY AND EXTRANEOUS MATTER ANALYSIS

NORMAL OPERATING SPEED ☐ OTHER OPERATING SPEED ☐

Sample No.											Mean
Bin No.											
Sample weight plus container											
Container wt.											
Sample wt.											
Billet Analysis:	kg	%	kg	%	kg	%	kg	%	kg	%	Mean %
Sound billets:											
0-10 cm											
10-20 cm											
20-25 cm											
25-30 cm											
30-40 cm											
> 40 cm											
TOTAL:											
Damaged billets:											
0-10 cm											
10-20 cm											
20-25 cm											
25-30 cm											
30-40 cm											
> 40 cm											
TOTAL:											
Damaged billets											
Sausaged billets											
Mutilaced bill.											
Split in half											
Extraneous Matter Analysis:	kg	%	kg	%	kg	%	kg	%	kg	%	Mean %
Tops											
Trash											
Dead cane											
Dirt											
TOTAL E M											
No. of stools											

Comment on other extraneous matter: _____

Test No.: _____ Time of Day: _____

BILLET QUALITY AND EXTRANEOUS MATTER ANALYSIS

NORMAL OPERATING SPEED ☐ OTHER OPERATING SPEED ☐

Sample No.											Mean
Bin No.											
Sample weight plus container											
Container wt.											
Sample wt.											
Billet Analysis: Sound billets:	kg	%	kg	%	kg	%	kg	%	kg	%	Mean %
0-10 cm											
10-20 cm											
20-25 cm											
25-30 cm											
30-40 cm											
> 40 cm											
TOTAL:											
Damaged billets:											
0-10 cm											
10-20 cm											
20-25 cm											
25-30 cm											
30-40 cm											
> 40 cm											
TOTAL:											
Damaged billets											
Sausaged billets											
Mutilated bili.											
Split in half											
Extraneous Matter Analysis:	kg	%	kg	%	kg	%	kg	%	kg	%	Mean %
Tops											
Trash											
Dead cane											
Dirt											
TOTAL E M											
No. of stools											

Comment on other extraneous matter: _____

MILLABLE CANE LEFT IN FIELD

Test No. ____________

Speed: Normal ☐ Other ☐

Time of Day: Early morning ☐ Other ☐

Sample area:

Length of row: 20 metres

Number of rows per sample: Single row crop - 5 rows
Dual row crop - 4 rows

Row width ____________m Sample area _______________ha

Number of samples per test: 3

Sample No.	Time collected	Time analysed	Size category mm	Condition	Measured weight kg	Loss factor from graphs	Adjusted weight kg	Totals kg: Each size category (mm) 0-250	250-500	>500	All cane
			0-250	sound							
				damaged							
				squashed							
			250-500	sound							
				damaged							
				squashed							
			> 500	all							
			0-250	sound							
				damaged							
				squashed							
			250-500	sound							
				damaged							
				squashed							
			> 500	all							
			0-250	sound							
				damaged							
				squashed							
			250-500	sound							
				damaged							
				squashed							
			> 500	all							
TOTALS:											
TOTALS t/ha (Area sampled _______ ha)											
TOTALS per cent of cane yield (Yield est. ______ t/ha											

Comment on reasons for cane left in field:

____

____

____

____

MILLABLE CANE LEFT IN FIELD | Test No. ____________

Speed: Normal ☐ | Time of Day: Early morning ☐

Other ☐ | Other ☐

Sample area:

Length of row: 20 metres

Number of rows per sample: Single row crop - 5 rows
Dual row crop - 4 rows

Row width ____________m | Sample area ________________ha

Number of samples per test: 3

Sample No.	Time collected	Time analysed	Size category mm	Condition	Measured weight kg	Loss factor from graphs	Adjusted weight kg	Totals kg			
								Each size category (mm)			All cane
								0-250	250-500	>500	
			0-250	sound							
				damaged							
				squashed							
			250-500	sound							
				damaged							
				squashed							
			> 500	all							
			0-250	sound							
				damaged							
				squashed							
			250-500	sound							
				damaged							
				squashed							
			> 500	all							
			0-250	sound							
				damaged							
				squashed							
			250-500	sound							
				damaged							
				squashed							
			> 500	all							
TOTALS:											
TOTALS t/ha (Area sampled ________ ha)											
TOTALS per cent of cane yield (Yield est. ______ t/ha											

Comment on reasons for cane left in field:

____

____

____

____

HARVESTER SECTION ANALYSIS

TOPPER

Mean length of millable cane ☐ cm

Mean height of topper above ground ☐ cm (Measured on unsampled bin by stopping harvester.)

Is topper being operated? ☐ Yes ☐ No

If no, why? _____

_____

Comment on:

Variability of millable cane within the stool: _____

_____

_____

Topping height vs. extraneous matter: _____

_____

_____

Reliability: _____

_____

_____

Other comments: _____

_____

_____

Is cane topped before or after it is base cut? ☐ Yes ☐ No

MOUTH FEED MECHANISM:

Comment on:

Shoes: _____

_____

Spirals: _____

_____

Feed rollers: _____

_____

Cane pick-up: Grade (very good, 1 - very bad, 5)

- ☐ Normal operating speed - early morning
- ☐ Normal operating speed - late morning/early afternoon
- ☐ Other speed - early morning
- ☐ Other speed - late morning/early afternoon

Comment: _____

_____

Blockage to mouth:

- ☐ Nil ☐ Seldom ☐ Often - normal operating speed - early morning
- ☐ Nil ☐ Seldom ☐ Often - normal operating speed - late morning/ early afternoon
- ☐ Nil ☐ Seldom ☐ Often - other speed - early morning
- ☐ Nil ☐ Seldom ☐ Often - other speed - late morning/ early afternoon

Harvester reaction:

- ☐ slow down ☐ stop - normal operating speed - early morning
- ☐ slow down ☐ stop - normal operating speed - late morning/ early afternoon
- ☐ slow down ☐ stop - other speed - early morning
- ☐ slow down ☐ stop - other speed - late morning/early afternoon

Comment: _____

_____

Reliability: _____

_____

_____

Other comments: _____

_____

_____

BASE CUTTER:

Date of replacement or sharpening of blades: _____

Condition of blades: ☐ Grade (very good, 1 - very poor, 5)

Comment: _____

_____

_____

BASE CUTTER HEIGHT:

☐ Above ground ☐ Ground level ☐ Below ground

Height above ground: _____cm

Depth below ground: _____cm

Comment on:

Cane loss: _____

_____

Dirt removal and build-up: _____

_____

Reliability: _____

_____

Other comments: _____

_____

THROAT FEED MECHANISM:

Tendency to choke:

☐ Nil ☐ Seldom ☐ Often - Normal operating speed - early morning

☐ Nil ☐ Seldom ☐ Often - Normal operating speed - late morning/ early afternoon

☐ Nil ☐ Seldom ☐ Often - Other speed - early morning

☐ Nil ☐ Seldom ☐ Often - Other speed - late morning/ early afternoon

Harvester reaction:

☐ Slow down ☐ Stop - Normal operating speed - early morning

☐ Slow down ☐ Stop - Normal operating speed - late morning/ early afternoon

☐ Slow down ☐ Stop - Other speed - early morning

☐ Slow down ☐ Stop - Other speed - late morning/early afternoon

Comment: _____

_____

Build-up of Trash: Grade - (Very little, 1 - Extreme, 5)

☐ Normal operating speed - early morning

☐ Normal operating speed - late morning/early afternoon

☐ Other speed - early morning

☐ Other speed - late morning/early afternoon

Comment: _____

_____

Additional Cleaning of Cane:

Comment: _____

_____

Cane loss: Grade (Very little, 1 - Lot, 5)

☐ Normal operating speed - early morning

☐ Normal operating speed - late morning/early afternoon

☐ Other speed - early morning

☐ Other speed - late morning/early afternoon

Reliability: _____

_____

_____

Other comments: _____

_____

_____

CHOPPER SYSTEM:

Date of replacement or sharpening of blades: _____

Mean length of billet for which chopper is geared: _____ cm

Condition of blades: ☐ Grade (Very good, 1 - Very poor, 5)

Comment: _____

_____

_____

Reliability: _____

_____

_____

Other comments: _____

_____

PRIMARY EXTRACTOR:

Cane blown out: Grade - (Very little, 1 - Lot, 5)

☐ Normal operating speed - early morning

☐ Normal operating speed - late morning/early afternoon

☐ Other speed - early morning

☐ Other speed - late morning/early afternoon

Comment: _____

_____

Comment on cane juice blown out: _____

_____

Is extracted material re-entering harvester or bin?

YES	NO	
☐	☐	Normal operating speed - early morning
☐	☐	Normal operating speed - late morning/early afternoon
☐	☐	Other speed - early morning
☐	☐	Other speed - late morning/early afternoon

If yes, comment: _____

_____

Reliability: _____

_____

Other comments: _____

_____

REAR ELEVATOR:

Height from ground to top of bins: _____ cm

Height of rear elevator above ground: _____ cm

Comment on:

Ability to reach centre of bins: _____

_____

Control of cane flow to fill bins evenly: _____

_____

Dirt removal through floor of elevator: Grade (Lot, 1 - Very little, 5)

- ☐ Normal operating speed - early morning
- ☐ Normal operating speed - late morning/early afternoon
- ☐ Other speed - early morning
- ☐ Other speed - late morning/early afternoon

Comment: _____

_____

Reliability: _____

_____

Other comments: _____

_____

SECONDARY EXTRACTOR:

Cane blown out: Grade (Very little, 1 - Lot, 5)

☐ Normal operating speed - early morning

☐ Normal operating speed - late morning/early afternoon

☐ Other speed - early morning

☐ Other speed - late morning/early afternoon

Comment: _____

_____

Comment on cane juice blown out: _____

_____

Is extracted material re-entering harvester or bin?

YES	NO	
☐	☐	Normal operating speed - early morning
☐	☐	Normal operating speed - late morning/early afternoon
☐	☐	Other speed - early morning
☐	☐	Other speed - late morning/early afternoon

If yes, comment: _____

_____

Reliability: _____

_____

Other comments: _____

_____

HARVESTER GENERALLY:

Comment on:

Overall performance: _____

_____

Operator:

Access to controls: _____

_____

Vision: _____

_____

Comfort: _____

_____

Access for repairs: _____

_____

Reliability: _____

_____

Other comments: _____

_____

_____

ADDITIONAL COMMENTS: (to include handling and stability.)