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CONTENTS

Field evaluation of Walking Behind Self-Propelled Vertical Conveyor Reaper-cum-Windrower for harvesting losses in green gram crop

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ABSTRACT: The green gram crop is harvested manually by small and marginal farmers in India. Different types of reapers are available in India, which are used for harvesting different crops at the lower cutting height up to 5×10^{-2} m. In order to study the mechanization of green gram harvesting operation for small and marginal farmers, a walking behind self-propelled vertical conveyor reaper-cum-windrower with the lip-less guard was evaluated for harvesting of green gram crop at 86, 93 and 97 days after sowing(DAS). In this study,the field capacity of the reaper and harvesting losses and the average stubble height of the green gram were measured. The reaper's field capacity and harvesting losses were observed as 0.18 ha/h and 1-2%, respectively, at a forwarding speed of 0.57 m/s.

Key words: Green gram harvesting, lip-less guard, self-propelled reaper

Pulses are an important source of protein for the poor and vegetarians, which constitute the country's major population. India has the largest share, approximately 25, 33 and 27%, respectively, in the production, acreage and consumption of total pulses worldwide. Green gram (3.25%) is the fifth major contributor to pulse production after Gram (49.66%), Pigeon pea (15.67%), Lentil (10.26%) and Black gram (7.00%) according to the 4th advance estimates for 2021-22(Anonymous, 2022a). Green gram production of India in 2022 is estimated to be 3.06 million metric tonnes (Anonymous, 2022b). Rajasthan, Madhya Pradesh and Maharashtrawere the main contributors to green gram production in India in 2018-19. (Anonymous, 2021).

The mechanization of farm operations is necessary for the timeliness of the operation and to tackle labour scarcity. Farm mechanization saves inputs like seeds, fertilizers up to 15-20% and increases cropping intensity by 5-20%. It increases the efficiency of farm labour and reduces the time of agricultural operation by 15-20% (Sahni *et al*., 2018). The benefits of farmmechanization are also used in the harvesting operation which is a labour-intensive operation and it utilizes 1/3rd man-power of all operations. The mechanization of harvesting operations for cereal crops i.e., wheat and rice was already done by using machinery like vertical conveyor reapers, combine harvesters, etc.These machines are also used in pulse harvesting for reaping the benefits of mechanization. But due to pulse crop structure, multiple maturitystages and pods shattering during harvesting are the different reasons farmers are harvesting it either manually or by available harvesting machine (i.e., vertical conveyor reaper, combine harvester, etc.).

The small farmers were harvesting the pulse crop manually with the help of a sickle and after sun-drying it was threshed. The small and marginal farmers need small machinery for harvesting the pulse crop. A self-propelled vertical conveyor reaper-cum-windrower is a small harvesting machine available in India that is used for harvesting the crop and conveying harvested crop to the right side of the machine for windrowing. This machine saves time, and *bhusha* is an additional benefit.The different harvesting tools/machines including vertical conveyor reaper were evaluated by different researchers (Singh and Singh, 1978; Pitra and Gite, 1980, Devnani and Pandey, 1981; Kulkarni and Sirohi, 1985; Datt and Prasad, 2000; Gajakos *et al.* 2013; Laukik *et al.,* 2014; Shalini *et al.,* 2015,) on pod crops like soybean. But the evaluation of the walking-type self-propelled vertical conveyor

reaper-cum-windrower also needs to be done on the green gram for mechanizing the operation. So, field evaluation of existing walking-type self-propelled vertical conveyor reaper-cum-windrower was studied in this study.

MATERIALS AND METHODS

A self-propelled vertical conveyor reaper-cum-windrower is a small harvesting machine available in India and used for harvesting the crop and conveying harvested crop to the right side of the machine for windrowing. The walking-type self-propelled vertical conveyor reaper-cum-windrower was used to harvest green gram crops (Fig.1). The harvesting mechanism is a reciprocating type cutter bar that slides over a fixed cutter bar (stationary shearing section). The reciprocating cutter bar is receiving power from the engine by means of a belt pulley and linkage system. The cutting system of reaper consists of a blade Size 4×10^{-2} m in width, including an angle of 40º and 4×10^{-3} m thickness.

The details of the self-propelled reaper are given in Table 1.

The green gram crop (Variety – *Amrapali (65-75 days*)) was grown in the experimental field of ICAR-CIAE, Bhopal (D3 plot) during the Kharif season shown in Fig. 2.

The walking behind a self-propelled vertical conveyor reaper-cum-windrower was evaluated for harvesting losses in green gram crops. The independent parameter of the study was harvesting Days After Sowing (DAS) i.e. 86, 93 and 97 Days (selected on the basis of maturity) and dependent parameters were pre-harvesting loss, harvesting losses and stubble height at 0.57 m/s forward speed.The harvesting losses were measured according tothe BIS code (Anonymous, 2000).The forward speed is selected on the basis of walking speed. The soil type was black soil. The other reporting parameters such as average crop height, plant diameter, plant weight, lowest pod position and moisture content (wb) of grain, pod and stem were measured for 20 green gram plants. The harvesting capacity and harvesting efficiency of the reaper were observed.

Table 1: Details of walking behind type self-propelled reaper

A) Reaper		**C) Speed**	
Type	Walking Type Reaper	Speeds	2 Forward, 1 Reverse
Dimensions (L x W x H) m	2.2 x 1.6 x 1.1	Working Speed, m/s	0.72 - 1
Weight, Kg	200		
B) Engine		**D) Cutting**	
Engine Type:	Single Cylinder Air Cooled Diesel Engine	Cutting Width, m	1.2
		Crop Placing:	Right Side of the machine
Power, hp/rpm	4.0/2600	Width of the cutting blade, m	40×10^{-2}
Fuel Tank Capacity, l	4	Thickness, m	4×10^{-3}
Air Cleaner	Dry Type	Included angle, ^{0}	40
Starting	Hand Cranking	Knife guard	Fixed-type blade lipless

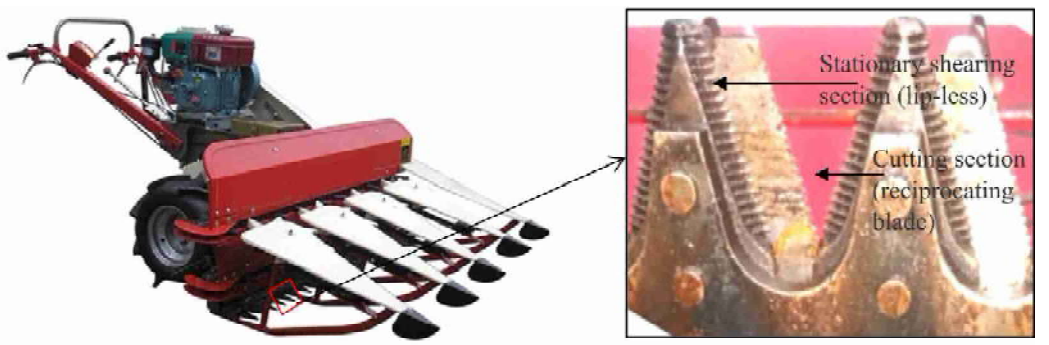

Fig. 1: Walking behind type self-propelled reaper-cum-windrower(photograph taken from the bottom side of the stationary blade)

RESULTS AND DISCUSSION

The average height, average stem diameter, and average weight of the plants of green gram without roots were observed as 0.48 m ± 4.4×10^{-2} m, 4.6 ± 0.4 ($\times10^{-3}$) m and 1.63 ± 0.5 ($\times10^{-2}$) kg, respectively. Whereas the average height of the lowest branch with pods from the ground level and the average height of the lowest pod from the ground level was observed in the range of 0.19 m ± 3.9×10^{-3} m and 0.33 m ± 3.4×10^{-2} m, respectively. The immature, mature green pods, matured black and over-matured were observed in the range of 15.3 ± 3.5, 10.3 ± 1.9, 74.4 ± 4.7 and 0%, respectively. The maximum crop pods formed at the top of the plant as shown in Fig. 3. This may be one of thereasons for low shattering losses during the operation of vertical conveying in vertical conveyor reaper-cum-windrower due to less interaction between pods and machine parts. The branching in the green gram crop was started at a lower height so during harvesting some cut branches may not be collected by its conveying system and fall on the ground which may increase losses.

The variation in moisture content of stem, pod and grains with respect to time is shown in Fig. 3. The difference in moisture content in stem and pods was observed as 21.7, 40.5 and 38% at 86 (19 Sep), 93 (26 Sep) and 97 (30 Sep) DAS, respectively. The moisture content of the stems in comparison to the pods and grains is high at the maturity stage (The maturity stage reached in green gram crop when the pods moisture content is in the range of 17 – 18% and 80% (Anonymous, 2022c) pods colour will be brown) as well as in latter stages. This may lead to less vibration in the plant at the time of harvesting of the plant.

The pre-harvesting losses, and after-operationof reaper harvesting losses and stubble height is presented in Table. 1. The pre-harvesting losses and harvesting losses in green gram were found in the range of 0-0.2% and 0.2-1% after 86, 93 and 97 DAS, respectively.

The lower harvesting losses in cases of 86 and 93 wereobserved may be due to the effect of the moisture content of green gram pods moisture content 15% which is more than the recommended moisture content for green gram (Anonymous, 2022c). In addition to that during three harvesting

Table 1:Pre harvesting and harvesting losses of green gram at the time of harvesting

Harvesting Time (DAS)	Pre-harvesting losses ,%	Harvesting losses,%	Average stubble height,m	Moisture content (%)		
				Grain	Pod	Stem
86	0.0	0.2	4.6×10^{-2}	25.4	29.2	66.1
93	0.0	0.3	-	23.3	23.6	64.1
97	0.2	1	-	13.5	14.3	46.0

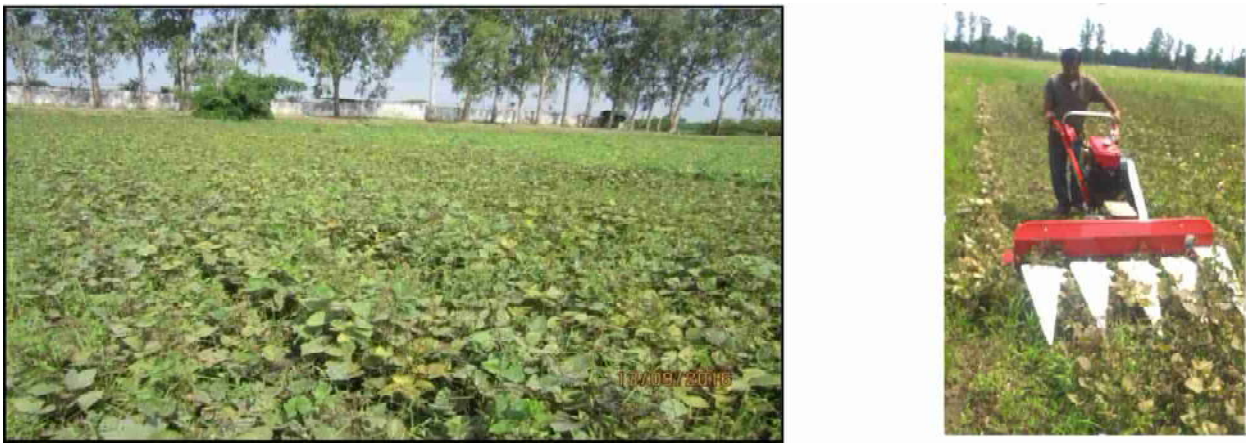

Fig. 2: Green gram crop and harvesting of green gram crop by walking type self-propelled vertical conveyor reaper-cum-winddrower

Fig. 3: Plant structure of green gram (*Amarpali*) crop

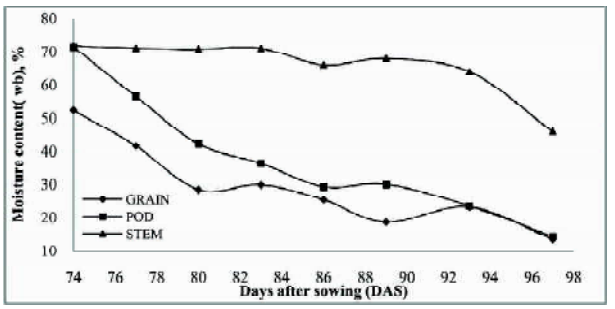

Fig. 4: Moisture variation of grain, pod and stem of green gram (*Amarpali*) with respect to time

stages the moisture content in the green gram stem was in the range of 46-66% this may be the one reason for less vibration during the cutting of the stem. The average cutting height was observed as 4.6±1.2 ($\times 10^{-2}$)mat a forward speed of operation of 0.57 m/s. The lower cutting height was observed due to the lip-less guard-type structure used in the machine. Whereas, the harvesting capacity of the reaper was found to be 0.18 ha/h, with 80% efficiency.

CONCLUSION

Green gram is harvested using a self-propelled vertical conveyor reaper-cum-windrower (Diesel 4 hp) with cutter bar width, cutting blade width, cutting blade thickness, and blade-included angle that is 1.2 m, 40 mm, 4 mm, and 400, respectively, with fixed blade sharing section. The cutting height, harvesting losses, field capacity and harvesting efficiency of vertical conveyor reaper-cum-windrower for green gram were observed as 4.6×10^{-2} m, 1-2%, 0.18 ha/h and 0.8%, respectively, at forwarding speed of 0.57 m/s and at the moisture content (wb) of the grain, pod and stem of 13.5-25.4, 14.3-29.2and 46-66%, respectively. The pre-harvesting and harvesting losses were in the range of upto 0.2 % and 0.2-1% for green gram. The reapermay be used for the cutting and windrowing of the green gram crop.

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