Review Article

PERFORMANCE EVALUATION OF MAIZE COB HARVESTER IN CHHATTISHGARH

Abstract

Maize is one of the vital crops after rice and wheat in India and is a widely produced cereal. Maize contributes only 2.4 percent of total world production. Maize occupied 22.98 lakh hectares, with a production of 36.61 MT in India. The average yield per hectare during 2020-21 was 2804 kg per hectare. The performance of the maize cob harvester was tested to know the effect of three independent parameters like forward speed of operation (1.7 km/h, 1.9 km/h, 2.1 km/h), snipper speed (55 m/min, 62 m/min, 68 m/min), Variety of maize crop(Dhania-9965, Sartaj-765, D-9081) on different dependent parameters like stripping loss, ratio of stem length before and after harvesting, number of cobs per hours, weight of cob per hours, cob cutting length and machine parameter like actual field capacity, field efficiency and fuel consumption. It was also observed that the machines work satisfactorily at forward speed 1.9 km/h and snipper speed 62 m/min. crop parameters stripping losses 0.197%, ratio of length of stem before and after harvesting are 825 mm and 113.33 mm respectively, number of cobs per hours 2965 cobs, weight of cobs per hours 565 kg, length of cut (stalk) 13 mm and machine parameter actual field capacity is 0.081 ha/h, field efficiency 75.7%, fuel consumption 1.22 l/h.The cost of operation of machine was found as Rs.337.65 per hour, breakeven point was found as 149.64 h and payback period was 2.5 years (approx.) The total output of machine is 75 q/ha.

Keywords:*Maize cob harvester;Stripping loss;Snipper speed; field efficiency; Stem length; length of cut (stalk).*

INTRODUCTION

Maizeis a native crop of America. During the 17th century, Portuguese traders introduced it to India. It is grown during the entire year in various parts of the country.The main growing season in northern India is the kharif (monsoon) season. But since the environment is warm at every year, maize can be planted there anytime during April and October. The optimal temperature for germination is 21°C, and the ideal temperature for growth is 32°C. It rises in

height from sea level to 3000 metres. It can also be grown on a variety of climatic conditions (Anonymous, 2021-22).Maize (*Zea mays L.)* is a coarse cereal and is the staple food in many developed countries. It is also an important input for many industrial products. The area under maize in India is 23.10 million tonnes with productivity of 19.89 million tonnes (Anonymous, 2022-23). The area and production under maize is just after the area of paddy in Chhattisgarh in *Kharif* season. It used 0.206 million hectares of land in *Kharif* 2020-21 and produced 5.76 t/ha. (Anonymous,2022). The Baster Plateau (Baster, Bijapur, Dantewada, Sukma, Kondagaon, Kanker), the Chhattisgarh plain (Durg, Rajnangoen, Gariyaband), and the Northern hilly regions of the state are where maize is primarily grown (Korea, Korba, Surajpur, Balrampur, and Sarguja districts).Small size maize cob harvester is an essential machine to reduce the cost of harvesting and to reduce the drudgery. Maize harvesting machine is the small type of corn cob harvester, the machine can work single row corn, the machine can work with tiller and walk tractor supporting the collection of the bucket is full, we can take off the filling beg, the height of stay is adjustable, the tension clutch work safely, and the turning radius is small. The corn harvesting machine can harvest corns and crush straws at the same time. The corn straws are grinded directly as fertilizer for the field. The developed harvester will also help in drudgery reduction, cost reduction and time consumption.

2. MATERIAL AND METHODS

The experiments on performance evaluation of the maize cob harvester were conducted in the field under different forward speeds. The evaluation was conducted at Agronomy Field, IGKV, Raipur in the month of April and May, 2023.Three different variables were selected viz. variety of maize crop, forward speed of operation and snipper speed (rolling speed) denoted by V, F andS respectively with three levels of each factor. The details about the independent parameter and dependent parameters for the studies was presentation in Table 1. Observed data were analysed by using factorial randomized block design.

Table 1: Different independent and dependent parameter for the performance evaluation of maize cob harvester.

S. NO.	Independent parameters		Dependent parameters
	Factors	Levels	Crop parameters
1.	Variety (V)	a) Dhania-9965 b) Sartaj-765	a) Stripping loss, (%) b) Length of stem before and after

		c) D-9081	harvesting,(mm)
2.	Forward speed (F)	a) 1.7 km/h	c) Number of cobs per hour
		b) 1.9 km/h	d) Weight of cobs per hour, (kg)
		c) 2.1 km/h	Length of cut,(mm)
3.	Snipper speed (S)	d) 55 m/min	
		e) 62 m/min	Machine parameters
		f) 68 m/min	a) Actual field capacity,(ha/h)
			b) Field efficiency,(%)
			c) Fuel consumption,(l/h)

2.1 Independent parameters

2.1.1 Variety

The different types of maize crop variety are taken to test and performance evaluation of the machine. The maize crop variety under different size of cob length are Dhania-9965, Sartaj-765 and D-9081 were large, medium and small size of cob variety respectively.

2.1.2 Forward speed

The three forward speeds were selected for the study i.e.1.7, 1.9 and 2.1 km/h which were available under field working of machine when operated at low and high gears with different throttle positions.

2.1.3 Snipper speed

The speed of snapping rollers increases with the machine forward speed.The peripheral speed of snapping rollers obtained for the corresponding forward speeds 1.7, 1.9 and 2.1 km/h were 55, 62 and 68 m/min,respectively.

2.2 Dependent parameters

2.2.1 stripping loss

The stripping loss of maize cobs is number of cobs losses(damaged) in harvesting. The stripping loss is calculated by total number of cobs in plant in one row before harvesting to the total number of cobs after harvesting.

$$\text{Stripping loss}(\%) = \frac{S1 - S2}{S1} \times 100$$

Where,

S1 = Number of cobs in plant in one row before harvesting.

S2 = Number of cobs after harvesting.

2.2.2 Length of stem before and after harvesting

In before harvesting the length of maize stem is the distance between the tassel branches to the base of the plant on the ground and after harvesting the length of maize stem is the distance between the top of cut edge of stem to the base of the plant on ground.

2.2.3 Number of cobs per hour

The number of cobs is total number of maize cobs is harvested in one hour.

2.2.4 Weight of cobs per hour

The weight of maize cobs is total weight of maize cob is harvested in one hour.Maize cobs was measured and the average values were recorded.

2.2.5 Length of cut (stalk)

The length of cut of maize stalk is randomlyselected maize stalk after harvesting is measured and the average values were recorded.

2.2.6 Actual field capacity

The effective/actual field capacity was determined by measuring the time consumed for real work and the time lost for other activities like turning, refilling the fuel tank and for discharging the cobs from collection bin.

$$\text{Actual feild capacity,} \left(\frac{\text{ha}}{\text{h}}\right) = \frac{\text{Actual area coverd}}{\text{Total time required to coverd area}}$$

2.2.7 Field efficiency

Field efficiency is the ratio of effective field capacity to theoretical field capacity.

$$\text{FE} = \frac{\text{EFC}}{\text{TFC}} \times 100$$

Where,

FE = Field efficiency, %;

EFC = Effective field capacity, ha/h; and

TFC = Theoretical field capacity, ha/h.

2.2.8 Fuel consumption

The fuel consumption of the self-propelled maize harvester during operation at different forward speeds was calculated by top filling method of fuel tank.

3. RESULT AND DISCUSSION

The result obtained through the experiments were presented and discussed in details in the following section. The effects of various independent parameters on the performance parameters of the maize cob harvester were also discussed.

3.1 Effect of forward speed, snipper speed and different variety, on stripping loss by maize cob harvester

The effect of forward speed and snipper speed at different maize crop variety, on stripping losses was given in Table2. It was observed that there is no significant effect of all three on stripping loss (α=0.05). It may be due to variety of different size of maize cob and it has no effect on the stripping losses. It was also observed that stripping loss was obtained as significantly highest (0.342%) at2.1 km/h forward speed, 68 m/min snipper speed and variety Dhania-9965. In higher forward speed the stripping loss was observed to be higher. It may be due to higher forward speed make the higher stripping losses at higher snipper speed.

3.2 Effect of forward speed, snipper speed and different variety, on length of stem before and after harvesting by maize cob harvester

The effect of forward speed and snipper speed at different maize crop variety, on length of stem after harvesting was given in Table 4It was observed that there is significantly effect of all three on length of stem after harvesting (α=0.05). It may be due to variety of different size of maize crop and it has effect on the length of stem after harvesting. It was also observed that length of stem after harvestingwas obtained as significantly highest (217 mm) at 2.1km/h forward speed, 68 m/min snipper speed and variety D-9081.In higher forward speed the effect of stem length after harvesting was observed to be higher.It may be due to higher forward speed make the higher length of stem after harvestingat higher snipper speed.

3.3 Effect of forward speed, snipper speed and different variety, on actual field capacity by maize cob harvester

Theeffect of forward speed and snipper speed at different maize crop variety, on actual field capacity was given in Table 4.. It was observed that there is significant effect of all three on actual field capacity (α=0.05). It may be due to variety of different size of maize cob, forward speed and snipper speed and it has effect on the actual field capacity. It was also observed that actual field capacity was obtained as significantly highest (1.072 ha/h) at1.7 km/h forward speed, 62 m/min snipper speed and variety D-9081. In higher forward speed the actual field capacity was observed to be higher.It may be due to higher forward speed make the higher actual field capacity at higher snipper speed.

3.4 Effect of forward speed, snipper speed and different variety, on field efficiency by maize cob harvester

The effect of forward speed and snipper speed at different maize crop variety, on field efficiency was given in Table 4.. It was observed that there is significant effect of all three on field efficiency (α=0.05). It may be due to variety of different size of maize cob, forward speed and snipper speed and it has effect on the field efficiency. It was also observed that field efficiency was obtained as significantly highest (95.613%) at1.9 km/h forward speed, 68 m/min snipper speed and variety D-9081.In lower forward speed the field efficiency was observed to be higher.It may be due to variety of different size of maize crop have taken higher snipper speed as compared to less forward speed.

Table 3: Effect of forward speed, snipper speed and variety, on stripping loss and effect of length of stem before and after harvesting.

Particulars			Stripping loss(%)			Length of stem after harvesting, mm		
Forward speed, km/h	Snipper speed, m/min	variety	R1	R2	R3	R1	R2	R3
1.7	55	Dhania-9965	0.269	0.275	0.257	120	126	124
		Sartaj-765	0.228	0.236	0.245	160	165	168
		D-9081	0.251	0.265	0.249	210	215	213
	62	Dhania-9965	0.245	0.238	0.254	130	137	139
		Sartaj-765	0.211	0.224	0.206	170	175	178
		D-9081	0.233	0.243	0.229	190	192	194
	68	Dhania-9965	0.278	0.285	0.264	110	116	114
		Sartaj-765	0.239	0.249	0.223	140	144	143
		D-9081	0.255	0.248	0.232	180	182	186
1.9	55	Dhania-9965	0.247	0.2531	0.239	125	126	128
		Sartaj-765	0.2201	0.2195	0.225	140	145	141
		D-9081	0.2334	0.242	0.226	190	191	193
	62	Dhania-9965	0.229	0.2276	0.2198	140	143	141
		Sartaj-765	0.192	0.2043	0.196	165	161	163
		D-9081	0.216	0.223	0.205	175	172	171
	68	Dhania-9965	0.262	0.257	0.2682	185	180	181
		Sartaj-765	0.236	0.241	0.229	195	192	194
		D-9081	0.2501	0.2534	0.2652	190	192	195
2.1	55	Dhania-9965	0.291	0.298	0.2829	148	145	144
		Sartaj-765	0.263	0.2672	0.2579	137	134	132
		D-9081	0.275	0.2765	0.2655	168	165	167
	62	Dhania-9965	0.282	0.2796	0.2835	176	174	172
		Sartaj-765	0.232	0.2346	0.252	186	184	183

		D-9081	0.267	0.2431	0.275	189	186	182
	68	Dhania-9965	0.341	0.3394	0.3462	180	181	179
		Sartaj-765	0.307	0.2954	0.3091	215	216	211
		D-9081	0.3238	0.326	0.3159	220	218	213
Factors			CD	SE(d)	SE(m)	CD	SE(d)	SE(m)
F× S × V			NS	0.006	0.005	2.873	1.428	1.01

Note: F = Forward speed, S = Snipper speed, V = Variety

Table 4: Effect of forward speed, snipper speed and variety, on actual field capacity and field efficiency.

Particulars			Actual field capacity, ha/h			Field efficiency(%)		
Forward speed, km/h	Snipper speed, m/min	variety	R1	R2	R3	R1	R2	R3
1.7	55	Dhania-9965	0.9468	0.954	0.9612	81.38	81.25	81.33
		Sartaj-765	0.9648	0.9684	0.9792	82.57	82.37	82.43
		D-9081	1.062	1.0656	0.9468	83.45	83.8	83.75
	62	Dhania-9965	0.9504	0.9648	0.9396	82.81	82.7	82.62
		Sartaj-765	1.026	1.0188	1.026	83.9	83.26	83.51
		D-9081	1.0656	1.0728	1.0764	84.71	84.62	84.74
	68	Dhania-9965	0.954	0.9756	0.9684	83.6	83.71	83.9
		Sartaj-765	1.0332	1.0188	1.0368	84.61	84.7	84.26
		D-9081	1.0728	1.0692	1.0656	85.32	85.46	85.37
1.9	55	Dhania-9965	0.9612	0.9684	0.9828	91.4	91.56	91.32
		Sartaj-765	1.0368	1.0404	1.0548	92.66	92.74	92.3
		D-9081	1.0764	1.062	1.0656	93.51	93.56	93.72
	62	Dhania-9965	0.9576	0.9684	0.9612	92.5	92.61	92.72
		Sartaj-765	1.0008	0.9936	0.9864	93.65	93.9	93.78
		D-9081	1.0512	1.0584	1.062	94.23	94.45	94.63
	68	Dhania-9965	0.9792	0.99	0.9864	93.12	93.25	93.58
		Sartaj-765	1.0404	1.0368	1.0332	94.52	94.41	94.53
		D-9081	1.0728	1.0656	1.0548	95.71	95.62	95.51
2.1	55	Dhania-9965	0.9828	0.99	1.0008	73.66	73.5	73.81
		Sartaj-765	1.0044	0.9936	0.9864	74.2	74.59	74.35
		D-9081	1.0332	1.0296	1.0368	75.82	75.83	75.7
	62	Dhania-9965	0.9936	0.9828	0.9864	74.32	74.42	74.57
		Sartaj-765	1.0188	1.0332	0.9864	75.64	75.72	75.86
		D-9081	1.0584	1.0728	1.062	76.84	76.55	76.92
	68	Dhania-9965	1.0152	1.0296	1.0116	75.83	75.72	75.63
		Sartaj-765	1.0368	1.0296	1.0224	76.71	76.85	76.45
		D-9081	1.0332	1.0404	1.0512	77.5	77.81	77.3
Factors			CD	SE(d)	SE(m)	CD	SE(d)	SE(m)
F× S × V			0.026	0.013	0.009	0.272	0.135	0.096

Note: F = Forward speed, S = Snipper speed, V = Variety

4. CONCLUSION

1. The result on performance parameters revealed that the machinework satisfactorily at forward speed 1.9 km/h and snipper speed 62 m/min.
2. The optimum stripping losses and length of stem after harvesting was found to be 0.197% and 825 mm. The highest field efficiency of 95.61 % was observed at1.9 km/h forward speed, 68 m/min snipper speed and variety D-9081. The developed machine work efficiently 75%.
3. Small size maize cob harvester is a machine to reduce the cost of harvesting and to reduce the drudgery.

   Hence, it can be concluded that the maize cob harvester can cover one row at a time, it can harvest whole cob, cuts the stem in small pieces and spread the mulch on the soil.The maize cob harvester works efficiently, It was also observed that the machines work satisfactorily at forward speed 1.9 km/h and snipper speed 62 m/min.

REFERENCES

1. Amer, A. H., Gomaa, A. H. and Baiomy M.H. 2008. Physical and mechanical characteristics for some agricultural residues. Agricultural Engineering, 25 : 121- 146.
2. Azadbakht, M., Rezaei, A.A. and Zahedi, A. T. 2014. Energy requirement for cutting corn stalks. International Journal of Biological, Bimolecular, Agricultural, Food and Biotechnological Engineering, 8 : 479-482.
3. Bainer, R., Kepner, R. A., Barger, E. L. 1956. Principles of Farm Machinery. First Edition, AVI Publishing Company, INC. Westport, Connecticut, 81(2): 155-158.
4. Bo, Li. and Shusen, Li. 2006. Research on the security of improved design of knapsack brush cutter. International Journal of Simulation, Systems, Science and Technology, 17 : 361-365.
5. Dange, A. R. and Thakare, S. K. 2011. Force and energy required for cutting pigeon pea stems. International Journal of Agricultural Engineering, 2 : 272-274.

6. Gang, W., Honglei, J., Tang, L., Zhuang,J., Xinming,J. 2016. Design of variable screw pitch rib snapping roller and residue cutter for corn harvesters. International Journal of Agriculture and Biological Engineering, 9 : 27-34
7. Kongre, U. V., Shahare, L., Mutkule, A. and Komawar, A. 2016. Fabrication of multi crop cutter. International Journal of Advanced Research inScience, Engineering and Technology, 3 : 1878-1883.
8. Shravani, M. and Mehta, A. K. 2022. Prototype development of a single row self-propelled maize cob picker cum stalk cutting machine. Eco. Env. and Cons., 28(4): 1738-1742
9. Singh, A. and Bhullar, K. S. 2016. Harvesting and threshing of maize with a combined harvester. International Journal of Agricultural Engineering, 9 : 249-251
10. Thakur, S. S., Chandel, R. and Singh, M. 2021. Technical, field and energy comparison of cutter bar maize header with snap roll maize header. Journal of Agricultural Science, 3(4): 2021.
11. Wang, K. R., Xie, R. Z., Ming, B., Hou, P., Xue, J., Li, S. K. 2021. Review of combine harvester losses for maize and influencing factors. International Journal of Agriculture and Biological Engineering, 14: 1–10.
12. Yang, R., Chen, D., Zha, X., Pan, Z. and Shang, S. 2021. Optimization design and experiment of ear-picking and threshing devices of corn plot kernel harvester. Agriculture, 11, 904 : 1-22
13. Zhang, Z., Chi, R J., Du, Y F., Pan, X., Dong, N X. and Xie, B. 2021. Experiments and modelling of mechanism analysis of maize picking loss. International Journal of Agriculture & Biological Engineering, 14 : 11–19.