Turkish Journal of Agricultural Engineering Research

https://dergipark.org.tr/en/pub/turkager
https://doi.org/10.46592/turkager.1118633

Turk J Agr Eng Res
(TURKAGER)

ISSN: 2717-8420
2022, 3(2), 204-213

Research Article

Usage of Special Feeder for Small Birds

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ABSTRACT

This study presents the possibility of using agricultural by-products to solve the problem of high forage prices. Rice mill pre-cleaning residues are considered solid waste in Egypt, as many tonnes are produced every day. These overgrown heaps always cause an environmental problem. Most millers don't know how to dispose of it. A simple device for the purification of it to use as a supplementary feeder for small birds has been manufactured. It comprises an air supply, a hopper, a case, and two drawers (one for receiving eaten parts and the other for receiving impurities). The mixture of rice millers' residues is agitated by the air stream and floats the fine particles upwardly in the far drawer while the air escapes through the final air holes. Performance evaluation was conducted on the manufactured device with various airspeeds (1.8, 2.6, 3.2 and 4.3 m s^{-1}), baffle angles (30, 40, and 50°) and feed rates (3.6, 5.7, 8.2, and 9.3 kg min^{-1}). The maximum value of purifying efficiency (87.67%) is achieved at an airspeed of 4.3 m s^{-1}, a baffle angle of 30°, and a feed rate of 3.6 kg min^{-1}. The minimum mean of losses (0.4%) is achieved at an airspeed of 1.8 m s^{-1}, a baffle angle of 50°, and a feed rate of 3.6 kg min^{-1}. There is a significant increase in the purifying efficiency and a significant decrease in losses when using the purifying device, so it is recommended to use it for the purification of rice residues.

RESEARCH ARTICLE

Received: 19.05.2022
Accepted: 18.07.2022

Keywords:

- Rice mill,
- Pre-cleaning residues,
- Purifying,
- Special feeder,
- Small birds

To cite: Al-Rajhi MAI (2022). Usage of Special Feeder for Small Birds. *Turkish Journal of Agricultural Engineering Research (TURKAGER), 3(2), 204-213.* https://doi.org/10.46592/turkager.1118633

INTRODUCTION

Rice in Egypt is the main cereal crop during the sunner season. The annual cultivated area is about 600000 ha, producing 6 million tons of paddy rice. The average yield of 10 t ha^{-1} is considered as one of the highest levels wordwide (RRTC, 2018). Rice milling is an important step in the production of rice, as rice is a vital source of food for about

3 billion people every year (FAOSTAT, 2017). Pre-cleaning, hulling, and post-hulling are all steps in the rice milling process. A pre-cleaner used in rice mills usually contains an oscillating double screen bed. The first screen is a scalper that lets through the grain but retains straw. The second screen retains the grain, but lets through broken grains, weed seeds, and fine dust. Pre-cleaning residues [broken grains, weed seeds such as Branyard grass (*Echinochloa crus-galli*), some light particles and fine dirt] are considered solid waste in common Egyptian rice mill centers. These overgrown heaps of rice residues cause environmental problems if not handled and adequately removed. There is an urgent need to search for the best method of disposing of this residue in order to encourage a healthy environment for everyone. Despite the numerous rice miller residues generated every day and their long-term effects on the surrounding environment, no serious attempts have been made to dispose of them safely (Njoku and Mbah, 2012).

Byproducts of rice milling have been investigated within animal production systems, particularly poultry (Ebling *et al*., 2015; and Rubinelli *et al*., 2017). Branyard grass is one of the most harmful weeds in rice crops (Heap, 2014a). Small birds like pigeons and canaries prefer to eat it, so it is grown for fodder, grain, or birdseed (Barkworth *et al*., 2003). Also, ducks have been observed to eat the seeds of Branyard grass (Kramer and Euliss 1986). It is tested as a forage (Mitich, 1990).

Gravity separators separate seeds according to their weight and size. Long seeds are separated from short ones by indented discs and cylinder separators. Velvet roll separators remove smooth seeds from rough seeds. Electronic separators sense a difference in the electrical properties of seeds. The better and more efficient way to separate seeds that present a different resistance to airflow is through pneumatic and aspirator separation (Emami *et al*., 2007).

In the Northern Delta of Egypt, large quantities of rice mill pre-cleaning residues accumulate from the numerous rice mills located in the area. So, it is necessary to study the possibility of using rice mill residues as a supplementary feeder for small birds. The specific objectives of the present study are to test and evaluate the device manufactured by EL-Shabrawy and Al-Rajhi, 2020, which is used to remove husks from the food [Barnyard grass (*Echinochloa crus-galli*)] of bet birds (Parakeets and Canaries) in removing impurities (fine dirt, dust, and very small particulates that either intermix with or adhere to rice grains) and to effectively use weed seeds and broken rice grains as a feeder.

MATERIALS and METHODS

Material

This study was conducted in a rice-producing district located 31.23º N, 31.98º E at Al-Manzala, Dakahlia Governorate, Egypt, during the summer season of 2021. A rice milling plant in the indicated producing region provided rice mill residues from rice varieties (*Oryza sativa* L.); namely cvs; Giza 178 (8.17 mm length, 3.97 mm width, 2.47 mm thickness and 16.87 g mass of 1000 grains). Giza 178 is an Egyptian high-class and high grain yield type with excellent cooking qualities. The used samples of rice mill pre-cleaning residues that accumulated under the pre-cleaner were collected and manually packed in polyethylene bags and kept at 4±1ºC for three weeks. Before the experiment began, the samples were taken out of the refrigerator and maintained at room temperature. The components of rice mill pre-cleaning residues were determined before purifiying operation such as: mass of broken grains, weed seeds and fine particles in one kg.

Principles of operation

The main working principle of the purifying device is that when air is blown from the side, heavier materials are collected at one place, while lighter materials are blasted away by the strong air. Mixture have varying characteristics, which require different airspeeds for achieving the best result of purifying, therefore adjustment of airspeed and proper feeding of mixture is essential.

Device description

Figure 1a and Figure 1 b illustrates the device manufactured by EL-Shabrawy and Al-Rajhi, 2020 and used for purifying rice mill pre-cleaning residues. The device was made using clear polycarbonate sheets, a material that is available locally at a cheap price and is characterised by its rigidity, durability and transparency. It consists of a rectangular transparent body with a maximum length of 350 mm and a maximum width of 270 mm. It is divided into two equal portions and provided with a hopper. A supply hopper is disposed above the inlet, and a sliding gate was used for controlling mixture flow. The hopper's dimensions were selected based on symmetry, and it was constructed as a trapezoidal shape. The volume of the hopper is 0.045 m^3, and the angle of the base to the vertical is about 45°. Hopper receives and conveys mixture to the purifying unit. Two blast fans work as an air source and created an airflow transverse to the path of the particle flow to remove the fine particulates from the main mixture, as illustrated in Figure 2. On opposite sides of the device, alternately arranged downwardly sloping baffles receive particle flow and direct it into a rotatable means that converts the linear momentum of the particle flow as it cascades down the baffles to angular momentum, fanning out the fine particulates into the airstream. Each successive baffle is longitudinally spaced from the previous baffle. The lower edge of each baffle remotely overlaps the top surface of the successive baffles, so the particulate material introduced into the particle flow channel must follow a circuitous route from the material inflow inlet to the material outflow outlet. Once the particle flows and passes through the inlet, it impacts and gravitationally moves down the uppermost baffle towards the lower edge. To release the air, there is a series of finely spaced air holes on the opposite side of its lower end to allow the current of air to pass through it. It has a vertically placed column with a particle flow channel through which an airstream is generated. Figure 2 illustrates the switch (dimmer) used for regulating the air blast. Both fans are connected to the adapter with suitable wiring. The mechanism of the device manufactured by EL-Shabrawy and Al-Rajhi, 2020 and used to purify rice mill pre-cleaning residues is shown in Figure 3. Shows schematic diagram of the device.

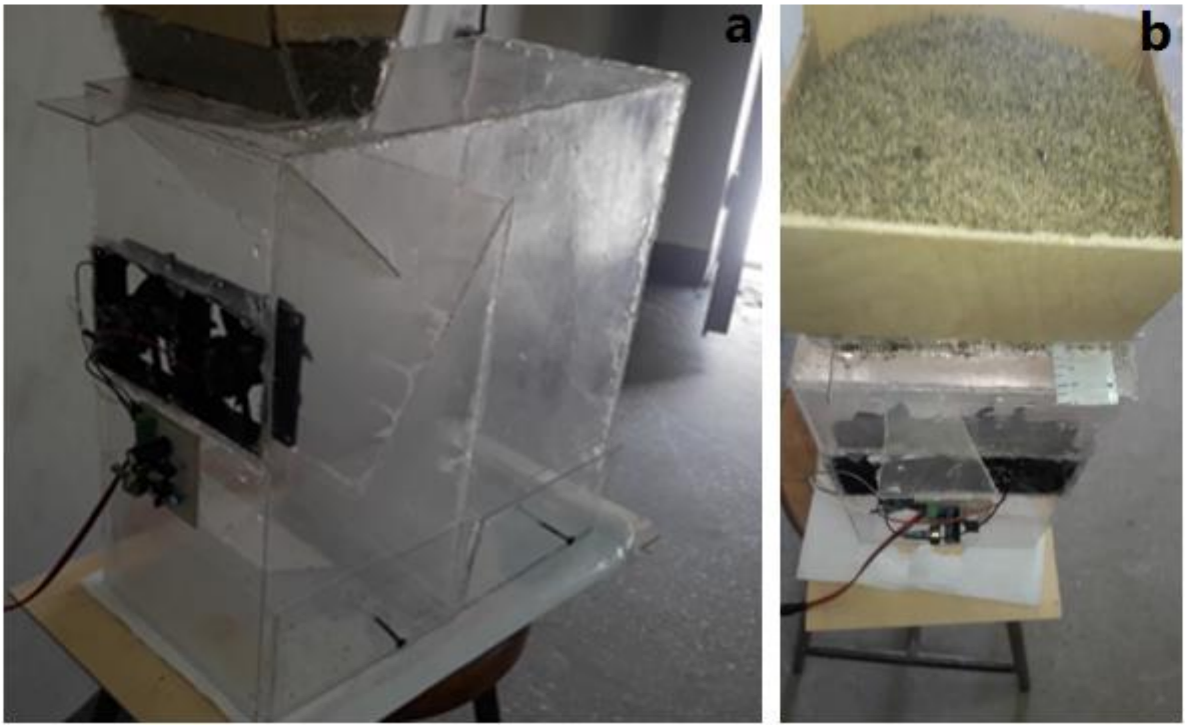

Figure 1. a. The device side view. **Figure 1. b.** The device rear top view.
Figure 1. The device of purifiying rice mill pre-cleaning residues.

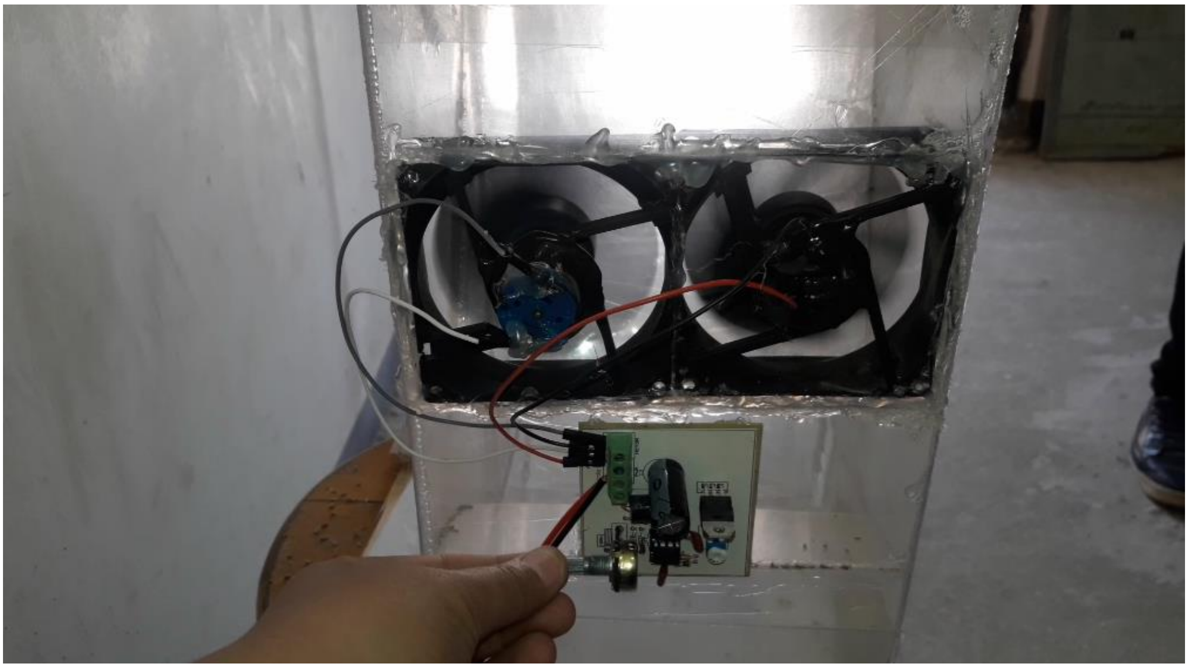

Figure 2: Blast fans and switch.

Methods
After a mixture of broken grains (1), weed seeds, fine dirt, dust, and very small particulates that either intermix with or adhere to rice grains is fed into the airflow path, the airflow removes the lighter material and allows the broken grains and weed seeds to fall into the first drawer (7). As shown in Figure 3, the material is subjected to a strong upward draft, which carries a significant portion of the lighter foreign matter into the air duct.

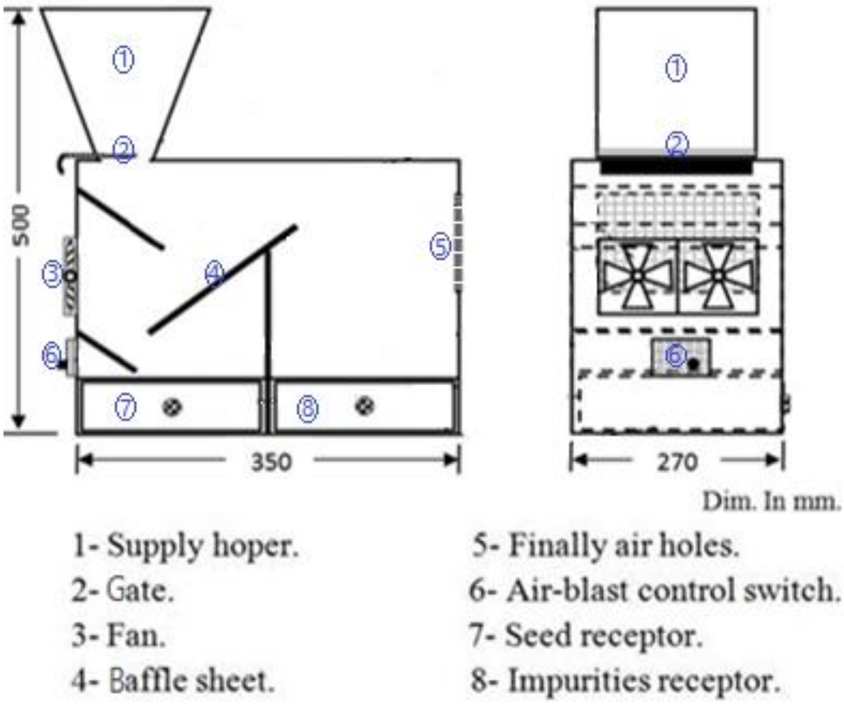

Figure 3. A schematic diagram of the device.

Experimental design and performance evaluation

The test's experimental design was a complete randomised. Anemometer was used to measure airspeeds in m s^{-1}. The baffle angle means the angle between the horizontal line and the line of the long baffle side. It was measured using a protractor. The feed rate test was timed using a stopwatch and the mass was measured using electric digital balance.

Tested variables

Three variables were studied. They were as follows:

1) Four airspeeds (S) of 1.8, 2.6, 3.2 and 4.3 m s^{-1} named S_1, S_2, S_3, and S_4 respectively, were adjusted using a dimmer located in the control panel (Figure 3).

2) Three baffle angles (A) of 30, 40 and 50° named A_1, A_2, and A_3 respectively, were investigated.

3) Four feed rates (F) of 3.6, 5.7, 8.2 and 9.3 kg min^{-1} were investigated, named F_1, F_2, F_3, and F_4 respectively.

Measurements

Feeding rate

The feed rate ($Fr.$, kg min^{-1}) was calculated using Equation 1.

$$Fr. = \frac{W_{\mathrm{mf}}}{T_t} \qquad (1)$$

Where:

W_{mf} = Mass of mixture fed into hopper, kg

T_t = Total time taked, min.

Purifying efficiency, %

Purifying efficiency (ηp., %) was calculated using Equation 2.

$$\eta_{P.} = \frac{I_{sample} - I_{separated}}{I_{sample}} \times 100 \quad (2)$$

Where:

I_{sample} = Mass of impurities in the sample, g

$I_{Separated}$ = Mass of separated impurities, gram.

Losses, %

Losses (*L*, %) is calculated using Equation 3.

$$L = \frac{w_{sample} - w_{separated}}{w_{sample}} \times 100 \quad (3)$$

Where:

w_{sample} = Mass of the sample's eaten part, g

$w_{separated}$ = Mass of separated eaten part, gram.

Statistical analysis

The experiments were replicated three times. The data were statistically analyzed using the Costat Program (Oida, 1997) to determine the statistical significance of the variables under consideration based on the probability ($P<0.05$).

RESULTS AND DISCUSSION

Specification of rice mill pre-cleaning residues

Three samples of about 1 kg each were taken randomly from the abovementioned producing region. The components of the mixture were as indicated in the following Table 1. The eaten part represented 60.9% of the whole component.

Table 1. The components of rice mill pre-cleaning residues.

Mixture components of about 1000 gram		
Broken grains	Weed seeds	Fine particles
403 gram	206 gram	391 gram

Factors affecting purifying efficiency, %

The results are shown in Figure 4 illustrate the effect of airspeed, baffle angles, and feed rate on purifying efficiency, %. Increasing the cleaning speed increased the mean purifying efficiency from 72.67% at an airspeed of 1.8 m s^{-1} to 80.69% at an airspeed of 4.3 m s^{-1}. However, the mean best values for purifying efficiency were 81.02 and 80.59%, respectively, which were directly related to a baffle angle of 30° and feed rate of 3.6 kg min^{-1}. The mean minimum values for purifying efficiency were 72.88 and 74.33%, respectively, at a baffle angle of 50° and a feed rate of 9.3 kg min^{-1}. These results can be attributed to the low baffle angle, which scatters the mixture and exposes the most amount of mixture to the air stream, as well as the lower feed rate, which allows for a longer exposure period to the cleaning air stream.

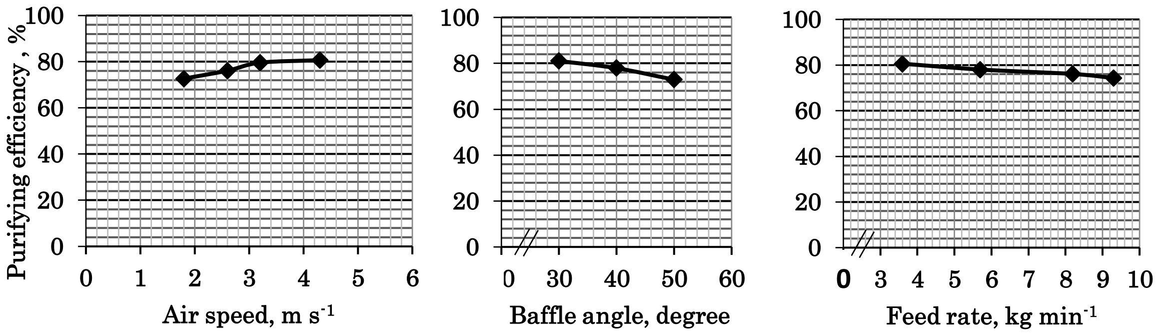

Figure 4. Effect of airspeed, baffle angle and feed rate on purifying efficiency, %.

Statistically, there's a highly significant difference between the tested factors of the purifying efficiency (Table 2). Also, the total interaction between different treatments shows a highly significant effect [P<0.05]. ANOVA analysis indicated highly significant differences between the treatments. A simple power regression analysis was applied to relate the change in purifying efficiency with the change in the tested factors for all treatments. The obtained regression equation was in the form of:

$$\eta P, \% = 90.78 - 1.0399\ F. + 3.276\ S. + 0.4073\ A. \quad (R^2 = 0.8521).$$

[Where: Purifying efficiency (ηP, %), Feed rates (F), Airspeeds (S), and Baffle angles (A)]

Table 2. Means and standard errors for seed losses, % affected by studied factors.

Factors		**Purifying efficiency, %**
Air speed	**S_1**	72.67 ± 1.674^{a}
	S_2	76.11 ± 1.765^{c}
	S_3	79.58 ± 0.655^{b}
	S_4	80.69 ± 0.777^{d}
	P-value	0.0001
Baffle angle	**A_1**	81.02 ± 1.266^{b}
	A_2	77.90 ± 1.304^{a}
	A_3	72.88 ± 1.178^{c}
	P-value	0.0001
Feed rate	**F_1**	80.59 ± 0.104^{b}
	F_2	78.03 ± 1.544^{a}
	F_3	76.11 ± 1.174^{b}
	F_4	74.33 ± 0.924^{c}
	P-value	0.0001

[a-b] the means with no common superscript within each column differed significantly (P<0.05).

Factors affecting losses, %

The data presented in Figure 5 shows the effect of airspeeds, baffle angles, and feed rate on the loss percentage. Decreasing airspeed decreases the mean losses from 3.76 at an airspeed of 4.3 m s^{-1} to 0.98% at an airspeed of 1.8 m s^{-1}. The lowest mean percentage of losses was 2.28 and 1.66 with 50º of baffle angle and a feed rate of 3.6 kg min^{-1}. The slight increase in the losses may be due to the increase in the angle of the border and the increase in the feeding rate, which lead to an increase in the scattering of the larger amount of the mixture, which gives a greater chance for the drift of the mixture exposed to the relatively high air stream.

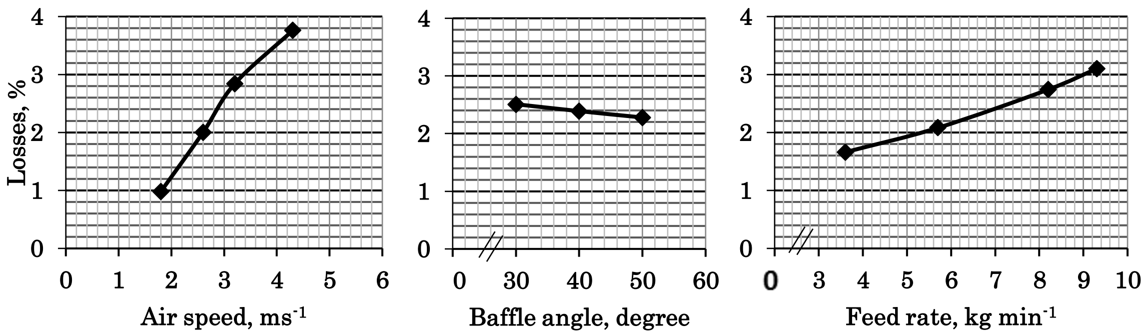

Figure 5. Effect of airspeed, baffle angle and feed rate on losses, %.

Also, the total interaction between different treatments indicates a highly significant effect of $P<0.05$ for the percentage of losses (Table 3). ANOVA showed highly significant differences between the treatments. Also, a simple power regression analysis was applied to relate the change in percentage of losses with the change in the tested factors for all treatments. [Where: Loss percentage (L, %), Feed rates (F), Airspeeds (S), and Baffle angles (A)]. The obtained regression equation was in the form of:

L, % = 1.214 - 0.2515 F. + 1.1196 S. + 0.01167 A (R^2=0.9067).

Table 3. Means and standard errors for losses, % affected by studied factors.

Factors		Losses, %
Air speed	S_1	0.98 ± 0.014^d
	S_2	2.00 ± 0.016^b
	S_3	2.84 ± 0.005^c
	S_4	3.76 ± 0.010^a
	P-value	0.0001
Baffle angle	A_1	2.51 ± 0.066^a
	A_2	2.39 ± 0.004^b
	A_3	2.28 ± 0.008^c
	P-value	0.0001
Feed rate	F_1	1.66 ± 0.044^d
	F_2	2.08 ± 0.071^a
	F_3	2.74 ± 0.014^c
	F_4	3.10 ± 0.024^b
	P-value	0.0001

[a-b] the means with no common superscript within each column differed significantly ($P<0.05$).

CHALLENGES AND FUTURE STUDIES

After purification of rice millers' residues, I find that I have a huge amount of light particles and fine dirt or dust. So, it is recommended to use it to improve soil properties and crop yield as mentioned by Anikwe (2000) and Njoku *et al.* (2011). We must also search for alternative sources of food for birds and fish due to the high price of forage.

CONCLUSION

This study investigated the posibitty of using weed seeds and broken rice grains as a special feeder for small birds. Four airspeeds, three baffle angles and four feed rates were studied. The maximum value of purifying efficiency (87.67%) was achieved at an airspeed of 4.3 m s^{-1}, a baffle angle of 30^o, and a feed rate of 3.6 kg min^{-1}. The minimum value of seed losses (0.4%) was achieved at an airspeed of 1.8 m s^{-1}, a baffle angle of 50°, and a feed rate of 3.6 kg min^{-1} So, it is recommended to use the purifying device at an airspeed of 4.3 m s^{-1}, a baffle angle of 30^o, and a feed rate of 3.6 kg min^{-1} to increase the purifying efficiency and use it at an airspeed of 1.8 m s^{-1}, a baffle angle of 50^o, and a feed rate of 3.6 kg min^{-1} to lessen seed losses.

DECLARATION OF COMPETING INTEREST

The author declares that he has no conflict of interest.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

The author would like to declare that he solely developed all the sections in this manuscript.

ETHICS COMMITTEE DECISION

This article does not require any ethical committee decision.

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