ISSN 2347-4289

Development And Performance Evaluation Of Low-Hp Tractor Operated Stubble Shaver-Cum-Off Barring Implement With Fertilizer Metering For Sugarcane Crop

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Abstract: The implement was developed, designed, fabricated and tested for cutting stubbles of sugarcane, to enhance the productivity of sugarcane in Maharashtra State based upon RCS, CCS, DCM and SCM. Therefore Rotating Cutting System and Disc Cutting Mechanism was chosen because are applicable for cutting all of sugarcane stubbles have more than 2 cm diameter, cutting force was 31 N mm-1 with 2.90 m s-1 blade linear velocities had been taken. Result of the tests showed that the average effective field capacity was 0.442 ha h^{-1} with 81.97% field efficiency, 99.10% sugarcane stubbles cutting efficiency, 17.50 cm depth of off-barring operation, 15.92 cm depth of fertilizer placement, 11.70 cm distance of fertilizer placement away from crop. The operation cost was Rs. 533.70 ha^{-1} there was a net saving of Rs. 5446 ha^{-1}over conventional method.

Keywords: Ratoon Sugarcane Management, Development, Design, Fabricate, Device, Low-hp Tractor

1 INTRODUCTION

Sugarcane (Saccharam officinarum L.) is a cash crop mostly grown in tropical and subtropical areas of the world. India is one of the most important countries of sugarcane production in the world. Sugarcane crop is pride of Maharashtra State and plays a vital role in the socio-economic transformation of the state. There are four sugarcane cultivation types prevalent in Maharashtra State (Adsali, Pre-seasonal, Suru and Ratoon), Ratoon sugarcane is most popular with 50 to 55% cane area under it [1], Ratooning is a planting method for saving seedbed preparatory cost. It also extend the crushing period of sugar mills [2], Ruther ratoon cane reduces the frequency of soil preparation for stabilizing a new crop with the consequent reduction in inputs and soil erosion [3], Ratooning as a practice of growing full crop of sugarcane from sprouts of underground stubbles left in the field after harvesting of the previous maiden crop [4], Ratoonability was an important trait in sugarcane varieties hence, selection in ratoon seedlings was warranted, particularly in sub-tropical countries where seedlings remain immature at the time of next season's planting and hence, may not express their full potential [5], Cane crops as well as ratoons both are highly exhaustive crop having higher demand for nitrogenous fertilizer because of shallow root system, decaying of old roots, sprouting of stubble buds and immobilization of nitrogen. Ratooning management operations viz. stubble shaving, off-barring, fertilizer application, interculturing, trashing, etc. are extremely effective for achieving higher yield and quality of sugarcane [6], Tractor mounted ratoon management device was useful since it carried out stubble shaving, tilling, off-barring, and earthing up in one or two passes. The stubble is cut by a sharp edged concave spinning disc. The device could drill FYM and fertilizer simultaneously. An acre of ratoon field can be covered in about 1 to 1.5 h by using this implement as against 6 h when done manually [7], Low-hp tractor drawn sugarcane earthing up-cum-fertilizer applicator was developed at MPKV, Rahuri the implement has 0.330 ha h^{-1} average effective field capacity, 82.70% field efficient, 10.20 cm depth of operation, 22.35 cm ridge height, depth of fertilizer placement 8.25 cm and 10.73 cm away from the crop, 1.117% of plant damage. Cost of operation was Rs. 237.39 ha^{-1} with net saving Rs. 3261.61 ha^{-1}over conventional method [8].

Fig (1) *Sugarcane Field before ratoon operation*

2 THE OBJECTIVE OF THIS RESEARCH

To develop and performance test and evaluation of low-hp tractor operated stubble shaver-cum-off barring implement with fertilizer metering for sugarcane crop

3 MATERIAL AND METHOD

The implement formed from three main unit viz. cutting blade, off-barring and fertilizer metering unit as shown in Fig (4). The design of cutting system for sugarcane stubbles based on rotating cutting system (RCS) i.e. with impact and by shear method. CCM, DCM, SCM system have been consider as base, maximum cutting force was 31 N mm^{-1} (based on harvesting of sugarcane with 87% moisture) [9], blade linear velocities between 4 to 9 Km h^{-1}. Four blade fitted on flange and Off-barring operation done by two reverse shovels. Also the implement drill fertilizer all this operation done in one passes. The prototype developed at Laboratory of Technology, Depart. Of Farm Machinery and Power at Dr. A.S. College of Agril. Engg. MPKV Rahuri and field tests were conducted in Shrirampur, Ahmednagar Dist. The implement consists of horizontal cutting disc blade mounted on vertical drive shaft, the disc are fitted with four cutting blade driven by shaft run through gear-box which is mounted rigidly on the main frame in such a way that the shaft converts rotational motion from the horizontal to the vertical direction, connect with tractor PTO shaft with helping of universal joint then mounted on 25-hp tractor using the three point linkage. The operator rides the tractor and uses the hydraulic control lever coupled with three-point linkage to raise the implement to transport position. The field test were conducted as per RNAM test code, Off-barring operation was done by two tynes which cut shoulders and trim the old roots of ratoon on both sides of ridge and inverting, pulverizing and breaking the compacted sub soil layer. The fertilizer is placed behind the tynes, the rotors for fertilizer metering are fitted on the common shaft which gets rotation from the ground wheel with the help of chain and sprocket. The fertilizer flows by gravity from main box to auxiliary chamber, the cups on the periphery of the rotor lifts the fertilizer from auxiliary chamber and delivers to the inlet of fertilizer tube. Therefore, placed in the root zone of the sugarcane crop. Thus, some parameters were recorded as follows;

Fig. (2) *Sugarcane field after ratoon operation*

1. Dynamometer gauge: The hydraulic dynamometer was used for measuring the draft power which is required for pulling the implement.
2. Torque sensor: The sensor was used for measuring torque power by installing on middle of the blade shaft. It was connected to the strain amplifier.
3. Digital tachometer: Digital tachometer was used for measuring rotational speed of tractor PTO.
4. Stopwatch: Stopwatch of 0 - 60 min with least count of 0.5 sec. was used to record the travel speed during the test.
5. Measuring scale and measuring tapes: A tape of 30 m and steel tape of 3 m were used for measuring the size of field and the dimensions of the equipment, width of cutting and scale for depth of the cutting etc.
6. Weighing balance: A weighing balance of 0 to 1.0 kg with a least count of 1.0 gm was used for measuring the weights of the fertilizer during the calibration and field test of the implement.
7. Measuring cylinder: Measuring cylinder of 0 to 0.5 lit with a least count of 10 ml was used for measuring the fuel consumption of tractor during field test.
8. Soil sample boxes: Soil samples were collected in boxes for the determination of moisture content of the sample at randomly selected spots.

Fig (3) *Ratoon Implement front view*

3.1 Calculation of cutting blade development;

1. Blade Length (Lb), mm = $V \times \pi \times {}^{D}/_{V_m}$
2. No. of blade on disc = $Z = 2\pi \times {}^{h}/\left(L_b \frac{V_c}{V_f} - 2A\right)$
3. Cutting capacity (No. Stubbles h^{-1}) = Cp = $\frac{\text{No.of sugarcane stubble (S)}}{\text{Time (h)}}$
4. Cutting efficiency, (%) = Ef = $\frac{\text{Cp}}{\text{Theoretical cutting capacity}} \times 100$
5. Width of cutting = W = Zf–2d tan ∅s
6. Percentage of damage stubble = $\frac{\text{No.of damage stubbles after cutting (D)}}{\text{No.of stubbles befotre cutting (S)}} \times 100$
7. Force required to cut stubble is evaluated from the analysis of the force acting on the stubbles and angle of internal friction. These forces acts on the stubble

along perpendicular and parallel axis to the surface of the blade can be calculated as under:

Power at cutting shaft (KW) = P = $^{2\pi TN}/_{60000}$ [10]

8. Specific energy consumption requirement per output capacity = SEC = $\frac{W-h}{No.\ Stubbles}$ or $\frac{Kw-h}{No.\ Stubbles}$

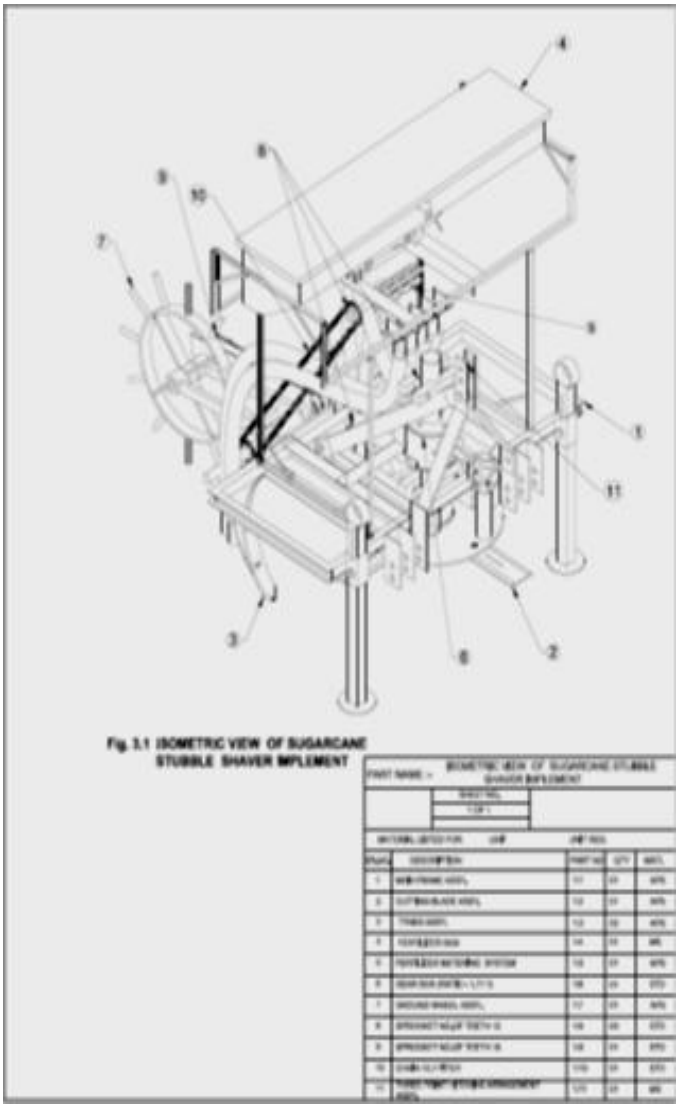
9. Percentage of tillering, % = $\frac{\text{Survived plant after month of ratooning (A)}}{\text{Total Ratoon Cane (B)}}$

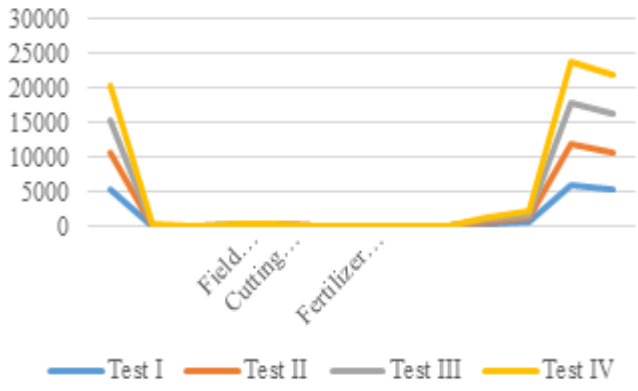
TABLE (1) IMPORTANT operation PARAMETERS

Parameters	
V	Forward speed of drive, ms^{-1}
D	Outter diameter of flange or disc of blade, mm
V_m	Speed of cutting unit, ms^{-1}
Z	Number of blades,
h	Maximum depth of operation,
L_b	Blade length, mm
A	Blade thickness, mm
V_f	Forward speed, ms^{-1}
P	Power at cutting shaft, kW
T	Torque requirement, N_{-m}
N	Shaft speed

4 Result and discussion

The result obtained from the field performance showed that the forward speed of the tractor was ranged from 4.13 to 4.86 Km h^{-1} while rotational speed was 540 and 1000 rpm, soil moisture content was 27.36%, ratoon sugarcane row spacing 120 cm, effective field capacity was 0.442 ha h^{-1}, field efficiency was 80.50%, average torque was recorded 20.60 Nm, Average number of stubble per sq.m. ranged from 22 to 25 numbers. Results of tests indicated that the value of torque was dependent on levelling of soil, depth of cutting, number of stubble per sq.m. and soil moisture content. Torque was increased due to depth of cutting, number of stubble per sq.m. and sugarcane trash on the field the result near to Javad et al., [11] The profile of furrow before and after stubble shaving operation was measured. Result of field test were showed that the developed prototype for sugarcane stubble shaving device could operate well and give satisfactory cutting. It was observed during field experiment that higher rotation of disk cutter give a better result of cutting as compared to lower rotational speed corresponding with [12], It is clear that higher rotational speed will have smaller “clip of cut” and cutting pitch. The efficiency of work also depends on the skill of tractor operator. Width of cutting was measured by recording ten observation from stubble per sq.m. before and after operation randomly as given in Table (2). The measurements of off-barring operation was in the range of 21.9 to 26.5 cm depth with average depth of 24.6 cm.





The performance of Low-hp Tractor Operated Stubble Shaver-cum-Off Barring Implement with Fertilizer Metering for Sugarcane Crop

Table (2) *Test Result Of Field Performance Evaluation Of Low-Hp Tractor Operated Stubble Shaver-Cum-Off Barring Implement With Fertilizer Metering For Sugarcane Crop.*

Sr. No.	Parameters	Test I	Test II	Test III	Test IV						
1.	Area covered, m2	5280	5250	4840	4998						
2.	Width of operation, cm.	45.87	45.25	45.34	45.55						
3.	Speed of operation Km h-1	4.132	4.182	4.672	4.448						
4.	Field efficiency, %	81.855	82.218	82.877	80.935						
5.	Cutting efficiency, %	98.93	98.93	98.93	98.93						
6.	Depth of operation, cm	16.85	16.85	18.15	18.15						
7.	Fertilizer placement from crop, cm	11.027	11.027	11.110	11.110						
8.	Stubble damage, Nos. m-2	1.405	1.405	1.074	1.074						
9.	Fuel consumption, lit ha-1	3.938	3.944	2.998	2.980						
10.	Draft required, Kgf	298.35	298.35	297.28	297.28						
11.	Operating cost, Rs ha-1	590.48	571.78	476.01	496.54						
12.	Total operating cost by local method, Rs ha-1	5980	5980	5980	5980						
13.	Net saving, Rs ha-1	5389.52	5408.22	5503.99	5483.46						

4 CONCLUSION AND RECOMMENDATION

The low-hp tractor operated stubble shaver-cum-off barring implement with fertilizer metering for sugarcane crop was designed, developed and tested well in the field, it is a useful device since it carried out stubble shaving, off-barring and fertilizer application. From performance and evaluation of such Implement concluded that;

1. Cutting blade has blade disc with 310 mm diameter and four bottom blades with 269 x 90 x 89.5 mm size, it was made from high carbon steel, that achieved a proper cutting for sugarcane stubble by impact force it can be increased to 6 blades to reduce the cutting pitch
2. The off-barring operation had been done by two double point shovel with 200 x 80 x 8 mm dimension for shovel, it was made from high carbon steel. It is a bear that reversing of soil and trimming of old roots of sugarcane stubble was optimum, but the clamps need to extend 500 mm to reduce the resistance and distributing the force.
3. The average operating cost of the low-hp tractor operated stubble shaver-cum-off barring implement with fertilizer metering for sugarcane crop was Rs. 235 h^{-1} and Rs. 534 ha^{-1} against Rs. 5980 of conventional method. Therefore, by using this Implement and Low-hp tractor in field of sugarcane it will enhance the production of sugar in the State
4. Overall saving over conventional method for new developed was Rs. 5446.30 ha^{-1}, it is a profitable for sugarcane growers
5. The overall weight of the implement was 260 kg. easy in operation and suitable for Low-hp tractor has 20 to 25 hp. Thus, it is expected that the low-hp tractor demonstrated well in sugarcane field and it will be able to work under different farm conditions in Maharashtra state.

5 ACKNOWLEDGEMENT:

I will be failing in my duties if I did not thank the foundation “MWALIMU NYERERE AFRICAN UNION SCHOLARSHIP SCHEME AFRICA-INDIA FELLOWSHP PROGRAMME AS WELL AS ICAR, NEW DELHI” which helped study in India and granted a substantive subsidy for this degree. Without their contribution, it would not have been possible to execute this research.

6 REFERENCE

[1] Himanshu Thakkar (2013). How efficient is Maharashtra sugarcane crop?. South Asia Network on Dams, Rivers and People.

[2] R. S. Verma, R. L. Yadav (1988). Intercropping in sugarcane for improving stubble sprouting under low temperature conditions in subtropical India. Bharatiya Sugar 13, 45–48.

[3] R. Lal (1998). Soil erosion impact on agronomic productivity and environment quality. Critical Reviews in Plant Sciences. Vol. 17 (4): 319 – 464.

[4] R. L. Yadav, S. K. Shukla, A. Suman, P. N. Singh (2009). Trichoderma inoculation and trash management effects on soil microbial biomass, soil respiration, nutrient uptake and yield of ratoon sugarcane under subtropical conditions. Biology and Fertility of Soils Vol. 45, 461–468.

[5] Ram Bakshi, B. S. Chaudhary, S. Singh (1997). Response to indirect selection in ratoon of sugarcane seedling. Australian Journal of Agricultural Research, Vol. 48: 207 – 13.

[6] M. Lal, A. K. Singh (2008). Multiple ratooning for high

cane productivity and sugar recovery. Proceedings of National Seminar on Varietal Planning for Improving Productivity and Sugar recovery in Sugarcane. P.P. 62 – 68.

[7] IISR News Letter (2011). Ratoon Management Device (RMD) for enhancing ratoon cane yield. IISR Newsletter No. 18 No. 2 India Institute of Sugarcane Research, P.O. Dilkusha, Luchnow – 226002. 18, 2.

[8] S. Y. Pachpute, V. M. Kadu, S. V. Rane, P. U. Shahare, P. T. Kolekar, J. S. Deshpande (2006). Development of low-hp tractor drawn sugarcane earthing up-cum-fertilizer applicator suitable for wide row sugarcane crop. Unpublished M.Tech. (Agril. Engg.), thesis, MPKV, Rahuri.

[9] Makarand Patil, P. D. Patil (2014). Optimization of blade angle for cutting system of sugarcane harvester. Shri Jagdish Prasad Jhabarmal Tibrewala University Jhunjhunu Raajasthan. P. S.G.V.P. Mandal's D.N. Patel College of Engineering, Shahada, Dist: Nandurbar. International Indexed & Refereed Research Journal, March, 2013, ISSN 0975-3486, (Print), E-ISSN- 2320-5482, RNI- RAJBIL- 2009-30097, VOL- IV * ISSUE -42

[10] D. Hunt, (1995). Farm Power and Machinery. 9th Edition, Iowa State University Press. Ames, Iowa.

[11] T. Javad, A. Reza, J. Ali (2012). Effect of sugarcane stalks' cutting orientation on required energy for biomass products, Department of Agricultural Machinery Engineering. Faculty of Agricultural Engineering & Technology University of Tehran. International Journal of Natural and Engineering Sciences 6 (3):47-53

[12] P. A. S. Radite and Nengah Suastawa (2009). Development of powered disk type Sugarcane stubble saver, jTEP JURNAL KETEKNIKAN PERTANIAN, Vol. 23. No.1, April 2009.