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PERFORMANCE EVALUATION OF SELF – PROPELLED FODDER CUTTER BAR TYPE HARVESTER FOR SUDAN AND BERSEEM HARVESTING

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Abstract: 3LD-450S Self-propelled cutter bar type fodder harvester was described to save time constraints and reduce the cost of harvesting operation of berseem and Sudan by mechanization. This Self-propelled cutter bar type fodder harvester was studied to recommend the appropriate system for Berseem and Sudan harvesting. The system was evaluated according to the technical parameters: operating speed, actual field capacity, and theoretical field capacity, field efficiency, height of cut, fuel consumptions and cost economics. The actual cutting width of the fodder harvester was 1.2 m. In this study, performance of Self-propelled cutter bar type fodder harvester used for berseem and sudan harvesting was assessed and compared with manual harvesting using sickle. The results showed that the actual field capacity of the fodder harvester was 0.24 ha/h at 2.5km/hr and for sudan it was .23ha/hr at 2.5 km/hr. Labor requirements for berseem fodder harvester and manual harvesting were 4 and 13 man-h/ha, respectively and for sudan it was 4 and 13 man-h/ha. For berseem harvesting the fuel consumption, operating speed and field efficiency were 0.35 l/h, 2.5km/h, 80% respectively. For sudan harvesting the fuel consumption, operating speed and field efficiency were 0.49 l/h, 2.5 km/h, 78.75% respectively. Cost of harvesting for berseem and sudan was ₹995.58/ha and ₹1002.54/ha. Statistical analysis and graphs produced from collected data showed that the operating speed had considerable effect on actual field capacity, field efficiency, no. of uncut plant and fuel consumption parameters.

Keywords: Self-propelled cutter bar, Sudan, Berseem, Fodder Harvester, Performance.

I. Introduction

It has been pointed out in the past that the ultimate goal of a farm business is to maximize its profit return (*Hunt, 1995a*). The use of agricultural machinery represents a major cost in the production of agricultural crops (*Buckmaster, 2003*). If farm managers are going to accurately plan and budget both time and money for the completion of farm operations, they must have access to appropriate machine performance data to determine machinery related costs (*Hassan & Larson, 1978*) and machine performance characteristics.

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Berseem (*Trifoliumalexandrinum*) is important winter forage, which plays a very vital role in stabilizing the fodder crop production in country from past many of the years. Berseem is a fast growing, high quality forage that is mainly cut and fed as green chopped forage. It is quite nutritive and succulent. It has 20% crude protein and 70% dry matter digestibility

Sudan Grass (*Sorghum vulgare var. sudanense*) is an annual forage grass native to areas throughout Africa and southern Asia. This is a valuable forage plant. Sudan grass grows from 4 - 7 feet tall, has leaves about 1/2 inch wide and stems about1/4 inch in diameter. It can be harvested as pasture, green chop, hay, or silage. Yields have ranges from 3 - 5 tons/acre dry matter. It can be ready for harvest about 45 days after planting.

Harvesting methods being used are manual harvesting and mechanical harvesting. The most farmers use manual harvesting with sickles which consumed more time and labor and then more cost requirements. To overcome these problems, mechanical harvesting is required to minimize quality deterioration and to maximize field capacity and efficiency and also save total cost requirements. The use of a large scale machine is inappropriate because it needs high technical experience for operation and maintenance and the large investment necessary. And then, field efficiency is low in small holdings.

So, the use of mechanical fodder harvester is appropriate for small holdings, the large investment unnecessary and low technical operation and maintenance experience. Fodder harvester is a fodder harvesting machine which reaps fodder mechanically and lays down the stems, providing an alternative to using laborers to gather in crops by hand at harvest time. In this study, fodder harvester 3LD-450S is mainly described.

Objectives of proposed works

The objectives of the study were as follows:

- To conduct field performance evaluation of Self Propelled Fodder Harvester for Berseem and Sudan crops.
- To calculate the cost economics of Self Propelled Fodder Harvester for berseem and Sudan crop.
- To compare the cost of operation of Self Propelled Fodder Harvester with traditional method.

II. Materials and methods

Description of Self-Propelled cutter bar type fodder harvester.

The riding type self-propelled cutter bar type fodder harvester is powered by a 7.5KW/10.2HP ,single cylinder ,air cooled diesel engine having rated engine speed of

3000rpm.It is provided with three pneumatic wheel in which two driving wheel in the front having agricultural tread pattern tires and one steering wheel at the rear having automotive type tire. Other system include clutch, brakes, steering and power transmission and operator seat are available to make the machine riding type. The width of cutter bar is 1.20m.

Table 1. Technical specification of self-propelled fodder cutter bar type harvester.

S. No.	Parameters	Specification
1	Manufacturer	BCS
2	Model	3LD-450S
3	Country of origin	Italy
4	Working capacity	0.4ha/ha
5	Gears	4 forward, 1 reverse
6	Weight	300kg
7	Power	10.2
8	Bore(mm)	85
9	Stroke	80
10	RPM: low & high	1150 & 3000
11	Air cleaner	Oil bath type
12	No. of Blade	17, serrated
13	Crops	Berseem, sudan, mentha, lucern

FIELD PERFORMANCE TEST

The field performance of the self-propelled fodder harvester was undertaken in the month of December, January and April. The harvester from SHIATS Allahabad was taken to the field. The land chosen for the field performance had a standing crop of Berseem and Sudan. The performance was done at full maturity of the crop.

Field Preparation

The different experiment plots were selected. For this purpose, four plots has been selected of same area (i.e. 600m^2) for berseem and 4 plots for Sudan of same area. These plots were named as A, B, C and D. one row of crop was harvested manually along the length of the field so that the crops could fall down properly on the ground.

EVALUATION OF FIELD PERFORMANCE OF A FODDER HARVESTER

The performance of fodder harvester was evaluated in the berseem and sudan field. Cutting mechanism consist of reciprocating knife wherein its movement is controlled by the crank connected to the gear box.

A. Operating Speed

On the outside of the long boundary of the test plot in field operation, two poles 20 m apart (A, B) are placed approximately in the middle of the test run as shown in Fig 1.

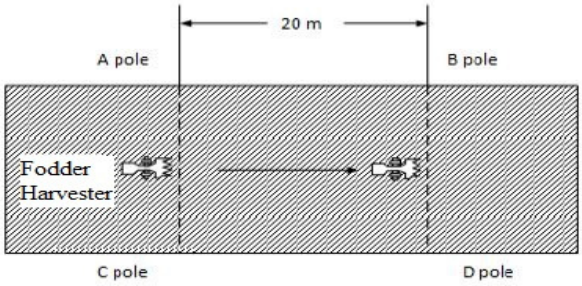

Fig. 1 measurement of operating speed

$$\textbf{F}\text{orward speed (m/s)} = \frac{\text{Distance (m)}}{\text{time (s)}}$$

B. Fuel Consumption

Fuel consumption, in litres per hour (L/h), is the amount of refueling for the test. In this method, before the start of each test trial, the fuel tank shall be filled to its capacity and after each test trial; the tank shall be refilled using graduated cylinder. When filling up the tank, keep the tank horizontal so as not to leave empty space in the tank.

$$Fc = \frac{q}{\text{t}}$$

Where:

Fc = Fuel consumption, l/h

q = quantity of fuel consumed, li

t = consumption time, hr

C. Actual Field Capacity

Actual field capacity, actual rate of being able to reap crop, was calculated based on area covered, and actual time. The actual time pertains to the total operating time which includes the time spent for turning at the headland, adjustment of machine and machine trouble.

$$\text{FCA} = \frac{\text{AT}}{\text{To}}$$

Where:

FCA = actual field capacity, ha/h

AT = area covered during test, ha

To = total operating time, h

D. Theoretical Field Capacity

Theoretical field capacity, computed rate of being able to reap crop, was calculated based on the operating speed and the width of the equipment.

$$FCT = \frac{So \times Wc}{10}$$

Where:

FCT = Theoretical field capacity, ha/h

Wc = Cutting width, m

S0 = Operating speed, km/h

E. Field Efficiency

Field efficiency is the ratio of the actual field capacity and theoretical field capacity, expressed in percent

$$E = \frac{FCA}{FCT}$$

Where:

E = Field Efficiency, %

FCA = Actual field capacity, ha/h

FCT = Theoretical field capacity, ha/h

III. Results and Discussions

Berseem and Sudan was harvested using 3LD-450S fodder harvester. Performance data were collected to operating speed, field capacity, field efficiency, losses due to machine operation, fuel consumption and labor requirement. The operating speed of harvester could be varied from to 1.5 to 2.5 kmph, average operation width of the harvester was found to be 119.5cm working of harvester found to be optimum at the speed of 2.5kmph.The loss as uncut plants on percentage basis was found to be 0.77 to .80 and .78 to .785 percent for berseem and Sudan respectively which was not very significant.

According to berseem and sudan density, both fodder was harvested at different operating speeds for checking reaper motion resistance, running conditions and harvesting quality. The operating speed was higher in low density and lower in high density. The harvester shall be operated at the speed of 1.5 km/h to 2.5 km/h. At operating speeds greater than 2.5 km/h, blockage was noticed on the cutter bar unit due to the high density of the berseem and sudan and insufficient engine power. To prevent blockage, harvesting was performed at operating speeds less than 2.5 km/h. The theoretical field capacity increased and the fuel consumption increased as operating speed increased. In addition, at high operating speeds, the field

efficiency decreased because of blockage. The fuel consumption with fodder harvester harvesting varied from 0.36 liters per hour to 0.49 and .35 to .48 liters per hour for Sudan and Berseem respectively at different operating speeds.

The field efficiency of the harvester varied from 73% to 79% and 72% to 78% for berseem and Sudan respectively. This field efficiency is the higher side as compared to the results of other research workers

The total labor requirement with fodder harvester harvesting was 30.4, 22, 17.3 man-hours per hectare at 1.5, 2.0, 2.5 kmph speeds respectively for berseem.

For Sudan, the total labor requirement with fodder harvester harvesting was 32, 23.48, 17.3 man-hours per hectare at 1.5, 2.0, 2.5 kmph speeds respectively

For Berseem, the cost of harvesting with fodder harvester was only ₹ 995.58 to ₹ 1754 at different speeds and with manual method, this cost was ₹ 8160.

For Sudan, the cost of harvesting with fodder harvester was only ₹ 1002.54to ₹ 1798.68 at different speeds and with manual method, this cost was ₹ 8160

The Statistical analysis were conducted using three different operating speed of fodder harvester to quantify the impact on fuel consumption, actual field capacity, field efficiency and cost of operation.

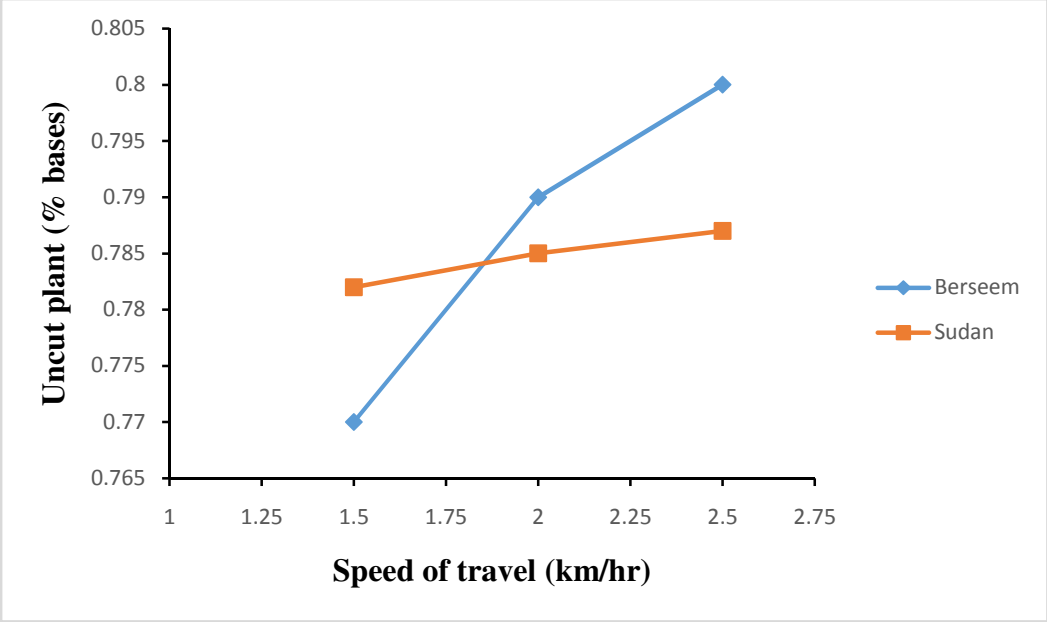

Fig. 2 Effect of forward speed on uncut plants for berseem and Sudan

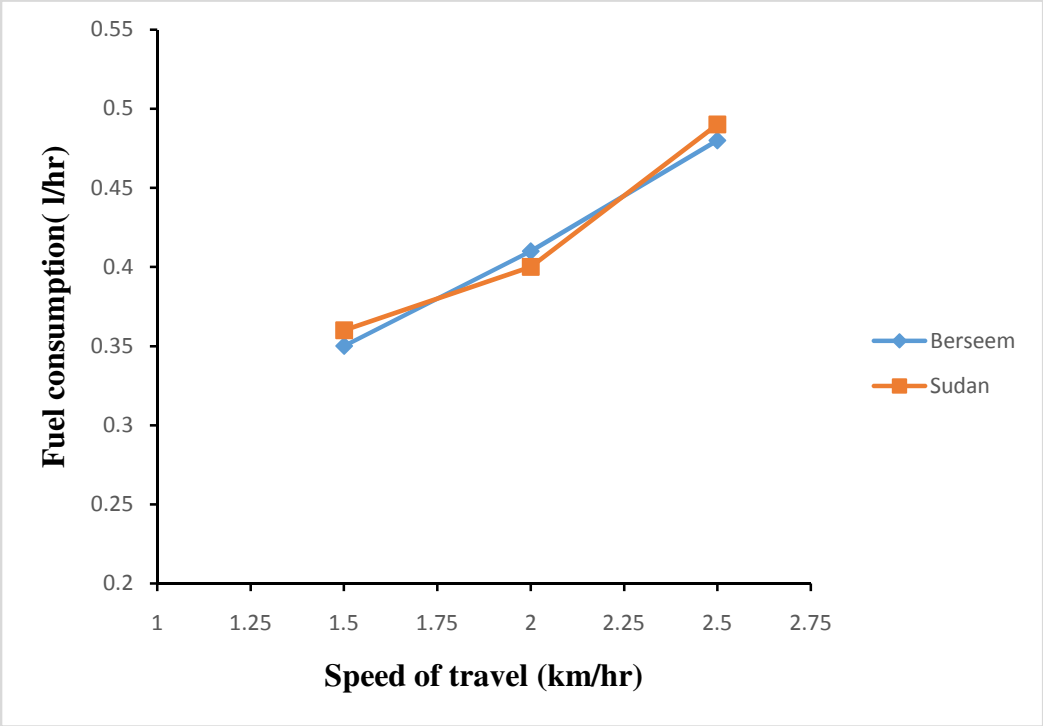

Fig. 3 Effect of forward speed on fuel consumption

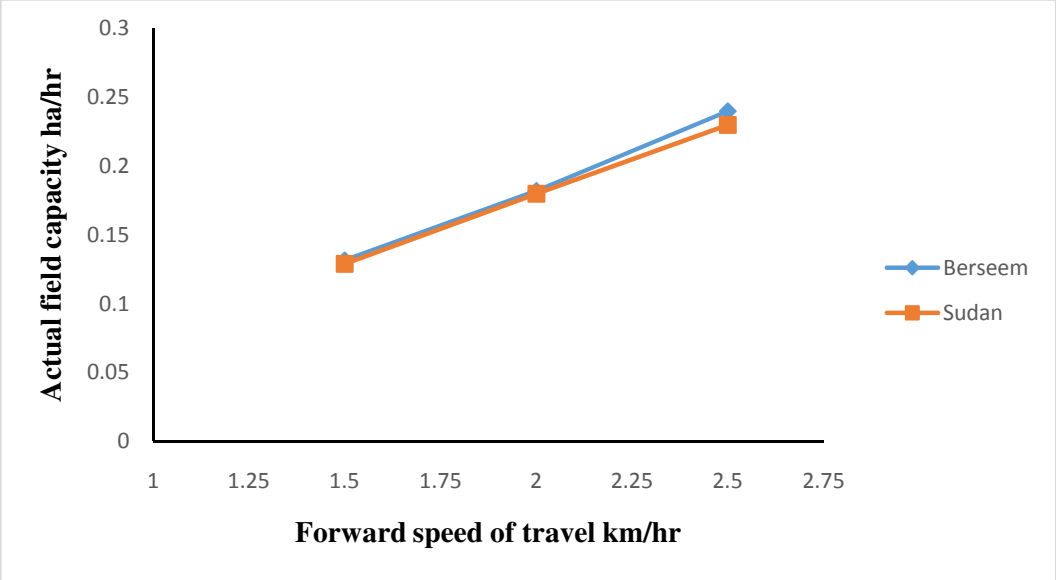

Fig. 4 Effect of forward speed and different crop on Actual Field Capacity

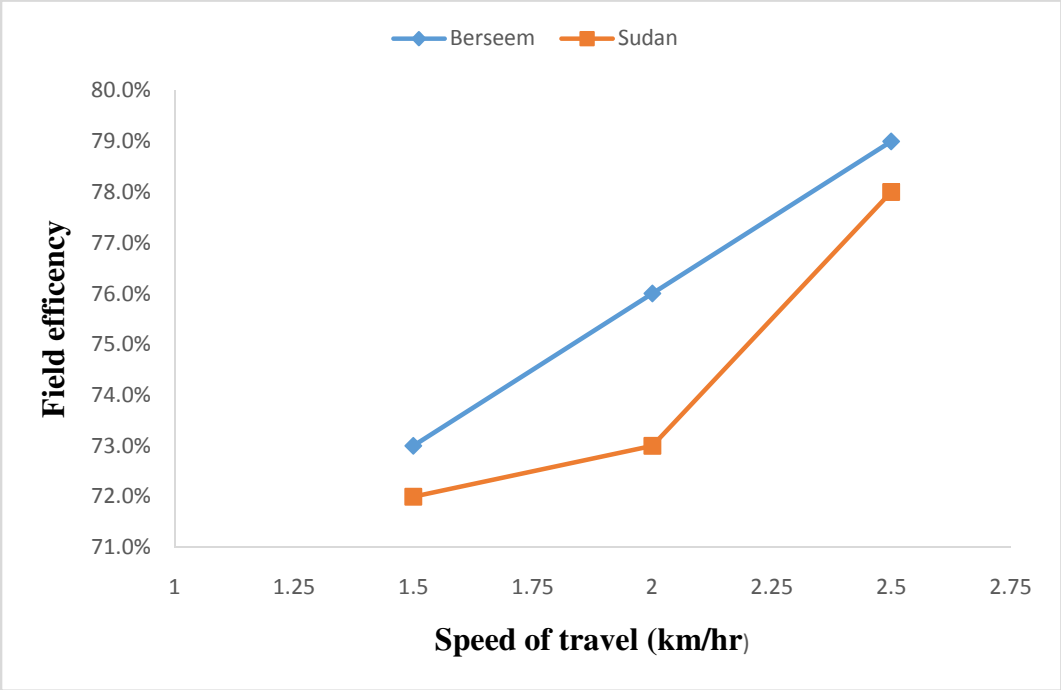

Fig. 5 Effect of forward speed and different crop on efficiency

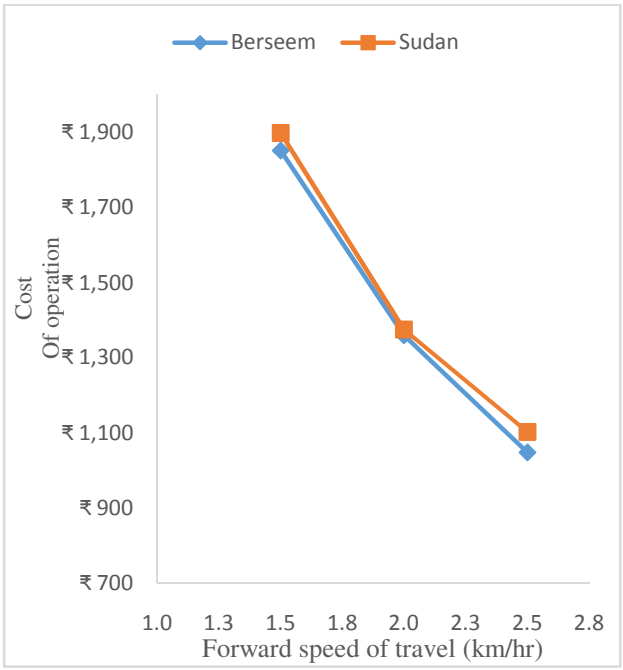

Fig. 6 Effect of speed on cost of operation for berseem and sudan

Table 2. Results of analyses of variance for Efficiency (Berseem Harvesting)

	df	*SS*	*MSS*	*Fcal*
Speed	2	0.00785	0.003925	5.28*
Area	3	0.003467	0.001156	1.546
ERROR	6	0.004483	0.000747	
TOTAL	11	0.0158		

Table 3. Results of analyses of variance for actual field capacity (Berseem Harvesting)

	df	*SS*	*MSS*	*Fcal*
Speed	2	0.0184	0.0092	43.77*
Area	3	0.0010	0.0003	1.64NS
ERROR	6	0.0012	0.0002	
TOTAL	11	0.0207		

* *Significant at 5% level.*
NS *Non Significant*
$F_{(2, 6)} = 5.143253$
$F_{(3, 6)} = 4.757063$

Table 4. Results of analyses of variance for fuel consumption (Berseem Harvesting)

	df	*SS*	*MSS*	*Fcal*
Speed	2	0.030017	0.015008	52.45*
Area	3	0.000633	0.000211	0.73 NS
ERROR	6	0.001717	0.000286	
TOTAL	11	0.032367		

Table 5. Results of analyses of variance for Efficiency (Sudan Harvesting)

	df	*SS*	*MSS*	*Fcal*
Speed	2	0.0095	0.00475	5.47*
Area	3	0.0039	0.00131	1.5 NS
ERROR	6	0.0052	0.00086	
TOTAL	11	0.0186		

Table 6. Results of analyses of variance for A.F.C (Sudan Harvesting).

	df	*SS*	*MSS*	*Fcal*
Speed	2	0.021505	0.010753	224.4*
Area	3	0.000282	9.41E-05	1.5 NS
ERROR	6	0.000287	4.79E-05	
TOTAL	11	0.022075		

Table 7. Results of analyses of variance for fuel consumption (Sudan Harvesting).

	df	*SS*	*MSS*	*Fcal*
Speed	2	0.0346	0.0173	93*
Area	3	0.000558	0.000186	1 NS
ERROR	6	0.001117	0.000186	
TOTAL	11	0.036292		

SS= Sum of squres
Df= Degree of freedom
MSS= Mean sum of Squares
F_{cal}= F calculated

From the ANOVA table 2 and 5 it is evident that the calculated value of F due to speed is greater than the tabulated value (Ftab) at 5 percent significance level for both Berseem and Sudan respectively. Therefore the significant effect of speed on efficiency of Speed was observed at various speed.

From the ANOVA table 3 and 6 it is evident that the calculated value of F due to speed is greater than the tabulated value (Ftab) at 5 percent significance level for both Berseem and Sudan respectively. Therefore the significant effect of speed on actual field capacity was observed at various speed.

From the ANOVA table 4 and 7 it is evident that the calculated value of F due to speed is greater than the tabulated value (Ftab) at 5 percent significance level for both Berseem and Sudan respectively. Therefore the significant effect of speed on fuel consumption was observed at various speed.

Conclusion

The overall performance of reaper was quite satisfactory. The average field efficiency and actual field capacity was found 78 to 80% and 0.23 to 0.24ha/h respectively. The price of fodder harvester ₹230000. The maximum area on which the reaper operated in a year 120

hectares. The cost of manual harvesting was ₹8160/ha as against ₹1350/ha in the case of mechanical harvesting for berseem and for sudan it was ₹1380/ha. Thus the cost of harvesting with manual method for Berseem and sudan is 6.0 and 5.9 times respectively costlier than the mechanical harvesting. The farmers are convinced that the harvesting of fodder by fodder harvester is much faster than manual cutting by sickle. So, self-propelled fodder harvester is more suitable for farmers. The operation was smooth, without noise and any exhaustion to the operator. Therefore, the farmer or labor in agricultural field is very comfortable for harvesting with machine.

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