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# DEVELOPMENT OF A SUITABLE SEED METERING DEVICE FOR CEREALS

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## ABSTRACT

Wooden and metallic (cast aluminum alloy) metering device with four different cell shapes were designed and tested in the laboratory. The cell sizes were determined according to the physical dimensions of various paddy and wheat varieties. Wooden metering device offered excessive resistance to uniform flow of paddy seeds. The performance of the metallic metering device with a modified cup shaped cross-section of the flutes was found best among others and almost eliminated cell fill and seed damage problems. Such a device performed satisfactorily over a wide range of ground speed enabling it to be adapted to animal or power tiller. At lower linear cell speeds (0.275 m/s) the seed discharged from the cells were in a group but, at higher cell speed (0.373 m/s) seed discharge pattern was found continuous. A recommendation was made for drilling as well as hill dropping of seeds with the same metering unit by changing gear ratio's between drive wheel and seed metering shafts.

Key words : Metering device, cell shape, cell speed, cell-fill.

## INTRODUCTION

Considering optimum plant population, gemination, emergence of seedlings, inter-cultural operations and yield drill seeding and hill dropping of paddy and wheat seeds in line are much favored over other methods of seeding. In recent days planting of germinated paddy seed is also being encouraged by the scientists. The most common metering devices used for hill dropping of seeds are edge drop plates and roller having cells along its periphery. Different rectangular and cup shaped cells on metering roller were reported by Hunt (1973), Culpin (1976), Kepner *et al.* (1977) and Michael *et al.* (1978). Cell type metering device for drilling seeds with rough surface and non-uniform flow behavior such as paddy faces two major problems : (i) inadequate cell fill and (ii) seed damage. Seed size, shape and roughness in relation to cell size, shape, exposure time of a cell to seeds in the hopper and linear cell speed have a great influence on the percentage of cell fill and distribution of seeds. Seed damage in most metering devices are caused by the cut off device. The percentage of seed damage increases with seed roughness and with

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the increase of cell speed. The seed damage also increased if the cells are too large in size. Kepner *et al.* (1977) suggested a cell diameter or length about 10% greater than the maximum seed diameter and cell depth equal to the average seed diameter or thickness for rounded seeds in combination with a flexible cut-off device for optimum cell fill with out noticeable seed damage in precision drilling.

Ali (1977) designed a cylindrical wooden metering device of 102 mm in diameter and eleven circular cells of 8 mm in diameter arranged circumferentially for paddy and BRRI (1984) designed another cylindrical metering roller with cup shape cells. However, both the devices had shown a non-uniform seed delivery associated with crushing of seeds.

IRRI (1978) developed a cylindrical metering device with rectangular cells for sowing germinated paddy seeds. However, the metering device has not yet become popular in rice growing countries.

In this paper an attempt was made to develop a suitable seed metering unit for paddy, wheat and other cereals of similar shape and size which may ensure proper cell fill and minimize seed damage.

## DESIGN AND CONSTRUCTION

Paddy is a grain with rough surface and non-uniform flow behavior. So, it is difficult to ensure proper cell fill and uniform metering. Initially four different types of cells, e. g. oval, rectangular and cup shaped cells ( Fig. 1 ) on metering roller were tested. Among with others the major difficulties, such as, seed crushing, roller jamming and missing cells were observed. To overcome these difficulties 'pick up from the bottom' principle with a flexible grain cut-off mechanism was tried and found suitable. The flexible cut-off device rides on the top of the metering roller and sweeps away execess seeds on the cell mouth as the cells move beneath it. From initital investigation it was evident that the rectangular shaped cells ensured satisfectory cell fill but, caused a higher degree of seed crushing. On the other hand, cup shape cells prevented seed crushing with slightly less probability of cell fill which was basically due to wide open mouth unable to retain seed. On the basis of the above observations a modified cup shaped cell was designed (Fig. 2). The design was made according to the physical dimensions of the seeds (Table 1). The diameter of each cup was selected approximately twice the maximum average breadth of the seed with 10% over size. Outer edge of the cup was bent inward giving more space in it. To meter various type of seed with variable amount the shape of the cell was made in the form of flute in the longitudinal direction so that the length of cell can be varied to accommodate upto 25-30 seeds per cell. A metallic roller of 73mm

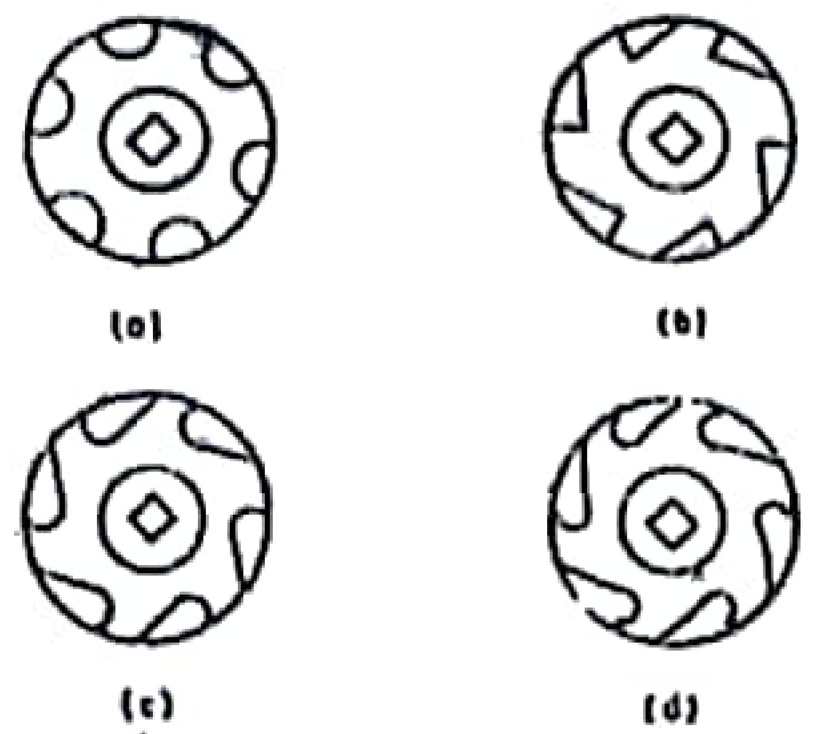


Fig. 1 Side view of different metering roller with cell shapes.
(a) Oval (b) Rectangular (c) Cup and (d) Modified cup

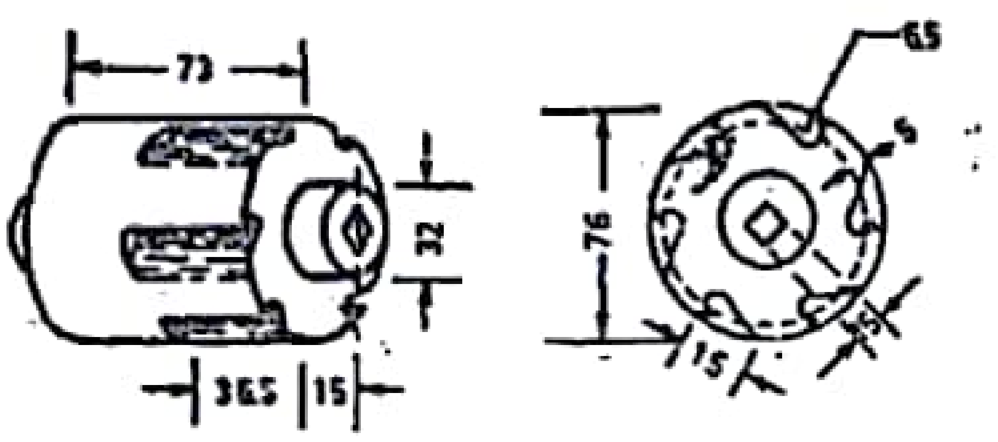


Fig. 2 Metering roller

All dimensions are in mm

length and 76mm diameter with six cup shaped cells on its periphery was selected keeping in view of cell spacing on the roller and metal economy.

A closely fitted metering case was designed to hold the flexible cut-off device and guide the metered seeds to the seed tube (Fig. 3 and Fig. 4). The unit was cast (Aluminum alloy) and machined properly to give a smooth shiny surface. The width of the metering case was selected according to the maximum cell size. The metering roller was bolted to a shaft and free to slide axially in the metering case. Required cell size was obtained by moving the metering shaft axially hence, the metering roller. A seed retainer plate rotating with the roller but encased in the metering case cover refixed the boundary of the cell. The nature of seed distribution i. e. drill seeding or hill dropping might be chosen by designing appropriate gear arrangement between ground wheel and metering roller.

## METHODS AND MEASUREMENTS

Metering devices of four cell shapes ( oval, rectangular, cup and modified cup ) were tested on the test bench to evaluate the performance of the units with respect to its operation at three different linear cell speed (peripheral speed of the metering roller) of

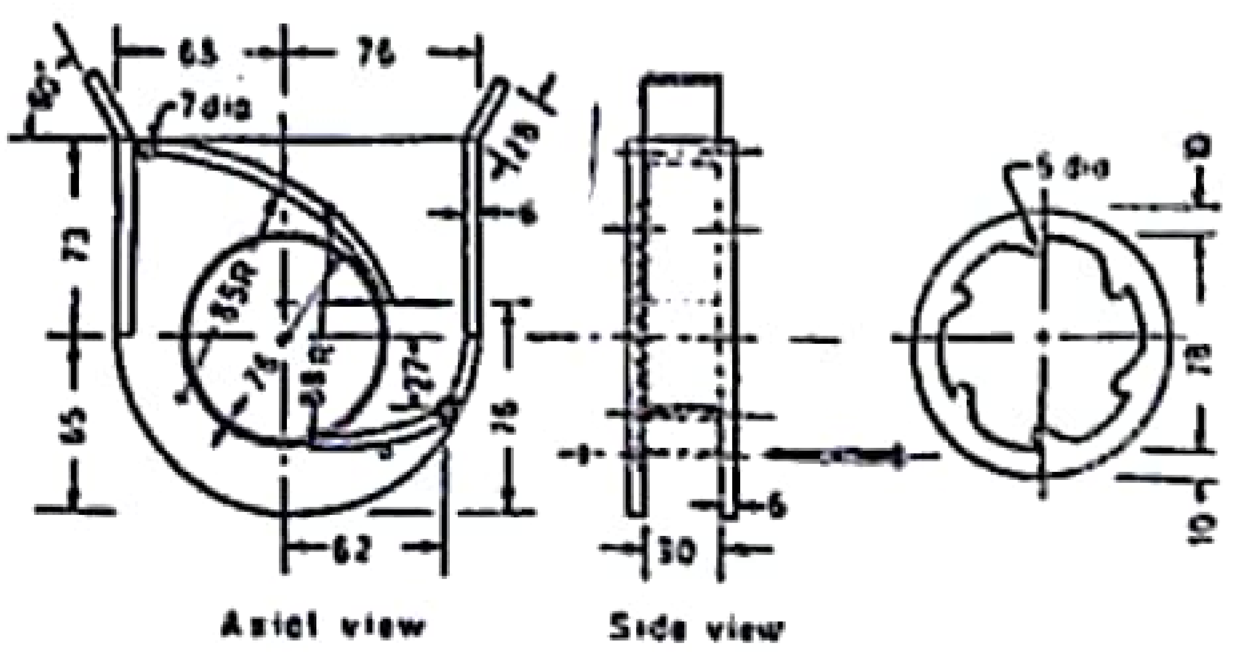


Fig 3a Metering case with replaced cover    Fig 3b Seed retainer

All dimensions are in mm

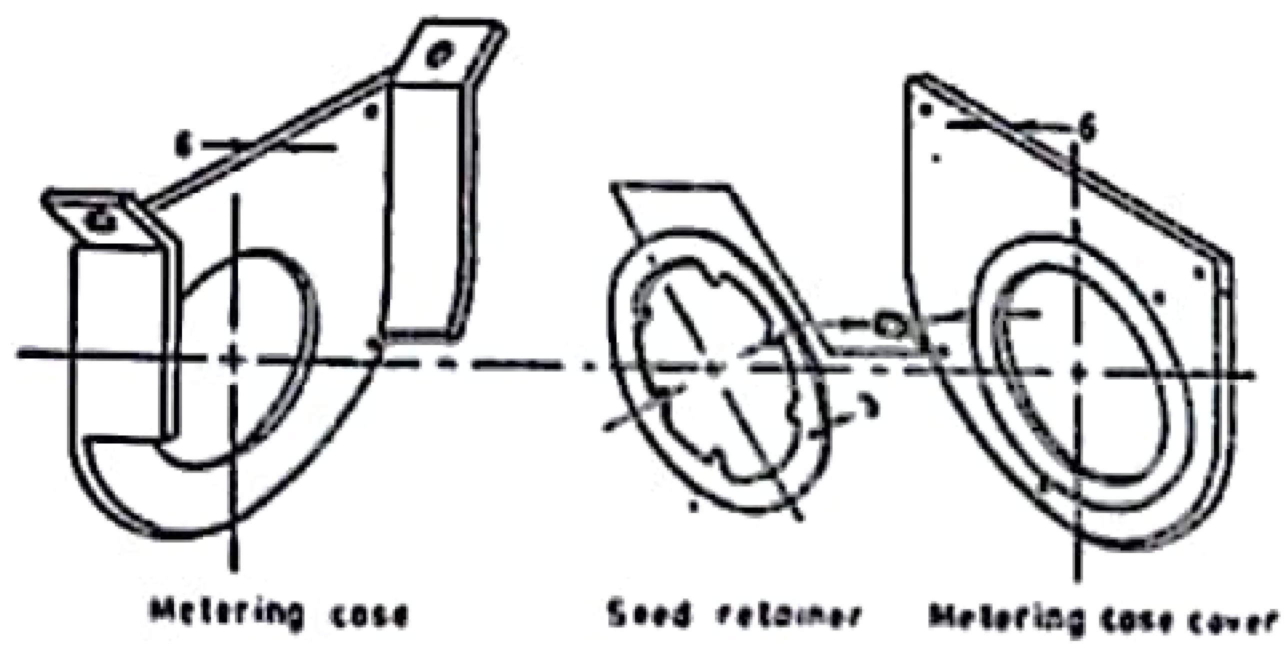


Fig 4 Metering case assembly

All dimensions are in mm

0.275, 0.346 and 0.373 m/s, and four different settings of metering cells as 3-4 seeds, 6-8 seeds, 10-12 seeds and 14-16 seeds. In each setting speed of the cells were maintained carefully and metered seeds were collected. Later seed rate were calculated. Four replications were made for each speed and cell setting.

Wooden and metallic (cast aluminum alloy) seed metering roller were also tried on the test bench and flow behavior of paddy and wheat seed were observed carefully. The physical dimensions of different varieties of paddy and wheat seed were measured by a micrometer (Table 1).

## RESULTS AND DISCUSSION

The irregular shape and rough surface of a paddy seed makes the prediction of its flow behavior difficult. However, the physical properties (Table 1) and flow behavior were carefully observed and accordingly metering cells were designed. It was observed that smooth shiny surface of metering roller and inner surface of the metering case and cover provided smooth grain flow and assured cell fill.

Table 1. Physical dimensions of several Paddy and Wheat Varieties ( Each data point represnts average of 100 kernels ).

| | Variety | Length (mm) | Breadth (mm) | Thickness (mm) | Volume ($mm^3$) |
|---|---|---|---|---|---|
| | Inia | 6.29 | 3.15 | 2.74 | |
| | Sonalika | 6.73 | 3.65 | 2.97 | |
| Wheat | Maxi-Pak | 5.92 | 3.35 | 2.76 | |
| | Average | 6.31 | 3.39 | 2.82 | 60.27 |
| | BR-3 | 8.94 | 2.79 | 2.11 | |
| | BR-7 | 9.39 | 2.00 | 1 80 | |
| | BR-8 | 9.04 | 2.72 | 2.11 | |
| Paddy | Chandina | 7.69 | 2.46 | 1.88 | |
| | Hashikalmi | 8.25 | 2.79 | 1.98 | |
| | Harinmuda | 8.43 | 2.84 | 2.03 | |
| | Katoktara | 8.48 | 2.31 | 1.83 | |
| | Average | 8.60 | 2.56 | 1.96 | 43.15 |

The flow behavior of paddy with metallic and wooden metering devices revealed that the wooden metering roller offered excessive resistance and hampered free flow of grain. Instead, cast aluminum alloy metering roller performed satisfactorily. Therefore, wooden metering roller was discarded. However, manufacturing of metallic metering roller required technologies like foundry and machining. However, the material and fabrication costs were still comparable with those of wooden ones.

The evaluation of the performance of metering units having different cell shape (oval, rectangular, cup and modified cup) with respect to different linear cell speed and cell setting were done through laboratory tests. It was hypothesized that there were no effect of speed and cell setting on seed rate. In case of speed the null hypotheses were accepted through the variance ratio test (Table 2) which, indicated that what ever the cell setting would be the seed rate will not be affected by speed of operation within the test range. In case of cell setting null hypotheses were rejected. Therefore, it was clear that cell setting had an effect on seed rate as expected. To find out the performance of different cell shape with respect to cell fill 't-test' statistics was used. The result clearly showed that the performance of the modified cup shaped cell was the best (Table 3). It was also observed from the test data that the modified cup shaped metering unit almost eliminated seed damage.

Table 2. Analysis of Variance for the laboratory test data with different Cell shape.

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F |
|---|---|---|---|---|
| Oval shape : | | | | |
| Speed | 2 | 6.06 | 3.03 | $F_1$= 0.66 |
| Cell setting | 3 | 4134.17 | 1378.06 | $F_2$=300.23** |
| Error | 6 | 27.55 | 4.59 | — |
| Total | 11 | 4167.78 | — | — |
| Rectangular shape : | | | | |
| Speed | 2 | 2.819 | 1.409 | $F_1$= 2.219 |
| Cell setting | 3 | 5156.466 | 1718.822 | $F_2$=2706.81** |
| Error | 6 | 3.807 | 0.635 | — |
| Total | 11 | 5163.902 | — | — |
| Cup shape : | | | | |
| Speep | 2 | 3.39 | 1.70 | $F_1$= 2.15 |
| Cell setting | 3 | 5177.01 | 1725.70 | $F_2$= 2184.59** |
| Error | 6 | 4.72 | 0.79 | — |
| Total | 11 | 5185.12 | — | — |
| Modified Cup shape ; | | | | |
| Speed | 2 | 1.55 | 0.78 | $F_1$= 0.43 |
| Cell setting | 3 | 4982.97 | 1660.99 | $F_2$=5190.59** |
| Error | 6 | 1.92 | 0.32 | — |
| Total | 11 | 4986.44 | — | — |

Tabulated values at 1% level $F_1$=10.92 and $F_2$=9.78
Tabulated values at 5% level $F_1$= 5.14 and $F_2$=4.76
**Indicate highly significant value.

Table 3. t-values for testing standard seed rates.

| Shape of the cell | Computed values of 't' at cell setting | | | |
|---|---|---|---|---|
| | 3-4 seeds | 6-8 seeds | 10-12 seeds | 14-16 seeds |
| Oval | 6.596** | 18.383** | 9.056** | 5.058** |
| Rectangular | 1.984 | 1.420 | 1.578 | 2.32* |
| Cup | 1.636 | 4.80** | 3.699** | 3.101* |
| Modified Cup | 0.146 | 0.144 | 1.973 | 0.213 |

Tabulated value at 1% level =3.106
Tabulated value at 5% level =2.201
*Indicate significant value, **Indicate highly significant value.

Some useful observations were also made during the test of metering units. It was found that at lower linear cell speed (0.275 m/s) the seeds discharged from the metering roller were in a group but, at higher cell speed (0.373 m/s) it leaves the metering roller in a continuous manner. So, by keeping lower linear cell speed through proper gear arrangement between the ground wheel shaft and the metering roller shaft hill dropping of seeds might be achieved. On the other hand by increasing linear cell speed through increased gear ratio between the ground wheel shaft and metering roller shaft drill seeding may also be ensured.

## CONCLUSION

The performance of the metallic (cast aluminum alloy) metering device with a modified cup shaped cross-section of the flutes was found best among others and almost eliminated the cell fill and seed damage problems. Even. at higher linear cell speed (0.373 m/s) the seed rates were found satisfactory in the range of 3-4 seed to 14-16 seeds per cell.

It was observed that at lower linear cell speed (0.275 m/s), the seeds discharged pattern was found continuous. So. hill dropping and drill seeding action with the same seed metering unit might be possible by making proper gear arrangement between the drive wheel and the seed metering shafts.

The material and fabrication costs of the metallic metering device was comparable with those of wooden ones. If it could be manufactured in plastic injection molds it would be further cheap and the production process would be simple.

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