J. Agril. Mach. Bioresour. Eng. 6(1&2), 2013: 7-10 ISSN 1993-4041

Development of a Manually Push Type Urea Briquette (*Guti*) Applicator

M. Hasan[1], M. Islam[1], M. M. Billah[2] and A.T.M. Ziauddin[3]

Abstract

An improved version of manually operated push type urea briquette (*guti*) applicator was designed and developed in the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh. There were four small wheels which were fabricated using small steel rings instead of skids. The discharge tubes of the improved model were modified with the additional bended PVC tubes. In the laboratory test the effective field capacity was found 0.3554 ha/hr for urea briquette (*guti*) size of 2.7 gm. The missing rate, applicator capacity, average distance between dropped *guti*, depth of application of *guti,* covering performance, and force requirement were 29.17%, 8.402 kg/hr, 41.61 cm, 5.02 cm, 43.33%, and 69.18 N, respectively. The device needed further improvement for reduction of its missing rate and covering performance.

Key words: *Guti* urea, Applicator, Effective field capacity

1. Introduction

Urea has emerged as an important nitrogen fertilizer for rice production in Bangladesh. Statistics indicates that about 80% of total urea production is used by the rice plant (Prasad and Datta, 1979). Nitrogen loss occurs due to ammonia volatilization, de-nitrification, run-off, seepage and leaching. Therefore, there is a great need to improve nitrogen use efficiency for rice production. Due to excessive loss of nitrogen, farmer in Bangladesh have not able to make more efficient use of fertilizer to boost their rice yields. Much effort has been made to improve fertilizer use efficiencies in low land rice production. Deep placement of urea fertilizer in the form of *guti* into the anaerobic soil zone is an effective method to reduce volatilization loss. Placement of *guti* urea fertilizer at a depth of 60-70 mm from the soil surface by hand is not only laborious but also time consuming. Due to the shortage of labor resulting from the migration from rural to urban areas and laborious time consuming task, several research institutes like BRRI, BARI have developed USG applicators.

Ahamed (2011) modified the existing manually operated *guti* urea applicator of BARI model, in the workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. After different models of applicator tested in different soil conditions, the modifications of the best performed applicator (BARI model) was done on the basis of test result and comments of farmer about the applicator. In order to obtain satisfactory performance of applicator several prototype models were developed by changing design of different components (e.g. the plastic skids, furrow openers and furrow closers, plastic elbows, plastic cage wheel etc.) and dimensions. Then, the final model of modified *guti* urea applicator was developed and tested side by side with BARI model both in the laboratory and at different field with different soil conditions. Overall performance of the applicator was found quite satisfactory.

Wohab *et al.* (2011) solved most of the problems of USG applicator. A manually operated push type fertilizer applicator for puddle rice field has been developed in Farm Machinery and Post-harvest Process (FMP) Engineering Division of Bangladesh Agricultural Research Institute (BARI).

[1]Graduate student, Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[2]Assistant Professor, Department of Computer Science and Mathematics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[3] Professor, Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
Corresponding address: E-mail: atm.ziauddin@bau.edu.bd

The farmers of Bangladesh are interested in using USG in rice field. *Guti* urea is presently applied manually just like transplanting of rice seedlings in the field. It is placed at a depth of 60-70 mm under the soil at a center of 4 consecutive hills of 2 adjacent rows. The hand placement of USG is laboour intensive and is a very slow having a field capacity of 0.07–0.12 ha/workday (Iqbal, 2009). Therefore, an attempt was made to develop an improved version USG applicator for reduction of cost and increased efficiency. The objectives of the study were:

a) Development of an improved version of manually push type *guti* urea applicator.
b) Evaluation of performance of the applicator in a testing bed.

2. Materials and Methods

The device has been designed and fabricated in the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. The major components of the improved of *guti* urea applicator are plastic discharge tube, plastic cage wheel, plastic hopper, small steel drive wheel, and frame. The isometric and pictorial view of the applicator is shown in Fig. 1 and Fig. 2 respectively.

2.1 Discharge tube

Discharge tube and small metal guide strip were used to reduce missing rate and was fixed with hopper using a small nut. The height of the discharge tube was 330 mm. The top and bottom diameters of the discharge tube are 100 mm and 40 mm, respectively. The discharge tube was connected with the frame.

2.2 Cage wheel

A cage wheel with 24 flat spikes was made by plastic sheet having a diameter of 460 mm to share the distributed weight load of the applicator equally with the small cycle rings. The spikes provide traction while rotating over muddy land. The cage wheel, placed in the middle of the device, transfers motion to the metering unit through an axle (metallic shaft) inserted into the center of the cage wheel. This rod helps to operate the metering disk using the rotation of the cage wheel.

2.3 Hopper

The hopper having a capacity of about 900 gm of *guti* urea was made of plastic. It was fixed with the frame of the device. A metering disk having four cups to hold a single *guti* was placed inside the hopper. This metering disk is coupled with the axle of the cage wheel to receive power from the cage wheel. The length, width and depth of the hopper are 160mm, 90mm and 120 mm, respectively with gradual tapering at the bottom. It was readily available in the market.

2.4 Driven wheel

The external and internal diameter of each driven wheel ring was 208 mm and 160 mm, respectively. The width of the driven wheel was 30 mm. There are four wheels and these are readily available in the cycle market.

2.5 Frame

Frames for holding the different components of the applicators were made of M.S. flat bars of 20mm. The length, width, and height of the frame were 600mm, 320 mm, and 510 mm, respectively. Frame was tightened with the driven wheel using nut and bolt. The handle was made of square bar of 1230 mm long, attached with a 320 mm U shaped flat bar of 20 mm long to push the applicator in forward direction.

2.6 Performance evaluation

The applicator was tested to see its performance for several parameters i.e. missing rate, effective field capacity, pushing force requirement, applicator capacity, spacing between the dropped *guti,* depth of *guti,* applied and covering performance in the testing bed near the department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. In order to determine the performance of applicator five replications were taken for each parameter under investigation. The time required for operation was

measured using s stop watch. The following sub-sections explain the methods of determination of technical performances of the applicator.

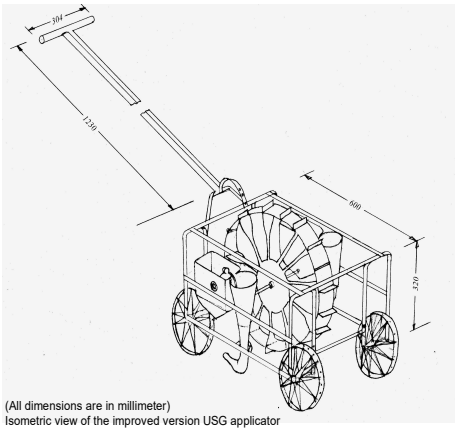

Fig. 1. Isometric view of the applicator

Fig. 2. Pictorial view of the applicator

2.7 Missing rate

The missing rate of the applicator was determined as the ratio of number of *guti* missed to pickup and/or failed to drop by metering disk into the discharge tube to the number of *guti* required to pickup and/or dropped into the discharge tube by the metering disk. Mathematically, missing rate can be expressed as follows:

$$\%\,\text{missing} = \frac{N_1}{N_2} \times 100$$

N_1 = Number of *guti* missed to pickup and/or failed to drop into the discharge tube.
N_2 = Number of *guti* required to pickup and/or dropped into the discharge tube by the metering disk.

2.8 Effective field capacity

The effective field capacity is the actual field coverage when the applicator was operated within a specified time. The effective field capacity of the applicator was calculated using the following equation.

$$\text{Effective field capacity}\left(\frac{\text{ha}}{\text{hr}}\right) = \frac{\text{Field coverage in ha}}{\text{Actual time of operation in hr}}$$

2.9 Pushing force

The force requirement of operation was determined in the testing bed using a spring balance and three persons were involved in the test. Spring balance was fixed between pulling wire and the applicator. One person pulled the applicator, while another person recorded the data of the spring balance and third person just hold the handle of the applicator along with line of action. The horizontal component of the pull was considered as the pushing force of the applicator.

3. Results

The study was undertaken to determine the missing rate, applicator capacity, effective field capacity, covering performance, and pushing force requirement in the laboratory testing bed. The average values of the parameters are shown in Table 1. The cost per hectare of operation of the applicator was compared with

the cost of manual operation. The cost components are depreciation, interest, repair & maintenance cost, and labor cost. It was calculated using its maximum effective field capacity of the applicator. The comparative results are shown in Fig. 3.

Table 1. Technical performance of the applicator measured in the testing bed

Mean missing rate (%)	Capacity of the applicator (kg/hr)	Effective field capacity (ha/hr)	*Guti* covering performance (%)	Required pushing force (N)
29.17	8.40	0.35	43.33	69.18

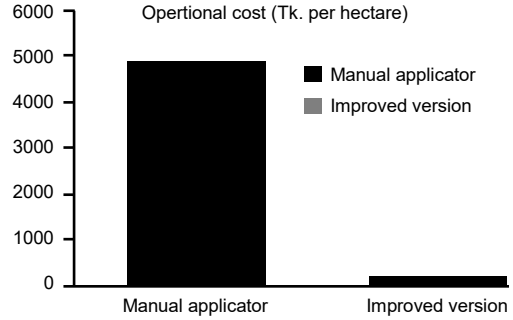

Fig. 3. The cost operation of the applicator compared with manual operation.

4. Conclusions and Recommendations

The average missing rate, pushing force requirement and the *guti* covering performance were 29.17%, 69.18 N and 43.33%, respectively. The result of this experiment indicates that the values of all the three parameters were comparatively higher. But, in the economic aspects, the cost of manual operation was 40 times higher than the operational cost of the improved version applicator. On the other hand, the effective field capacity is comparatively higher. However, the following problems have been encountered during the study. a) High missing rate and low *guti* covering performance of the applicator. b) The self-weight of the applicator was comparatively higher (11.97 kg) and considered uncomfortable to push and carry. USG sometimes gets clogged inside the discharge tube due to narrow diameter of the tube. For further improvement of the applicator, the following recommendations are made

a) Replace the drive wheels with light plastic floats to reduce weight and pushing force requirement of the applicator.
b) Further study is needed to improve the applicator.

References

Ahamed, M S 2011. Improvement of *Guti* Urea Applicator, M.S. Thesis. Dept. of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh.

BARI 2009. Design and development of a urea super granule applicator for puddle rice field, journal of Agricultural Engineering Technology, Vol. 37, pp. 57-62.

Iqbal S H 2009. Improvement of the Existing USG Fertilizer Applicator, Dept. of Agricultural Engineering, Bangladesh Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.

Prasad R and Data S K 1979. Increasing fertilizer N efficiency in wet land rice. Nitrogen and Rice, IRRI, Philippines.

Wohab M A, Hoque, M A, Mohiuddin M and Hasan M S 2011. Field performance evaluation of BARI USG Applicator. Research Report, 2010-2011. Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur-1701, Bangladesh.