# Study on Performance Evaluation of Cotton Boll Stripper

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## Abstract

Pakistan is among top 4 cotton-producing countries worldwide. However, the attack of pink bollworm at different stages of cotton boll growth is becoming a challenge for modern agriculture. At the end of picking season, farmers remove the cotton sticks from the fields and store them for domestic fuel purposes. These sticks containing brackets and infected bolls, transfer the insect to the next cotton crop. Therefore, there is a need to remove these infected bolls from the cotton sticks. In this regard, a tractor front mounted cotton boll stripper was designed and developed atAMRI (Agricultural Mechanization Research Institute), Multan, Pakistan. The performance of the developed implement was evaluated in the actual field conditions based on field capacity and percentage boll removal. Moreover,the impact of tractor speed on the performance of the cotton boll stripper was also accessed. The results revealed that the percentage boll removal of the implement lies in the range of 80-90% depending on field conditions and tractor speed. The higher tractor speed enhances the field capacity of the implement while lowering the percentage of boll removal. Finally, it was concluded that the removal of infected cotton bolls from the field using the cotton boll stripperis an effective way to reduce pink bollworm attacks in the next crop season.



***Keywords:*** *Cotton; Pink bollworm; Brackets; Stripper; Field Capacity; Tractor speed*.

## 1. Introduction

Cotton is vital cash crop grown in Pakistan. Closely 1.7 million people grow the cotton crop in Pakistan. During the year 2017-18, 2699 million hectares of land was used for cotton sowing resulting in 11935 thousand bales of cotton [1]. During the last few years, cotton became non-profitable for farmers due to the attack of pest/disease on cotton crop resulting in low yield and high input cost. The farmers even could not meet their actual expenses. The pink bollworm (Pectinophora Gossypiella) is most dangerous for cotton production as it multiplies rapidly due to a short life cycle of 25-35 days. Attack of pink bollworm at different stages of cotton boll growth is becoming a challenge for modern agriculture. Mostly in cotton areas, the crop rotation is wheat. Farmers try to remove cotton sticks from the field after final picking as soon as possible to vacate the field for wheat sowing. After the last picking of cotton from the crop, the cotton sticks are manually cut and stored for fuel purposes to the storage point near cotton fields. These sticks containing brackets and infected bolls communicate or transfer the insect to the next cotton crop because the pink bollworm stays in the infected bolls during the period of hibernation in the pupae stage. The pink bollworm hidden in unopened cotton bolls easily completes its life cycle at storage point and hibernates till favorable conditions and attacks on the next cotton crop. It covers its life cycle from egg, larva, pupa, and adult within 25-35 days during the summer season. The adult pink bollworm is about 38 mm in length having mottled brown to grey color. The pink bollworm usually comes out of the infected bolls and brackets during the month of April or it might prolong its hibernation for years. The eradication of pink bollworm is the necessity of time to stop its growth during the off- season period.

The conventional method to destroy the insects is to graze sheep and goats in the cotton fields after final picking to remove the leftover bolls and brackets. Some progressive farmers rotavate the sticks along with left-over bolls and brackets. This technique although helps to control the insects, but to early vacate the land for the next crop, farmers cut down the stick and save them at their farmhouse or at the some corner of the same field. If a rotavator is applied to bury the trash, it is beneficial for the fertility of soil and time saving to vacate the field for sowing of wheat but more expensive. The cotton stalks are used as fuel in villages for cooking and heating because of non-availability of other



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energy resources. The burning of cotton stalks for fuel purposes raises environmental issues due to the emission of carbon dioxide ($CO_2$) and Nitrogen Oxide (NO) [2]. Manual cutting of cotton stalks need higher labor and is a time-consuming job; thus, researchers are trying to develop techniques for cutting/combing cotton sticks from the crop field. In this regard, Bansal et al.[3] developed a stubble collector cum planner consisted of the wooden plank coupled with steel spikes. Yumak et al.[4] developed a cotton stalk pulling machine which having field capacity and efficiency of 9.2 ha/h and 95%, respectively. Gangade et al.[5] Studied and compared different cotton stalk removal implements and compared their efficiencies and concluded uprooting efficiency of tractor-drawn V blade, tractor operated uprooter, and tractor operated slasher as, and as 99%, 80%, and 100%, respectively. Similary, Sheikh et al.[6] designed a machine for uprooting of cotton stalks which consisted of a horizontal cutting edge. Ramzan & YYR [7] designed and evaluated the performance of the cotton stalks puller prototype which could till at 45° and rotate at speed of 18.9 m/s. Murugensen et al. [8] investigated a stalk puller integrated chipper drawn by a tractor. Sidhar N et al. [9] calculated the shredding efficiency of an experimental shredder at three different speeds and levels of peripheral velocity. Fiaz Ahmad et al. [10] evaluated the performance of cotton stalk puller-shredder at three different forward speeds (1.8, 2.0, and 2.2 km/hr) and four-blade attachment angles (30°, 45°, 60°, and 75°) and concluded that 2km/hr forward speed and 30° attachment angle is most suitable for its best performance.

The necessity to develop a cotton boll stripper was being felt for last many years. The agriculture department, extension wing has been motivating the farmers to destroy the left-over/infected cotton boll and brackets after final picking and before removing the sticks from the field. Agricultural Mechanization Research Institute, Multan studied the problem, crop the field condition, and evolved various concepts to remove these bolls and brackets from the field. The simplest concept was selected to be tried and consequently, the AMRI cotton boll stripper has been designed. AMRI cotton boll striper has been designed and developed to strip off the infected bolls and brackets from cotton sticks. It is tractor front-mounted and hydraulically controlled with lower links of the tractor which strips off the infected bolls and brackets by combing the cotton sticks while it is run through the standing crop after final picking of cotton. After its operation, farmers can remove the cotton sticks from the field for fuel purposes and the infected bolls and brackets are destroyed during land preparation. Moreover, these infected cotton bolls are also used for bricks kiln as a fuel which also increases the income of the farmers.

This study aimed to investigate the performance evaluation of cotton boll strippers in the field at different forward speeds of tractor and to recommend optimum speed for its efficient performance.

## 2. Materials and Methods.

The test of cotton boll stripper was conducted after final picking of cotton format MNS University of Agriculture farms, Multan Pakistan having co-ordinates 30.14164 N, 71.466248 E. The texture of the soil lied in the clay loam category. The temperature was 27°C, wind velocity was 7 km/hr, relative humidity 45%, and visibility 1.93 km. Cotton variety NIAB 878 with the dibbling method was sown at the site.

Tractor front-mounted hydraulically controlled cotton boll stripper was designed and developed by AMRI (Agricultural Mechanization Research Institute), Multan. This implement has overall dimensions as L 1180× W 2725× H 760 mm. Cotton boll stripper is designed to comb the cotton sticks having 38 no of strips equally spaced apart at a distance of 20 mm. The details of technical specifications of the developed machine are given in Table 1.

Measurements of field and crop were taken using different gadgets. The average plant height, plant canopy, row-row, and plant-plant spacing were determined using a measuring tape. Dia of the plant stem and cotton bolls were determined using a vernier caliper. The time was noted using a stopwatch. The cotton seed was sown on furrows by the dibbling method that caused variations in row-row and plant-plant spacings.

**Table 1. Technical specifications of the developed cotton boll stripper**

| | |
|---|---|
| **General** | |
| Applications | For the collection of boll from remaining cotton crop after the last picking |
| Type | Tractor front-mounted |
| Tractor Power Req. | 50 + hp |
| Working Width | 2640 mm |
| **Overall dimensions** | |
| Length | 1180 ± 50 mm |
| Width | 2725 ± 100 mm |
| Height | 760 ± 20 mm |
| **Material specifications** | |
| Mainframe | MS box 75x43x 6 mm , 02 Nos. side supports of MS box 42x42x6 mm, 02 Nos. center supports of MS box 50x50x6 mm, MS angle 38x38x4 mm welded on top, and MS flat 38x4 mm welded on the bottom |
| Hitch attachment | 02 Nos. MS rectangular box 75x43x6 mm, 920 mm long and 100 mm tapered at ends |
| Stripper Frame | MS box 40x40x6 mm bolted with 12 Nos. of bolts of size12 mm bolted with the main frame, 02 Nos. of pins 18 mm dia.<br>for support.14 gauge MS sheet, welded at front and sides |
| Strips | 762x50x4.5 mm T.iron welded with stripper frame with front tapered 120 mm and 4 mm tip size. MS sheet 14 gauge<br>250mm wide, welded on the rear end of stripper frame |
| Tractor Attachment (Front) | 25 mm thick MS plate bolted with tractor frame, 9 mm MS plate welded for support pulley. MS box 50x50x6 mm with<br>adjustment holes. MS plate 75x16 mm attached with mainframe through 25 mm pins |
| Pulley for wire Rope | 04 Nos. 90 mm dia, wire rope dia. 10 mm flexible |
| Rear hydraulic link | L shaped 460x235 mm, made of 50x6 mm MS angle hinged at the place of lower links with wire rope tightener |

**Table 2. Characteristics of the cotton field**

| Parameter | Value |
|---|---|
| Plant to plant spacing (mm) | 145-198 mm |
| Row to Row spacing | 755-860 mm |
| Average plant height | 1117 mm |
| Average dia of stem | 11.2 mm |
| Average dia of cotton boll | 25.5 mm |
| Average weight of cotton boll | 6.8 mg |

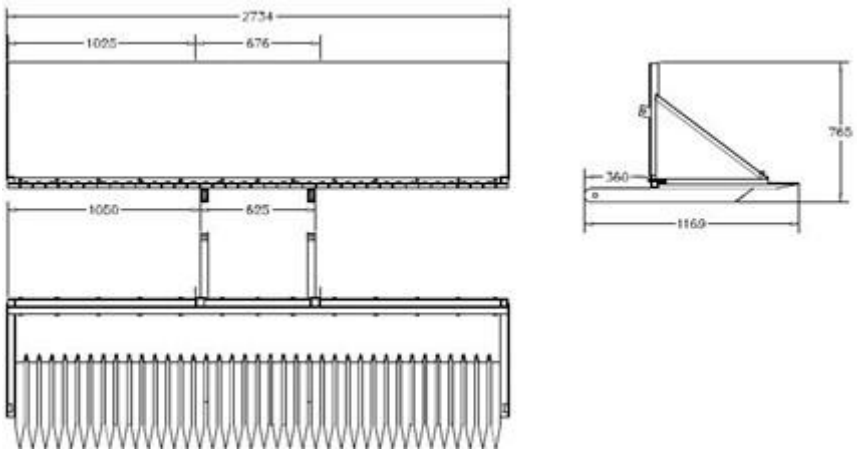


**Fig. 1: 2D drawing of the cotton boll stripper**

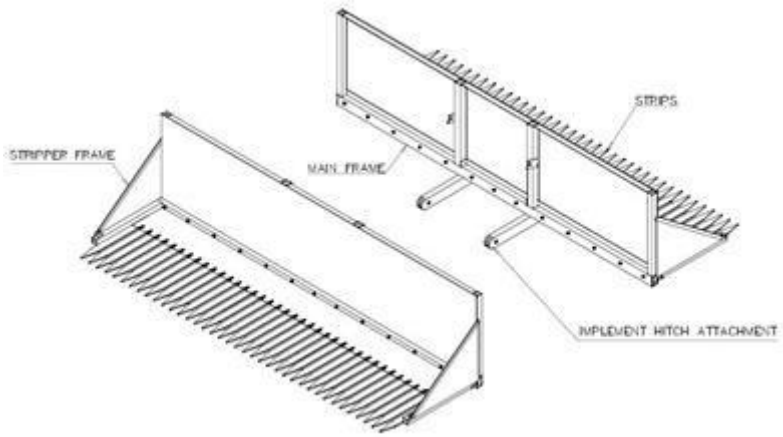


**Fig. 2: 3D drawing of the cotton boll stripper**

The cotton boll stripper was tested in a cotton field at three different forward speeds (1.4, 2.5, and 2.9 km/hr) to study the impact of speed on the efficiency of implement in terms of percentage of cotton bolls removal and field capacity of the implement. Speed of tractor/ implement was determined by calculating distance covered in unit time using a stopwatch and measuring tape.

Field capacity was determined for different tractor speeds by calculating total productive time to operate the tractor in the field and turing time. The time taken to travel at unloading point and to unload the striped bolls and leaves, and time taken to reach back for the operation of the implement were not considered in calculating the field capacity of the implement.

The percentage of bolls removed at different tractor speeds was also determined. For this purpose, an area of 9*10 sq.ft at three different spots of the field was randomly selected and the total number of plants and total number of bolls and brackets in the selected area before and after implement operation were counted. The difference in number of bolls and brackets before operation of implement and after its operation resulted in the percentage of boll removal or efficiency of the implement.

## 3. Results and discussion

The analysis shows that tractor/ implement forward speed significantly affects the field capacity and implement efficiency. At higher forward speed, field capacity is increased and efficiency of implement in terms of percentage of boll removal is decreased. At low forward speed, field capacity is decreased while higher implement efficiency is obtained. Forward speed and field capacity have a linear relationship as shown in Fig 3.

The implement was operated in the field at three different speeds ( i.e 1.8, 2.4, and 2.9 km/hr) and the field capacity of implement at these speeds was determined which were calculated as 1.12, 1.46, and 1.7 acre/ hr respectively. This clearly shows that at higher forward speed, the field capacity is increased thus reducing the required time to complete field operation.

The efficiencies of bolls removal at different speeds were also determined. The result showed that maximum removal efficiency was obtained as 93% at a forward speed of 2.4 km/hr, whereas minimum efficiency (82%) was achieved at speed of 2.9 km/hr. It is clear from the result that less efficiency of the implement is achieved due to the selection of inappropriate forward speed of implement.

At the minimum forward speed of 1.8 km/hr, minimum field capacity (1.12 acre/hr) is determined and removal efficiency at this speed is 89%. It was also observed that at higher forward speed (2.9 km/hr), the cotton plants began to uproot and caused blockage of strips of cotton boll stripper resulting in lesser bolls removal efficiency (82%). Furthermore, at high speed, the implement could not comb/ strip the crop properly due to which less removal efficiency was achieved.

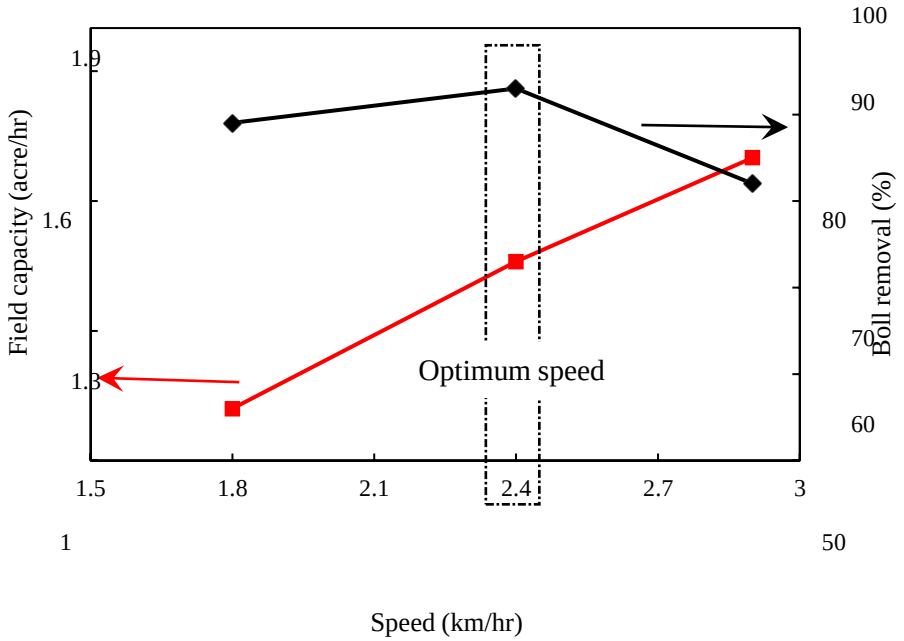


**Fig. 3: Impact of tractor speed on the field capacity and percentage boll removal of the cotton stripper.**

## 4. Conclusion

Cotton boll stripper is an effective tool to control pink bollworms by eradicating the affected cotton bolls from the field after the final picking of cotton from the cotton crop. The infected bolls collected can be used for fuel purposes in brick kilns. It is concluded from the results that the implement attained maximum boll removal efficiency (93%) at a forward speed of 2.4 km/hr with a field capacity of 1.46 acre/ hr.

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