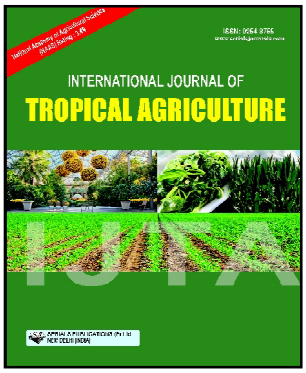

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Performance of Ratoon Cultivator in Establishment of Sugarcane Crop

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Abstract: Area under ratoon crop represents more than 70% of the total area under cane in the Sudanese Sugar Company (SSC), Sudan. Conventional operations for ratoon establishment on those fields comprised loosening of cane inter-rows, broadcasting of fertilizers and ridge reshaping. The main objective of this study was to study the performance of implements for ratoon establishment in terms of basic performance parameters (Field capacity, fuel and power consumption). Performance of locally fabricated six – shank chisel plow, fertilizer broadcaster, 2-row ridge re-shaper and ratoon Cultivator were studied during the cropping seasons 2011/12 and 2012/13. Results showed that the ratoon cultivator accomplished the placement and covering of fertilizer, reshaping of ridge and furrow profiles in once - over operation with draw bar pull of 7 kN, fuel consumption (2.9 L/feddan) and energy of 3.9 kW-h/feddan while the conventional method consumes 8.6 L /feddan, 7.1 kW/feddan of energy respectively.

Keywords: fertilizer placement; Fuel and energy consumption; Ratoon cultivator; Sugarcane ratoon

INTRODUCTION

Cane sugar is produced in about 120 countries across the world and abounds of approximately 80% of the world sugar. Sudan was (and partially is) one of the countries that imports the demands of sugar from abroad. Sugar consumption in Sudan is estimated to range between 1.2 - 1.3 million of metric tons.

Sugar production in Sudan from Sudanese Sugar Company and Kenana is about 750,000 metric tons annually without the contribution of the White Nile Sugar Company which is established to produce 450 thousand tons of sugar/annum. Imported sugar is now sold in local markets at prices lower than those of locally produced sugar. Therefore, the sugar industry in Sudan should format one of its objectives to revert this situation. Cane production operations and the machinery involved, are areas of consideration.

In the Sudanese sugar company, average area for the last five years under ratoon cumulatively was 313, 600 feddans (1 feddan = 4200 m^2) out of 431, 500 feddans under cane. Hence, For the Sudanese sugar company ratoon cane represents 70% of the area under cane.

Field operations for ratoons are aimed at reshaping of the ridge and furrow system to apply fertilizers, allow adequate irrigation and to provide traffic lanes for mechanical operations.

Also, in Sudan, land preparation for sugarcane planting includes successive operations with off-set disc harrow to provide ridge and furrow system for placement and covering of cane setts in the furrow.

Sugarcane has an inherent ability of giving out new shoot from underground stems. A cane production cycle starts with plant cane and may continue upto the 4th ratoon according to productivity of the particular field. Therefore, the high cost of establishing the field for plant cane can be paid back over a number of lower cost of ratoon crops.

Adopted cultivation practices for ratoon cane establishment operations start with broadcasting of fertilizers followed by chiseling the furrows (inter–rows) to an approximate depth of 10 cm to loosen surface soil and is completed with reformation of ridge using double–row ridgers.

Good machinery management requires that individual operations in a machine system must be adjusted and combined in a manner so that their overall performance returns the greatest profit to the farm business.

MATERIALS AND METHODS

Sites of the experiment

Experimental measurements were made in ratoon fields of Sennar and Assalaya sugar factories.

Implements

Six vertical shank broadcaster locally fabricated in the Sudanese sugar company; two bodies ridger and ratoon cultivator which carried out in one pass, the three operations of fertilizer application, chiseling and reformation of furrow system.

Measuring devices

1. Hydraulic pull – meter
2. Graduated measuring cylinder (100–2000 ml) for measuring fuel consumption as required during the experimental work.
3. Other simple devices used in the experimental work were a measuring tape (100 m), stop watch, fuel containers, and calculator.

Performance parameters

Main field performance parameters were implement draft, actual field capacity, fuel consumption and energy per unit area. Measurements were taken during operations in ratoon fields in the two sugar farms (Sennar and Assalaya) during the cropping seasons 2011/12 and 2012/13. Six test locations were used, in each location tests were replicated three times for local chisel, broadcaster, ridger and ratoon cultivator.

The test plot was from 16–20 furrows wide (24–30 m) and 120 – 200 m long. According to location, bottoms of the furrows were firm, nearly flat and approximately 60 cm wide. Center to Center distance of two adjacent furrows was 1.5–1.55 m.

Measurement of performance parameters

Draft requirement of each implement measured with hydraulic pull–meter. A tractor carrying an implement was pulled by other tractor with the pull–meter connected between the two tractors. The hydraulic system and the rear tractor were used to raise and lower the implement as required for normal operation, with transmission system kept neutral. In

this arrangement drawbar force for pulling the rear tractor and implement was supplied by the towing tractor.

Rolling resistance of the rear tractor was determined by pulling the tractor with the implement raised. Difference between the two measurements was the net drawbar of the implement under study.

For measuring field capacity, dimensions of the test field were measured with measuring tape and time needed to carry an operation was determined with stop watch.

Area to be plowed (m^2) = field width (m) × field length (m)

$$\text{Field} = (4200)^2$$

$$Field\ capacity\ fed/hr = \frac{area\ m^2/hr}{4200}$$

To calculate actual speed of the operation, time to travel 100m along the field was measured in seconds while the implements were working on the test plots.

$$Speed\ (km/hr) = \frac{100 \times 60 \times 60 \times 1000}{4200 \times 1}$$

Ratoon establishment methods

1. Conventional method: this consists of fertilizer broadcasting followed by six–shank chisel plowing and then ridging.
2. Combination method (R.C): In this method ratoon cultivator (R.C) was used to carry out the three operations of fertilizer application, chiseling and ridge reshaping.

Calculation

After measuring performance for the individual operation, time, field capacity and power requirement for the cultivation methods were found out by adding the values of the parameters for the component of the method. As an example, fuel consumption (L/feddan) for the conventional method was the sum of fuel consumption of fertilizer broadcasting plus that for chiseling and that for ridging operation.

The number of tractors was determined by dividing field capacity required for every operation by the measured field capacity of each operation.

Hilling up operation

Ratoon Cultivator adjustment

Ratoon Cultivator

RESULTS AND DISCUSSION

Fuel

One of the concerns in machinery is fuel consumption. Fig (2) showed that R.C has required the least fuel for ratoon establishment (2.9 L/feddan) while the conventional method consumed (8.6 L/feddan).

As it can be shown in table 7, RC reduced fuel consumption per season in Sennar by 21683 gallon in comparison with the conventional method. In terms of money, this amount was 57165 US$.

Time

The same argument was applied to the tractor time per feddan. Figure 1 showed that RC required the least time while the conventional method required the highest time to complete the same operation.

Time required by the RC was approximately one third of the time required by the conventional method which was reflected in the number of tractors required for each sugar estate to complete their seasonal schedule of work with the R.C; only two tractors were required for the operation while the conventional method required 6 tractors (Table 6).

CONCLUSION

From the present study the ratoon cultivator (R.C) showed better performance in comparison to conventional ratoon establishment method. The R.C consumed lower energy by 45.1% than the conventional method and reduced time required per feddan to complete the three operations by two thirds. This means that introduction of R.C can reduce number of tractors required for ratoon establishment by two thirds. Moreover, the R.C has the advantage of fertilizer placement near to the cane roots which is recommended by the sugarcane scientists. So, for time and power saving, the ratoon cultivator is recommended to be used for ratoon establishment in the sugarcane farms.

Table 1
Performance Parameters of Local Chisel Plow (Six–Shank)

Location	*Field Capacity (Feddan/h)*	*Speed (km/h)*	*Fuel Consumption (L/Feddan)*	*Draw bar Pull (kN)*
1	7.4	13.15	2.6	9.7
2	9.2	16.4	2.6	7.6
3	8.1	14.7	3.0	7.6
4	8.1	14.7	3.0	11.6
5	8.7	13.0	3.3	11.5
6	8.2	14.9	2.7	10.7
7	7.3	14.4	2.9	11.2
8	7.3	14.4	2.0	-
Average	8.0	14.5	2.7	-
SD	0.7	1.1	0.4	0.4

SD = Standard Deviation

Table 2
Performance Parameter of Ratoon Ridger

Location	*Field Capacity (Feddan/h)*	*Speed (km/h)*	*Fuel Consumption (L/Feddan)*	*Draw bar pull (kN)*
1	7.9	9.4	2.3	7.2
2	7.5	9.3	3.4	7.1
3	7.8	9.5	4.6	7.3
Average	7.7	9.4	3.5	7.2
SD	0.2	0.1	1.2	0.1

SD = Standard Deviation

Table 3
Performance of Fertilizer Broadcaster

Location	*Field Capacity (Feddan/h)*	*Speed (km/h)*	*Fuel Consumption (L/Feddan)*
1	8.8	18.1	2.5
2	8.7	18.4	2.3
3	8.7	18.2	2.2
Average	8.7	18.2	2.4
SD	0.05	0.13	0.13

SD = Standard Deviation

Table 4
Performance Parameters of Ratoon Cultivator (R.C.)

Location	*Field Capacity (Feddan/h)*	*Speed (km/h)*	*Fuel Consumption (L/Feddan)*	*Drawbar pull (kN)*
1	7.9	.231	3.1	**7.0**
2	7.8	15.7	3.3	**SD= 0.9**
3	8.1	15.9	.32	
Average	0.8	14.9	2.9	
SD	0.1	1.2	0.4	

SD = Standard Deviation

Table 5
Mass of Chisel Plows and Ratoon Cultivator (R.C.)

Implement	*Giad chisel plough*	*6-shank chisel plough*	*10-shank chisel plough*	*R.C.*
Mass (kg)	240	270	550	580

(R.C.) = Ratoon Cultivator

Table 6
Required number of implements for the assumed field capacity 12.5 feddan/h

Cultivation implement	*Measured field capacity (Feddan/h)*	*No. of required implements*
Fertilizer broadcaster	8.7	2
Locally Chisel plow six-shank	8.0	2
Ridger	7.8	2
R.C.	8.0	2

Note: NP: number of implements = number of required tractors.
(R.C.) = Ratoon Cultivator

Table 7
Total Fuel Requirements for Ratoon Establishment Operations Per season for Sennar

Cultivation methods	*Fuel consumption*	
	L/feddan	*Gal/feddan*
Conventional	146200	32489
R.C.	53720	11939

(R.C.) = Ratoon Cultivator

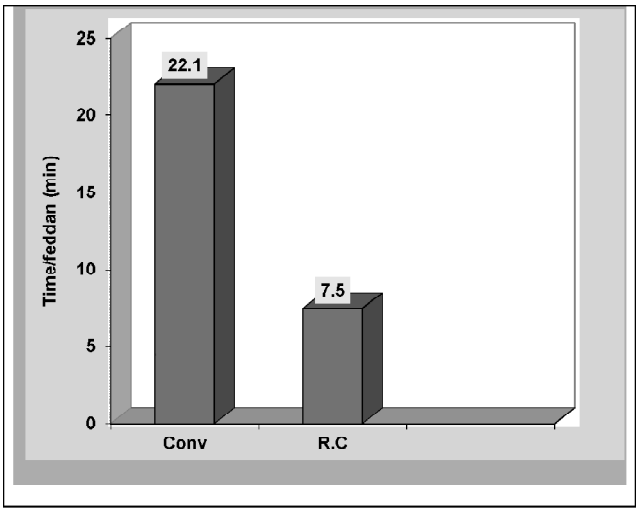

Figure 1: Time required per feddan for the cultivation method

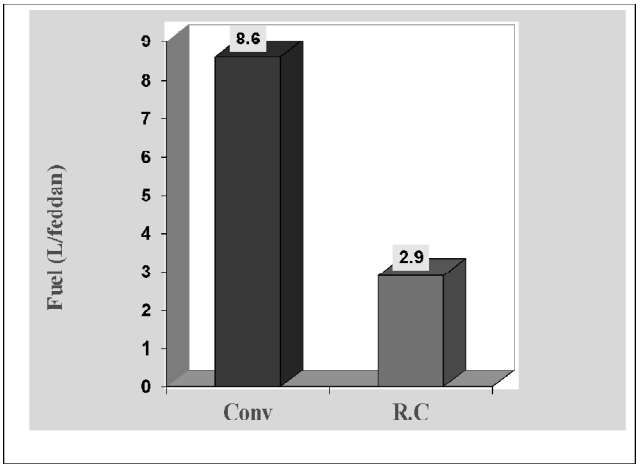

Figure 2: Fuel consumption for the cultivation method

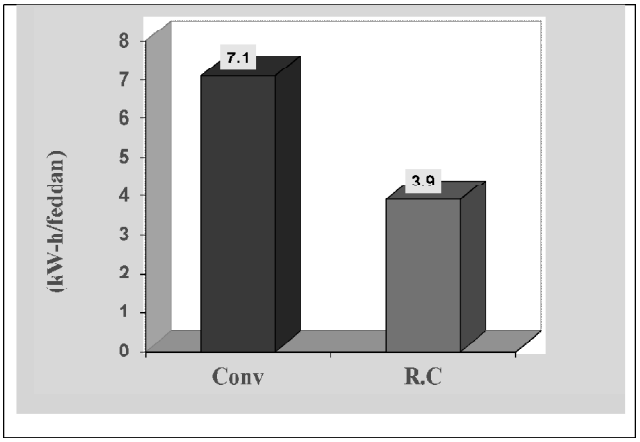

Figure 3: Energy requirement for the cultivation method