All the food sources comprise edible and non-edible waste portions. With increasing demand for food and feed the current agriculture is focusing on agro-processing to utilize the maximum portion of the plant or animal resources. This review paper aims at summarizing the present status of utilization of jackfruit (*Artocarpus heterophyllus* Lam, Moraceae) wastes in food, feed, and other industry. Apart from the non-edible portion like peel and axis, the edible by-products like seeds of jackfruit mostly remain underutilized worldwide including Bangladesh. This article has reviewed the works devoted to utilize different waste portions of jackfruit other than the juicy edible bulbs. There are many works which suggested that the thick peel of jackfruit can be utilized in nutrient enriched cattle feeds, extraction of bio-fuel, nano-porous adsorbent for removing dye etc. The peel and central axis of this fruit also had investigated for extraction of pectin. The seeds of jackfruit were attempted by many researches to be used in various bakery products. The starch and protein fractions were isolated from jackfruit seeds flour to make them use at a purified state in the food formulations.

**Keywords:** Jackfruit peel, jackfruit seeds, jackfruit central axis, nutritional composition.

**Introduction**

The varied agro-climatic zones of Bangladesh are amenable to grow a wide variety of fruits like mango, jackfruit and pineapple. Among them, jackfruit (*Artocarpus heterophyllus* Lam.) belonging to the family Moraceae is one of the most popular and evergreen trees in tropical areas like Bangladesh. It originated from the Western Ghats of India (Goswami et al., 2010). For the abundant production and popularity, this fruit is termed as the national fruit of Bangladesh, locally called kathal. The climatic condition of this country is very suitable for jackfruit cultivation (Rahman et al., 1999). The annual production of jackfruit is about 1031316 MT from about 27316 acres of land in Bangladesh (BBS, 2016). It is a leading source of bioactive compounds like vitamin C and beta-carotene that act as antioxidants to protect the body against free radicals and strengthens the immune system. It is also rich in various phytonutrients such as lignans, isoflavones, and saponins (Swami et al., 2012).

There are abundant production of food wastes during processing the raw agricultural products to finished products. Some of this wastes end up as animal feed and some are returned to the land as a nutrient. Different industries related to the agricultural sector generate a lot of waste in the form of peels, seeds, whey, waste liquid, molasses, bagasse, and so on (Balasundram et al., 2006). The generated waste is not only biodegradable
but also rich in nutrient components such as carbohydrate, protein, and vitamins depending upon the sources. Recycling is one of the most important means of utilization of the agricultural waste components to a number of new products such as organic fertilizer and as a raw material in the paper industry. Recovery of the beneficial bioactive compounds from fruits and vegetable wastes is a newer research trend. The isolated or extracted valuables from these wastes are evidently contributing to meet the nutritional requirements for human, animal, and plant as well as in the pharmaceutical industry (Sogi et al., 2002).

The increased food demand by the rapidly growing population of the world has posed a great challenge to the incumbent sectors such as food researchers and manufacturers to maximize the utilization of the existing food or plant resources. About, 70 to 80% of a jackfruit consists of waste and by-products. The outer rind or peel, central core, and perianth make up about 55 to 60% of this fruit (Subburamu et al., 1992). Seed is an important by-product that consists around 12-14% of a whole jackfruit (Prathima, 2008). Numerous food and feed research groups have been working on the possibility of using the waste or underutilized portion of jackfruit (Tiwari and Vidyarthi, 2015; Singh et al., 1991; Moorthy et al., 2017; Mukprasirt and Sajjaanantakul, 2004). This review paper has outlined the relevant literatures to summarize the information on processing and utilization of jackfruit wastes that would be useful for the possible extension of food and feed industries.

**Jackfruit**

Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the largest edible fruits grown worldwide. A distinguishing feature of jackfruit tree is its ability to produce a higher yield of fruits than any other tree in the Moraceae family producing 70-200 kg of fruit per tree depending on variety, cultural practices, and environmental factors. Average weight of a fruit is about 3.5 to 10 kg and sometimes a fruit may reach up to 25 kg (Kumar et al., 1988). Various types of jackfruits such as Khaja, Gala, and Durasha are found in the south-east Asian region (Haque, 1993). Khaja is characterized by the hard and crispy bulb, gala poses soft, juicy, and melted bulb, and Durasha is an intermediate between Khaja and Gala. The tender jack fruit is a popular vegetable and used in making soup and pickles. Chips and papads are also prepared from ripe and unripe pulp. The juicy pulp of the ripe fruit is eaten fresh or preserved in syrup. This fruit is potential for preparing jam, jelly and value added products due to the presence of pectin (Singh et al., 1991). During season, the poor people generally used to eat this fruit instead of rice at least once a day in jackfruit growing area. That’s why it is commonly referred to as “The Poor man’s food” (Rahman et al., 1995).

**Common wastes and by-products of jackfruit and its utilization**

The consumption of fresh jackfruit as well as the processing of this fruit result in a high amount of non-edible fruit such as peel and central axis and edible by-products such as seeds and perianth.
Non-edible wastes

Jackfruit peel
Jackfruit peel, also known as rind or skin, is the outer protective layer of the fruit which consists around 57.17, 46.45, and 40.05% in Khaja, Gala, and Durasha variety respectively (Anonymous, 1996). The unsystematic disposal of peel imposes a serious burden on the environment. However, proper utilization of the by-products not only increases the economic value but also reduces the cost of disposal. Jackfruit peel is reportedly rich in cellulose, pectin, protein, and starch comprising about 27.75%, 7.52%, 6.27%, and 4%, respectively (Sundarraj and Ranganathan, 2017).

Central core or axis of jackfruit
Subburamu et al. (1992) prepared a meal from the jackfruit central core and found carbohydrate (20.5%), crude protein (10.6%), and crude fibre (15.9%) are the principal proximate compositions.

Utilization of non-edible wastes

Animal feed
Subburamu et al. (1992) recommended the jackfruit peel as a valuable raw material for the cattle feed as this is a rich source of carbohydrate, protein, and fiber containing 24%, 8.7%, and 17.3%, respectively. Ajey (2013) studied on jackfruit waste for the nutrient-enriched animal feed by supplementing nitrogen and fermenting with yeast (S. boulardii) and LAB (L. acidophilus). The results revealed that the jackfruit waste feed supplemented with 2% ammonium sulphate and fermented by combined yeast and LAB recorded the highest crude protein (22.34%) and crude fibre (23.37%). The developed feed from jackfruit waste in the form of dried powder contained moisture 5.42%, carbohydrate 71.40%, protein 23.81%, crude fibre 22.63%, crude fat 6.37%, and ash 6.5%.

Kusmartono (2007) suggested that the jackfruit waste consisting of peel and axis, has a high potential as a ruminant feed, especially for sheep and steers. The sheep feeds were prepared by several formulations of jackfruit waste mixed with rice straw, urea etc. Addition of urea resulted into depressed intake of jackfruit waste by sheep, with as compensatory increase in the intake of rice straw. Higher digestibility of the feed materials in sheep receiving N supplementation were directly related to their rumen ammonia concentrations. The authors advised for molasses-urea cake supplementation rather than mixing urea with jackfruit waste for the optimized digestibility of the cattle feed.

Bio-fuel
Soetardji et al. (2014) extracted bio-oil from the jackfruit peel waste by pyrolysis process in a fixed bed reactor and investigated the extracted oil. After pyrolysis in a range of high temperatures (400-700°C) they found that the peel contains high amount of volatile compounds which indicates this biomass as a suitable precursor for bio-oil production. Low sulphur (0.03%) and nitrogen (0.61%) contents were the strong indication to be environmental friendly bio-oil. The study found the best quality bio-fuel at the temperature of 550°C with the highest organic content (85.2%) and the lowest water content (14.8%). On the other hand, Yuvarani and dhas (2017) extracted bio-ethanol (oxygenated fuel) from jackfruit peel by fermentation using Saccharomyces
Cerevisiae yeast as a microorganism. The main types of raw materials for ethanol production using biological method were cellulose, carbohydrate and sugar. The effect of various parameters such as composition of jackfruit peel, temperature, shaking rate, fermentation time, and nutrients were studied and the optimum conditions were obtained. The result showed that the ethanol extraction was increased by increasing the jackfruit peel composition and decreased by increasing the temperature.

**Extraction of pectin**

Xu et al. (2018) explored jackfruit peel for pectin content using different organic acids and mineral acids. They introduced a new method, ultrasonic- microwave- assisted extraction (UMAE), for extracting pectin and compared its performance with a conventional heating method. The UMAE method showed superior performance in extracting pectin in the optimum conditions such as extraction temperature 86 °C, extraction time 29 min, and solid-liquid ratio 1:48 (w/v). Begum et al. (2014) studied for yield and characterization of pectin from the core of jackfruit. The waste treated with ammonium oxalate, dilute sulphuric acid, and sodium hexametaphosphate yielded a good amount of calcium pectate (1.74-1.92%). However, the extracted pectin was poor in terms of solubility and high ash content compared to the commercial pectin.

**Extraction of bioactive compounds**

Zhang et al. (2017) carried out a comparative study to quantify the antioxidant and hypoglycemic contents in jackfruit peel, pulp, and seeds. The extracts were analyzed by HPLC and the results revealed that the peel extract contained the highest total phenolic and total flavonoid compounds than that of pulp and seeds. The predominant bioactive compounds like as prenylflavonoids, hydroxycinnamic acids and glycosides were also found in peel extract. The authors implied the jackfruit peel as a new source of natural antioxidants and hypoglycemic agents.

**Nano-porous adsorbent for removal of industrial dye**

In the race of finding organic compounds to remove the industrial dyes, Jayarajan et al. (2011) found the jackfruit peel as a nano-porous adsorbent for removing Rhodamine (Rd) dye from the wastewater. They explained the Freundlich isotherm model to show the extent of dye reduction by the jackfruit peels at different dosages, temperatures, and pH. The study recommended the jackfruit peel as a low-cost alternative for removing Rd dye from the commercial wastewater.

**Edible wastes**

**Jackfruit seeds**

The seeds make up around 10 to 15% of a jackfruit (Ocloo et al., 2010). These seeds are indeed very rich in digestible starch, protein, and minerals (Singh et al., 1991). Kumar et al. (1988) reported that jackfruit seeds contain 76.1% carbohydrate, 17.8% protein, and 2.1% lipid, on dry basis. Sumathy et al. (2007) quantified the significant amount of lignin, isoflavones, saponins, and many phytonutrients in jackfruit seeds. The health benefits of these nutrient components are wide-ranging from anticancer to antihypertensive, antioxidative, and antiulcer effects. Fernandes et al. (2011) found the seeds are good sources of vitamin B₁ and B₂. Bhat and Pattabiraman (1986)
F. Akter and M. A. Haque

reported that the seeds extract inhibits the proteolytic activities of pancreatic hormones in different animal. Additionally, Odemelam (2005) found the satisfactory functional properties such as bulk density, oil absorption capacity, and gelation concentration of the seeds flour. Theivasanthi and Alagar (2011) proved the antibacterial effect of nano-sized particles of jackfruit seeds against *E. coli* and *B. megaterium*.

**Jackfruit perianth**

The edible bulbs in jackfruit are separated into compartments by latex-like filaments called ‘rags’ or perianth. This waste portion consists about 25% of a total fruit weight (Dam and Nguyen, 2013).

**Utilization of edible wastes**

**Extraction of oil from jackfruit seeds**

Babu (2017) carried out research on the extraction of oil from jackfruit seeds by a traditional milling process. About 6kg of the seeds was obtained to extract 2L of oil. He reported that jackfruit seeds oil was rich in Essential Fatty Acids like linoleic acid and alpha-linolenic acid. They estimated 1.35g/100g free fatty acid in the jackfruit seeds oil.

**Processing of jackfruit seeds into flour**

The jackfruit seeds can be processed into flour by using different processing methods such as autoclaved, dried, roasted, boiled and germinated (Eke-Ejiofor *et al.*, 2014). Akter (2018) prepared jackfruit seeds flour by using the simple drying method. The seeds were washed properly after separating from the jackfruit bulb. Then they were sun dried so that the white outer layers of the seeds were easily separated. After cutting approximately 3 x 4 mm sized pieces they were dried into cabinet dryer to bring the moisture content within 10 - 12%. Finally, the seeds were ground to make flour and passed through a 75 micro size mesh sieves. The obtained flour was packed into airtight containers.

The flour from seeds is a fruit residue established as an alternative source of protein, starch, and fiber. Akter (2018) determined the proximate compositions of jackfruit seeds flour. The results are presented in Table 1, where she found the highest amount of carbohydrate (78.65%) in jackfruit seeds flour followed by protein content of 10.26%. This flour is a good source of minerals. Rengsutthi and Charoenrein (2011) studied the seeds flour for micronutrients and some functional components which are presented as in Table 2. Many works have been carried out to use the seeds flour as an ingredient in food formulation. Some works dedicated to separate the seed flour into starch and protein and to characterize them for their efficient uses. This part collated the research works on making seeds flour, isolation or extraction the flour components, and their use in food preparation.

**Table 1. Proximate composition of jackfruit seeds flour**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Values (%) dry matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>7.63</td>
</tr>
<tr>
<td>Crude fat</td>
<td>1.11</td>
</tr>
<tr>
<td>Ash</td>
<td>2.35</td>
</tr>
<tr>
<td>Protein</td>
<td>10.26</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>78.65</td>
</tr>
</tbody>
</table>

Source: Akter (2018)
Extraction of starch from jackfruit seeds flour

Starch is the most abundant and important food ingredient that attributes in innumerable industrial applications. Jackfruit seeds flour has been proved to be a good source of starch applicable to the various food industry (Mahumod et al., 2014; Rengsutthi and Charoenrein, 2011; Kittipongpatana and Kittipongpatana, 2011). Noor et al. (2014) studied the physicochemical and functional properties of flour and starch from three varieties of jackfruit seeds. They found the flours contain 81.05%-82.52% starch with 26.49%-30.21% amylose. They extracted starch using distilled water, alkaline, and α-amylase enzyme. The extracted starch contained a varied amount of components such as 8.39 to 12.20% moisture, 1.09 to 3.67% protein, and 0.03 to 0.59% ashes. Tulyathan et al. (2002) reported that the jackfruit seeds starch had 25% water absorption capacity, 17% oil absorption capacity, and 6% amylogram concentration. Rengsutthi and Charoenrein (2011) extracted starch from jackfruit seed and corn and compared their effectiveness to use as a thickener and stabilizer in chilli sauce.

Extraction of protein from jackfruit seeds flour

Protein from animal origin is continuously being replaced by that of the plant origin for its appreciated nutritional properties and expected health benefits (Nunes et al., 2003). Unlike starch, there are very limited reports on jackfruit seeds protein in the literature. Reis et al. (2016) studied the extraction of protein from the flour of jackfruit seeds by reverse micelle system. This system was composed of sodium dodecyl sulfate (SDS) as a surfactant, butanol as a solvent, and water. The study isolated the seeds protein with 79.00% crude protein content. Recently Akter (2018) has isolated the protein from jackfruit seeds by pH treatment and centrifugation process. This study isolated the crude protein with 76.9% purity. The isolated protein showed acceptable functional characteristics such as foaming, emulsion, and gelling properties (Table 3). The observed properties implied that the isolated protein is suitable for use as an ingredient in the food formulation.

Preparation of bakery products using jackfruit seeds flour

Value addition not only enhances proper utilization during the glut but also increases the shelf life of food materials in processed form. There are numerous works on the utilization of jackfruit seeds flour is documented in the literature (Chowdhury et al., 2012; Airani, 2007; Tulyathan et al., 2002). Some of them are discussed in the ensuing sections.

### Table 2. Micronutrients and some functional properties of jackfruit seeds flour

<table>
<thead>
<tr>
<th>Micronutrients/other components</th>
<th>Jackfruit seed Flour (per 100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg)</td>
<td>77.3</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.59</td>
</tr>
<tr>
<td>Phosphorous (mg)</td>
<td>43.7</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>14.7</td>
</tr>
<tr>
<td>Copper (mg)</td>
<td>1.04</td>
</tr>
<tr>
<td>Manganese (mg)</td>
<td>0.12</td>
</tr>
<tr>
<td>Neutral detergent fiber (g)</td>
<td>5.19</td>
</tr>
<tr>
<td>Amylose (%)</td>
<td>20</td>
</tr>
<tr>
<td>Amylopectin (%)</td>
<td>80</td>
</tr>
<tr>
<td>Titratable acidity (%)</td>
<td>5.78</td>
</tr>
<tr>
<td>Lactic acid (%)</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Source: Rengsutthi and Charoenrein (2011)
F. Akter and M. A. Haque

Table 3. Functional properties of the jackfruit seeds protein isolate

<table>
<thead>
<tr>
<th>Properties</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein solubility</td>
<td>58.44%</td>
</tr>
<tr>
<td>Water holding capacity</td>
<td>2.89 mL/g</td>
</tr>
<tr>
<td>Oil holding capacity</td>
<td>1.57 mL/g</td>
</tr>
<tr>
<td>Bulk density</td>
<td>0.67 g/mL</td>
</tr>
<tr>
<td>Least gelation concentration</td>
<td>12%</td>
</tr>
<tr>
<td>Foaming capacity</td>
<td>74% at pH 11.5</td>
</tr>
<tr>
<td>Foaming stability</td>
<td>47% at pH 11.5</td>
</tr>
<tr>
<td>Emulsion capacity</td>
<td>63% at pH 11.5</td>
</tr>
<tr>
<td>Emulsion stability</td>
<td>52% at pH 11.5</td>
</tr>
</tbody>
</table>

Source: Akter (2018)

Pasta

Abraham and Jayamuthunagai (2014) used the blends of jackfruit seeds flour and wheat flour at different proportions (100:0; 95:5; 90:10; 85:15; 80:20) for the preparation of pasta. Based on the study, the composite flour increased the nutrient content and improved the textural properties of the pasta. Substitution of 10% jackfruit seeds flour in the composite got the maximum consumer acceptability. The cooking quality of pasta was assessed based on the cooking time, cooked weight, and cooked firmness. The authors remarked that the control pasta exhibited a wavy like structure because of a good network by gluten matrix; however, the addition of jackfruit seeds flour resulted in the pasta with slightly swollen and irregular in size and shape. Incorporation of 10% jackfruit seeds flour provided a good starch and gluten network yielding a well-embedded starch molecule in the matrix.

Bread and biscuits

The availability and rich nutritional and functional properties of jackfruit seeds flour have drawn the attention of the researchers and bakery manufacturers. Butool and Butool (2015) successfully added jackfruit seeds flour in bread and biscuit preparation. Incorporation of 10% and 20% jackfruit seeds flour into bread and biscuit formulations gave an outstanding eating quality in terms of colour and texture. Addition of jackfruit seeds flour increased the crude fiber content of the products. The jackfruit seeds flour incorporated biscuits showed slightly increased ash and crude fibre contents but decreased carbohydrate content (Fig. 1). Aziz (2006) supplemented the jackfruit seeds flour with wheat flour in bread preparation and found increased fiber but slightly decreased protein content in the bread. In a similar work, Hasidah and Noor (2003) incorporated jackfruit seeds flour into bread up to 25% level and was accepted by sensory panel. They concluded that jackfruit seeds flour can be substituted at a certain level with wheat flour satisfying the consumer demands. Hossain et al. (2014) used jackfruit seeds flour in different proportion with wheat flour to find out the best composition for preparing bread. The percentages of jackfruit seeds flour used in the breads were 25%, 35%, 45% and 55%. They reported the bread with a substitution of 25% jackfruit seeds flour was most acceptable in terms of nutritional value and overall acceptability.

Cake

Khan et al. (2016) prepared cake by substituting wheat flour with 10%, 20%, and 30% jackfruit seeds flour. The specific volume of cake for 20% substitution was higher than that of all other cakes.
However, the cake with 10% jackfruit seeds flour supplementation received the highest acceptability by the panelists. There were varied crust and crumb characteristics because of incorporating jackfruit seeds flour. Unlike fat and protein, other proximate compositions like carbohydrate, ash, and fiber increased in the cakes. Some other researchers are found in the literature to develop nutritionally enriched cake by supplementing jackfruit seeds flour with wheat flour (Faridah and Aziah, 2012; Arpit and John, 2015).

**Instant powder**

Hema (2015) studied the development of nutritious instant dried powder by mixing bulb and seeds of the jackfruit. The study suggested that the increment of the jackfruit seeds powder in the formulation resulted into higher protein content and lower moisture content in the instant powder.

**Use of jackfruit perianth**

Dam and Nguyen (2013) prepared fermented beverage from the fruit rags and investigated the effects of using pectinase at different rates and temperatures. The study found the optimum conditions for juice extraction were use of 0.3% pectinase at 90°C. The beverage achieved the best fermentation condition after 84 hours while kept at 25°C. Subburamu *et al.* (1992) reported that the perianth meal contains valuable nutrients like 28.9% carbohydrate, 10.3% protein, and 12.7% crude fibre.

**Discussion**

After reviewing the relevant literatures, the current article suggests that the edible bi-products such as seeds and perianth of jackfruit have great potential to be used in food industry. Presence of high content of starch, protein and minerals in the seeds has attacked the interest of many food processing
researches and manufactures of bakery and confectionary products worldwide. Incorporation of seeds flour in the bakery products not only contributes in nutrient quality but also protects the physical properties like crumb and crust characteristics of cake. High crude fiber content of jackfruit seeds is a plus point for it’s usage in food formulation. The literature also advises that the edible perianth of jackfruit has good scope to be used in preparation of fermented beverage. The dried perianth could be used in mixed feed meal for its significant content of carbohydrate, protein and crude fiber. The non-edible portion such as peel and central core of jackfruit also has prospective to be used specially in animal feed manufacturing. Apart from direct use of peel, researchers suggested for fermented and dried peel for enhanced nutrient quality of feed meal. The peel and central core of jackfruit were also proved as the source of pectin, although more scientific study are required to establish their utility in food processing.

However, utilization of the above edible and non-edible waste portion of jackfruit is not very popular and has not been commercialized in Bangladesh. More researches collaborated with possible investors are required to scale up the utilization of these bi-products in food and feed industry.

Conclusion
With increasing pressure on the existing resources, there has been a substantial effort for the use of more and more agricultural waste and by-products to value-added products. Using jackfruit wastes and by-products for further exploitation have gained augmented interest because of their high value contents.

The current review summarizes the important research efforts and findings on the utilization of jackfruit waste and by-products to make the information handy. The compiled information in this article would help the cattle feed producers, alternate food manufacturers and future researchers. Commercial production of animal feed using jackfruit peel, perianth and central core can be recommended in Bangladesh, as this country produces huge amount of these wastes every year. The seeds powder can be supplemented with other ingredients in the bakery food formulation.

References

Airani, S. 2007. Nutritional quality and value addition to jack fruit seed flour. MS Thesis, Department of Food Science and Nutrition, University of Agricultural Sciences, Dharwad.

Ajey, G. 2013. Microbial processing of jackfruit waste as animal feed. MS Thesis, University of Agricultural Sciences, Bangalore, India.


Arpit, S and D. John. 2015. Effects of different levels of jackfruit seed flour on the quality


Jayarajan, M. 2011. Agricultural wastes of jackfruit peel nano-porous adsorbent for


Guidelines to Author
(Ann. Bangladesh Agric.)

Annals of Bangladesh Agriculture is published biannually in June and December by the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). It publishes peer reviewed papers concerned with the advancement of agricultural sciences.

Aims and Scope
The “Annals of Bangladesh Agriculture” publishes original scientific work related to strategic and applied studies in all aspects of agricultural science including rural development as well as reviews of scientific topics of current agricultural relevance. Specific topics of interest include (but are not confined to): all aspects of crop improvement, crop management, plant protection, soil & water management, climate change & environment, socioeconomics & rural development, animal production and health care, fish improvement & hatchery management, marine resources and agro-processing. Novelty and originality of research are the criteria for manuscripts published in Annals of Bangladesh Agriculture.

Types of Papers Published
Contributions should fit one of the following categories: (i) Full-length articles, (ii) Short communications and (iii) Reviews. Full-length articles and short communications: These should be original research findings that have not been submitted or published elsewhere. Editor’s Note: ABA accepts Letters to the editor, a letter to the editor is a comment on research published in the journal or elsewhere. Reviews: Reviews should summarize the current state of meta or art analysis on a topic that is unique and useful in the field of agricultural sciences.

Manuscript Submission
I. Legal Requirements - Submission of a manuscript implies that the work described has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all authors as well as by the responsible authorities at the institute where the work has been carried out. The publisher will not be held legally responsible should there be any claims for compensation.

II. Permissions - Authors wishing to include figures, tables, or text passages that have already been published elsewhere are required to obtain permission from the copyright owner(s) and to include evidence that such permission has been granted when submitting their papers. Any material received without such evidence will be assumed to originate from the authors.

III. How to Submit - Manuscripts should be written in English. If the manuscript conforms to the guidelines specified in the instructions, the date received will be the date the manuscript received at the editorial office. Authors should submit their manuscripts to the Annals of Bangladesh Agriculture office or online (www.bsmrau.edu.bd/aba). Electronic submission substantially reduces the editorial processing and reviewing times and shortens overall publication times. Please connect directly to the website and this site will give the authors guideline step by step to complete submission process.

IV. Author Contribution - Each manuscript is to be accompanied by an Author Declaration Form filled in by all authors during the first submission. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content. Contributors who do not meet the criteria for authorship should be listed in the acknowledgment. Groups of persons who have contributed materially to the paper, but whose contributions do not justify authorship should be listed in the acknowledgment.
**Editorial Procedure**

Manuscript is subjected to go through blind pair review process. The Editorial Board reserves the right to accept or reject the manuscript for publication. The Board may advise the author to revise the manuscript according to suggestions by reviewers. A manuscript written in poor English may not be accepted regardless of its content. When revision of a manuscript has been requested, the revised manuscript should be submitted by the due date. Otherwise, the manuscript will be processed as one withdrawn from submission. The accepted date will be the day when the Editor-in-Chief has judged it to be publishable after the completion of the reviewing process.

**Page Limits and Page Charges**

Reviews and Full-length articles should not exceed 12 and 10 printed pages, respectively, and Short communications should be no longer than 5 printed pages. There is no page charge for publication in Annals of Bangladesh Agriculture. Color art is free of charge for online publications. For the print version, the charge for color art is TK 2000 ($25 for foreign author) for each page.

**Manuscript Preparation and Submission**

Double-spaced manuscripts should be written in English, printed on one side of A4 paper with 2.5 cm margins all around using the font Times New Roman, 12 point. Text of a full paper should not exceed 12 typed pages excluding photographs, tables and figures with max file size 2MB. All pages, including tables, figures, and legends, should include the author’s name and the page number at the bottom right corner for identification. Line numbers should also be included in the left margin of all papers. Manuscript should be submitted through online submission system of Annals of Bangladesh Agriculture. Manuscripts not complying with the format and style of the Journal or of unacceptable quality will be notify to the author(s). Principal/corresponding author of the articles accepted for publication have to submit signed copy copyright transfer form. Articles reporting research findings of five years old or more are not considered for publication in Ann. Bangladesh Agric.

**Arrangement of the Manuscript**

*Title Page*: The title page should include:
  - A concise and informative title
  - The name(s) of the author(s)
  - The affiliation(s) and address(es) of the author(s)
  - The e-mail address, telephone and fax numbers of the corresponding author

*Abstract and Keywords*

**Abstract**: Please provide an abstract of no more than 300 words for Reviews and Full-length articles and 200 words for Short communications. The abstract should not contain any undefined abbreviations or unspecified references.

**Keywords**: Please provide a maximum of six keywords not used in the title may listed beneath the abstract for indexing purposes.

**Text**

Please provide a text, divided into the following sections: Introduction, Materials and Methods, Results and Discussion, Conclusion, Acknowledgments, References. Authors should consult recent issues for details of style and presentation. A short communication, letter to the editor should not be divided into
sections, except for References. Use the automatic page numbering function to number the pages. Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

**Heading Levels**
Please use no more than three levels of displayed headings.

**Abbreviations and Acronyms**
Abbreviations should be defined at first mention and used consistently thereafter.

- **Units of Measurement**
  - Length: km, m, mm, µm, nm, etc.
  - Area: km², m², cm², a, ha, etc. are acceptable.
  - Capacity: kl, l (liters in the text), ml, µl, etc. Do not use lambda and italic l.
  - Volume: km³, m³, cm³ (not cc), mm³, etc.
  - Mass: Kg, g, mg, µg (not gamma), ng, pg, etc.
  - Time: s, min, h, day(s), week(s), month(s), year(s)
  - Concentration: M, mM, N, % (only after number and in tables and figures), g/l, mg/l, µg/l, ppm, ppb
  - Temperature: ºC
  - Molecular weight: mol wt
  - Others: Radioisotopes: ³²P
  - Radiation dose: Bq
  - Oxidation-reduction potential: rH
  - Hydrogen ion concentration: pH

Genus and species names should be in italics. The common names of plants should not be capitalized.

**Equations**
Please use the standard mathematical notation for formulae, symbols etc.

- Italic for single letters that denote mathematical constants, variables, and unknown quantities.
- Roman/upright for numerals, operators, and punctuation, and commonly defined functions or abbreviations, e.g., cos, det, e or exp, lim, log, max, min, sin, tan, d (for derivative).

**Tables**
All tables are to be numbered using Arabic numerals. Tables should always be cited in text in consecutive numerical order. For each table, please supply a table title. The table title should explain clearly and concisely the components of the table. Identify any previously published material by giving the original source in the form of a reference at the end of the table (Table 1).

Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body. A unit of measure should be reported as the actual quantity multiplied by a power of 10 to give the reported quantity (the unit may be changed by the use of m or µ).
Table 1. Range, mean, standard error and co-efficient of variation of different characters of 31 inbred lines of sunflower

<table>
<thead>
<tr>
<th>Characters</th>
<th>Range</th>
<th>Mean</th>
<th>SE(±)</th>
<th>Coefficient of Variation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM (day)</td>
<td>88-101</td>
<td>96</td>
<td>2.39</td>
<td>3.04</td>
</tr>
<tr>
<td>PH (cm)</td>
<td>48.29-137.67</td>
<td>97.25</td>
<td>8.50</td>
<td>10.71</td>
</tr>
<tr>
<td>HD (cm)</td>
<td>6.68-17.87</td>
<td>13.23</td>
<td>2.81</td>
<td>25.98</td>
</tr>
<tr>
<td>SD (cm)</td>
<td>1.12-2.27</td>
<td>1.60</td>
<td>0.19</td>
<td>14.96</td>
</tr>
<tr>
<td>SH (no.)</td>
<td>37-250</td>
<td>118.81</td>
<td>44.11</td>
<td>45.43</td>
</tr>
<tr>
<td>SW (g)</td>
<td>2.23-21.42</td>
<td>10.58</td>
<td>5.22</td>
<td>60.48</td>
</tr>
<tr>
<td>SY (g)</td>
<td>30.23-541.20</td>
<td>266.65</td>
<td>65.89</td>
<td>30.26</td>
</tr>
</tbody>
</table>

DM= days to maturity, PH= plant height (cm), HD= head diameter (cm), SD= stem diameter (cm), SH= number of seeds per head, SW= seed weight per head (g), SY= Seed yield (g)

Source : Rashid et al. (2018)

Figures
All figures are to be numbered using Arabic numerals. Figure parts should be denoted by lowercase letters (a, b, c). If illustrations are supplied with uppercase labeling, lowercase letters will still be used in the figure legends and citations. Figures should always be cited in text in consecutive numerical order (Fig. 1 and 2). For each figure, please supply a figure legend. Make sure to identify all elements found in the figure in the legend. Identify any previously published material by giving the original source in the form of a reference at the end of the legend. The publisher reserves the right to reduce or enlarge figures. Figure legends should be grouped together in text. Figure should submit in TIF or GIF format.

Fig. 1. The priorities of LUFs assigned by policy makers at present.

Source : Miah et al. (2018)
Acknowledgments
Acknowledgments of people, grants, funds, etc. should be placed in a separate section before the reference list. The names of funding organizations should be written in full.

References
The list of References should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text. Do not use footnotes or endnotes as a substitute for a reference list.

Citation in Text
Cite references in the text by name and year in parentheses. Some examples:
Negotiation research spans many disciplines (Thompson, 1990).
This result was later contradicted (Becker and Seligman, 1996).
This effect has been widely studied (Shils, 1991; Liakat et al., 1995; Hossain and Smith, 1998; Medvec et al., 1993).

List Style
The reference list at the end of the paper should include only works cited in the text and should be arranged alphabetically by the last names of the first author of each work. References should be cited as follows:

Journal Article

Book
Hill, D. S. 1787. Agricultural Insect Pests of the Ttropics and Their Control. 2nd ed. Cambridge Univ. Press, New York, USA 746 P.
Book Chapter

Online Document

Always use the standard abbreviation of a journal’s name according to the ISSN List of Title Word Abbreviations. If you are unsure, please use the full journal title.

Responsibility for the accuracy of bibliographic data rests entirely with the author.

Change to Authorship
All author(s) are expected to make judiciously the list and order of authors before submitting their manuscript. Any change, deletion, addition or rearrangement of order of author names in the authorship list must be made only before the manuscript has been accepted. On condition that a confirmation (e-mail, letter) from all authors that they agree with the changes through corresponding author. The editor could be considered the changes after the manuscript has been accepted only in exceptional circumstances.