



Possibilities and Challenges of Dragon Fruit in Chapainawabganj Region of Bangladesh from the Growers Perspective

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ABSTRACT

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Farmers in Bangladesh are enthusiastic in dragon fruit farming as a new and promising crop that offers both difficulties and potential. The purpose of the study was to examine the advantages and disadvantages of this novel fruit from the perspective of growers. It is a descriptive survey research which was conducted in purposively selected four Upazilas of Chapainawabganj region of Bangladesh including Chapainawabganj Sadar, Gomastapur, Nachol, and Godagari from 16th April to 25th May, 2022. Pearson's correlation test was administered to determine the relationship between socio-demographic characteristics of the growers and their knowledge on dragon fruit production. Socio-demographic profile of the randomly selected growers of the study revealed that majority of the respondents were in their middle age, highly educated, had a medium annual income with medium sized land, little farming experience, less training and higher cosmopolitan behavior. Majority of the dragon fruit growers showed high level of understanding regarding dragon fruit cultivation and their fellow farmers and mass media were determined to be the most effective sources of information. According to the study's findings, the majority of farmers were inspired to grow dragon fruit because it is more resistant to pests and diseases, promotes excellent health, yields for a long time, and can be grown from both seeds and cuttings. Furthermore, the fruit has a higher profit margin than other field crops. Weeds, bird invasions, high labor expenses, lack of technical knowledge of farmers on dragon fruit farming were recognized as major obstacles to fruit production. According to a correlation analysis, farmers' age, extension contacts, and cosmopolitan nature were significantly and positively correlated with their knowledge of growing dragon fruit. More government support, especially from the Department of Agricultural Extension (DAE), and fixing the issues described above could increase the fruit's future prospects in the country.

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Introduction

Bangladesh, a riverine country known as the "Land of the Bengals," is one of the most densely populated countries in the world (Tinker et al., 2022). It's historical climate has experienced average temperatures around 26°C, but range between 15°C and 34°C throughout the year. The warmest months coincide with the rainy season (April-September), while the winter season (December-February) is colder and drier (BBS, 2020). The land of Bangladesh is very fertile for agricultural prospects. Bangladesh produces a wide range of agricultural products, including dairy products, rice, wheat, corn, legumes, fruits, vegetables, meat, fish, and other seafood. Rice is the most often consumed grain in Bangladesh (Agricultural

Resources of Bangladesh, 2022). Different exotic fruit also started to cultivate in the country like Dragon fruit, Chom Chom (Rambutan), Durian, Mangosteen, Longan, Persimmon, Kumquat, etc. Among them, dragon fruits are much familiar and most cultivated exotic crops which is commercially cultivated at this time.

Dragon Fruit, *Hylocereus spp* or also known as pitaya is an edible vine cactus species belonging to the family Cactaceae which has received worldwide recognition first as an ornamental plant and then as a fruit crop (Patwary et al., 2013). Although the pitaya originated in the tropical regions of North, Central, and South America, it is now grown commercially all over the world but once upon a

time, dragon fruit trees were planted in the yard as a hobby. Over 20 tropical and subtropical nations, including the Bahamas, Bermuda, Indonesia, Colombia, Israel, the Philippines, Myanmar, Malaysia, Mexico, Nicaragua, northern Australia, Okinawa (Japan), Sri Lanka, southern China, southern Florida, Taiwan, Thailand, Vietnam, Bangladesh, and the West Indies, commercially cultivate dragon fruit (Mercado-Silva, 2018).

Dragon fruits were introduced to Bangladesh by a few private entrepreneurs, and several eminent farmers began to cultivate them for sale in several locations, including Ashulia, Dhaka and Halda Valley Tea State, Fatikchari, and Chittagong. It has already been the subject of research at the Bangladesh Agricultural Research Institute (BARI), Gazipur, and the Bangladesh Agricultural University (BAU), Mymensingh, Germplasm Center (Patwary et al., 2013). The Department of Agricultural Extension (DAE) is making a lot of effort to introduce this promising fruit crop to the farmers. Already, mass media (television and newspapers) have drawn public attention regarding the cultivation of this nutritious fruit. Its market price is quite high. The fruit costs between BDT 350 and 600 / kg in the Bangladeshi local market (Irani, 2020). So, many farmers in our country are currently giving dragon fruit importance and attention. Due to the country's favorable topography and ecology, there are excellent opportunities for cultivating dragon fruit in many regions.

Dragon fruit is a super fruit because of its high nutrient content and antioxidant properties. Fresh fruit contains 82.5–83% moisture, 0.16–0.23% protein, 0.21–0.61% fat, 0.70–0.9% fiber. About 6.3 to 8.8 mg of calcium, 30.2 to 36.1 mg of phosphorus, 0.5–0.61 mg of iron, and 8 to 9 mg of vitamin C are all present in 100 g of fresh fruit pulp (Hossain et al., 2021). amount. This fruit is suitable for both consumption and production. The best fruit for salads because of its colorful bracts, dark red and white meat, and tasty little black seeds contained in them. Because of its attractive fruit color and excellent pulp, which has an edible black seed embedded within the pulp, it is becoming more and more well-liked among cultivars. The pulp can also be used to make value-added goods such as juice, jam, jelly, candy, syrup, and wine (Xiang & Rui, 2004).

Due to the lucrative prices of dragon fruit in both domestic and international markets, the number of commercial producers is gradually rising. With a lengthy production cycle from May to December in several flushes each year, it has tremendous export potential and is highly lucrative since it yields stem cutting from 14 to 16 months after planting and yields up to 20 years (Jiang et al., 2012). Kikon et al. (2021) found a positive relationship between total investment and net income and the benefit-cost ratio was also positive for the cultivation of dragon fruit in Nagaland state India. Because of its beautiful nocturnal flashy white blossoms, which may be employed in the moon garden, it is also a type of urban horticulture. Three different varieties of dragon fruits are typically grown in various countries which have slightly leafy, leathery skin. These are *Hylocereus ubdatus* (red-skinned fruit with white flesh), *Hylocereus costaricensis* (red skinned fruit with red flesh), and *Hylocereus megalanthus* (yellow-skinned fruit with white flesh) (Hunt, 2006).

Nowadays exotic Dragon fruit is gaining attention and interest from many growers inside the northwestern part of

Bangladesh under Rajshahi division. Chapainawabganj is a significant district of the division due to its agricultural diversity. In Chapainawabganj, mango is the single most cultivated crop. It is being cultivated on a total area of 62820.0 acres (BBS 2019; Hasan et al., 2020). Following the mango, most farmers in this area grow rice and blackgram. Boro-Aus-Blackgram is a cropping pattern found exclusively in Chapainawabganj Sadar upazila on 8,000 hectares of land. With a 12,030 ha area covering, Wheat-Aus-Blackgram is a pattern which is absolutely practiced in Chapainawabganj district (Rashid et al., 2017). Therefore, it is difficult to promote dragon fruit adoption in the region.

In a research, conducted in Chitwan district Nepal, farmers were found to be interested in expanding dragon fruit cultivation, but their awareness and understanding were found to be lacking in the majority of cases (below 50 % of the knowledge index). i.e., 66.67 % of all farmers had little or no understanding of the dragon fruit. The second most critical reason preventing acceptance was discovered to be the high expense of cultivation (Dhakal et al., 2021). Another research was conducted in Southeast Sulawesi's South Konawe area of Indonesia. According that research, dragon fruit production is profitable, with net returns that are higher than many other crops. Farmers saw dragon fruit farming as having various advantages, including ease of cultivation, shorter flowering time, year-round harvesting, the minimal danger of harvest failure, and a favorable market price (Saediman et al., 2021).

Although dragon fruit is a potential exotic crop, its acceptance is minimal. Farmers are hesitant to grow dragon fruit on their farms. Extensive research is needed since the fruit is gaining popularity in Bangladesh. To make dragon fruit farming sustainable, study must be done on farmers' and customers' attitudes of the fruit. It will be difficult to implement effective policies and programs to help dragon fruit production if we don't know what farmers think of the crop. Dragon fruit can help Bangladesh transition from subsistence agriculture to commercial agriculture. Commercialization without appropriate research may cause severe conditions. However, existing literature focused mostly on the nutritional value and the profitability of dragon fruit but farmers standpoint regarding the crop is rarely explored. The research gap leads the current study to investigate the prospect and problems of dragon fruit cultivation with following specific objectives:

- a) To assess farmer's knowledge of dragon fruit cultivation techniques.
- b) To determine the possibilities & problems of dragon fruit from farmers point of view.
- c) To find out the relationship between the selected characteristics of the respondents and their knowledge on dragon fruit cultivation.

Materials and methods

Area of the Study

The study was conducted in Chapainawabganj (Figure 1), one of the important agriculture prominent area of north-western part of the country. It is located between latitudes 24'22 and 24'57 and longitudes 87'23 and 88'23. Chapainawabganj District encompasses 1702.55 km². The principal rivers are

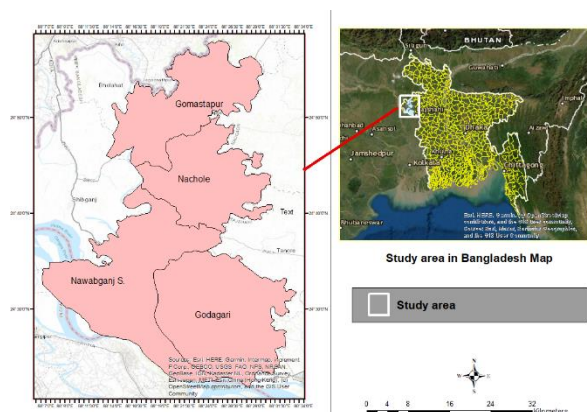


Figure 1. Location of the study

Chapainawabganj District has a population of 1,647,521 as per the 2011 Bangladesh census, of which 810,218 men and 837,303 women. There were 320,278 people living in cities, compared to 1,327,243 (80.56%) in the rural areas (19.44%) (Cabinet Division, 2022). The study was based on data from four Upazilas. Three Upazilas were from Chapainawabganj district, including the Sadar Upazila, Gomostapur Upazila and the Nachol Upazila., and one Upazila of Rajshahi district namely Godagari Upazila.

Population and Sampling

The entire dragon fruit farming community in the study area was taken into account when calculating the study's population. Due to the fact that this fruit is new to this region, the population of dragon fruit producers was minimal. Mango cultivation has been a major occupation for the local population for many years since they do not wish to readily alter their cultivation pattern. As a result, 26 growers of dragon fruit were chosen at random from 37 target population to make up the sample.

Data collection Procedure

A pre-structured questionnaire was used to collect primary data from respondents during a face-to-face interview from 16th April, 2022 to 25th May, 2022. Secondary data were gathered from a variety of secondary sources, including websites, magazines, newspapers, and journals.

Measurement of Independent Variables

The independent variables of the study were age, family size, educational qualification, farmer category, land type, annual income, farming experience, source of income, cosmopolitanism, training and extension contact. Age of a respondent is measured in terms of actual years on the basis of their statements. The entire number of members of a family, including the responder, his wife, children, and other permanent dependents who lived together as a family unit, was referred to as family size. Education status was measured by the number of years of schooling. The collected data were organized into illiterate (0), Primary (1-5), Secondary (6-10), Higher Secondary (11-12), and tertiary (>12) on the basis of statement of the respondents. Annual income of the respondents was measured in Bangladeshi taka (BDT) on the basis of total annual earnings from agricultural and non- agricultural sources of

their family and the annual income then classified into three categories; a) Low (<83676 00 BDT), b) Medium (83676 to 330000 BDT), c) High (>330000 BDT) (Ghosh et al., 2020). Respondents according to their land size were categorized into five categories; Landless farmers (<0.20 ha), marginal farmers (0.21-0.6 ha), small farmers (0.61-1.00 ha), medium farmers (1.1-2.5 ha) and large farmers (>2.5 ha) and their land types was a) Own, b) Shared, c) Leased. The respondent's farming experience was classified into six categories which were based on their years of crops cultivation: (a) No, (b) <5 years, (c) 5-10 years, (d) 11-16 years, (e) 17-22 years, (f) >22 years. Cosmopolitanism is the degree to which a person interacts with others inside his own social network while also traveling outside of it. On a four-point scale, the respondents were asked to rate their level of cosmopolitanism; frequently (once in a week), occasionally (once in a month), rarely (Once in six months), and never and their assigned score was 1, 2, 3 and 4 respectively. Extension contact indicated that the responders become receptive to the influence of various information media through various extended teaching approaches. The extension contact scores of the respondents were computed on the basis of their extension contact with different extension agents, including the village head, the SAAO, AEO etc. Their level of interaction was frequently, occasionally, rarely, and never and the corresponding scores were 4, 3, 2, and 1 respectively. The training of most respondents was measured by two factors: yes or no.

Measurement of Dependent Variable

The study's dependent variable was knowledge of farmers about dragon fruit cultivation. This method was used by Jaganathan et al. (2012) to calculate the knowledge level index was also used to evaluate the farmers' level of knowledge. This is provided by the formula below:

$$\text{Knowledge Index} = \frac{(\text{Respondents Total Score})}{\text{Total Possible Score}} \times 100$$

Following that, the respondents were divided into four groups depending on their obtained knowledge score: High, Average, Low, and Very Low level of knowledge. A set of 15 questions was made to evaluate farmers knowledge level on dragon fruit cultivation. A score of 2 was assigned for each correct answer. Respondents who got less than 40% number, their knowledge level was considered to be very low and those who got number between 40%-59% was considered to have a low knowledge level. Participants who scored between 60 and 79 % were thought to have average knowledge. The farmers who received an 80% score were regarded as having a high level of knowledge.

Measurement of the Advantages of Dragon Fruit Cultivation

The possibilities of dragon fruit cultivation were measured by using 3- point Likert scale. A 3- point Likert scale consisting of 11 statements was used for this purpose. A respondent was asked to express his extent of agreement or disagreement by checking against any of the three point, and scoring was assigned as i) Mostly agree (3), ii) Somewhat agree (2), iii) Do not agree (1). Then we calculated the mean against those statements and ranking of the statements were done according to their mean.

Problem Confrontation Index (PCI)

The Problem Confrontation Index (PCI) was used to examine the constraints that the study's respondents experienced. Farmers in the study areas were asked for their thoughts on 15 selected issues that were picked up during FGDs (Focus Group Discussions). The problem confrontation score was calculated using a three-point rating scale. Respondents were asked to check off any of the three items to indicate how much they agreed or disagreed, and the results were scored as follows: i) Mostly agree, ii) Somewhat agree and iii) Do not agree and these responses received the following weights: 2, 1, and 0 respectively. The problem confrontation score was calculated by adding the weight of the problems' responses. The problems were ordered in accordance with their PCI scores once the PCI scores were computed. The PCI was calculated to create a rank order according to the method used by Saha et al. (2021), Jahan et al. (2022). The following formula was used to calculate the PCI:

$$PCI = P_m \times 2 + P_s \times 1 + P_n \times 0$$

where,

P_m = Total number of farmers who mostly agreed with the problems;

P_s = Total number of farmers who somewhat agreed with the problems and

P_n = Total number of farmers who did not agree with the problems as not at all

Data Analysis

The data was collected through a questionnaire and each question was given a numerical score to code the data. The data collected from respondents was edited, coded, aggregated, revised to remove any unnecessary material and analyzed according to the purpose of the survey. Data analysis was performed using Statistical Package for Social Science (SPSS) version 25.0. Microsoft Excel was used for the making of different graphs, charts and tables. In order to understand the descriptive data, basic statistics including frequency counts, percentages, means and correlation were used.

Results and discussions

Prevalence of Dragon Fruits in the Study Area

A survey was administered to determine the familiarity of dragon fruit among the farmers. Both dragon fruit growers and non-growers were used for this purpose. A total of 100 farmers expressed their opinion on the matter. The bar graph (Figure 2) displays the respondents' expression on prevalence of dragon fruit.

From the figure it is observed that dragon fruit was unknown to 14% of farmers. 4% of farmers had only heard of the fruit and had not seen or consumed it. 58% of farmers saw the fruit, and the remaining 24% of them ate it. Thus, it can be said that despite being a new crop in the region, dragon fruit is already well-liked by farmers.

Majority of respondents (53.8%) were from the tertiary level of education. The data further revealed that 26.9% of survey participants were from the secondary level of education, 11.5% were from the higher secondary level and 7.7% were from the primary level with an average of

12.23. The study area has a high literacy rate, that is obvious from the results.

Most of the respondents had small sized family (65.4%) which contained up to 4 members. Some of them had medium sized family (30.8%) which contained 5-8 members and the large family (only 3.8%) contained more than 8 members with a mean of 5.15.

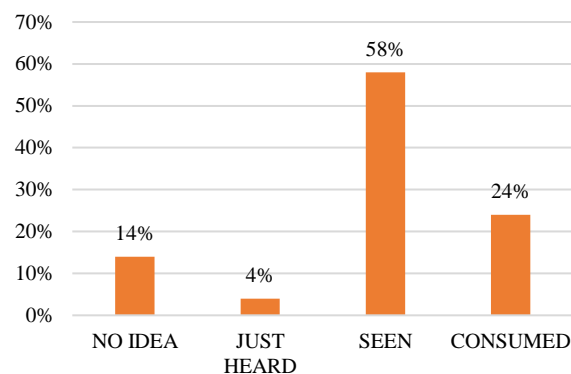


Figure 2. Distribution of farmers according to their opinion on dragon fruit prevalence

Respondents' Socio-demographic Characteristics

According to table 1 the majority of respondents (69.2%) were in the medium age range (29 to 52 years) with an average of 41.85 years, while 19.2% were old (> 52 years) and 11.5% were young (<29 years). Hasan et al. (2021) observed similar kind of respondents in terms of age in their study. Most middle-aged people have cultivated this fruit. The reason middle-aged people accepted it was because they were willing to take a risk.

Majority of the respondents (50%) were medium farmers with lands between 1.1 and 2.5 ha, followed by this some of the respondents (19.2%) were small farmers with lands between 0.61 and 1.00 ha and 19.2% participants were marginal farmers with lands between 0.21 and 0.06 ha. About 7% of the respondents were large farmers with lands greater than 2.5 ha, and the remaining respondents (3.8%) were landless farmers with lands less than 0.20 ha. Average land holdings by the farmer was 1.49 ha.

According to the survey, the majority of the respondents (34.6%) had leased land for farming. Following that, 30.8% of the farmers owned their own land and also cultivated crops on leased land; 26.9% of the participants owned their own property; and the remaining 7.7% owned their own land and also cultivated crops on shared and leased land.

Most of the respondents (61.5%) had medium level of yearly income followed by high income (30.8%) and low income (7.7%) respectively with an average of BDT 552500 per year. which is more than per capital income 2,824 USD or BDT 241,470 in 2021-22 fiscal of Bangladesh (BBS, 2022).

The majority of respondents (42.3%) had less than five years of farming experience, with an average of 8.92 years of experience. Followed by that 23.1% of participants had 5–10 years of experience, about 19.2% of respondents had 11–16 years of experience, then 11.5% had more than 22 years of experience, and 3.8% of farmers had no experience at all.

Table 1. Distribution of the respondents according to their socio demographic characteristics (N =26)

Variable	Categories	Frequencies	Percentage	Mean
Age (years)	a) Young (<29 years)	3	11.5	41.85
	b) Middle (29 to 52years)	18	69.2	
	c) Old (>52 years)	5	19.2	
Education (Years of schooling)	a) Illiterate (0)	0	0	12.23
	b) Primary (1 to 5)	2	7.7	
	c) Secondary (6 to 10)	7	26.9	
	d) Higher Secondary (11-12)	3	11.5	
	e) Tertiary (>12)	14	53.8	
Family Size (number)	a) Small (up to 4 members)	17	65.4	5.15
	b) Medium (5-8 members)	8	30.8	
	c) Large (>8 members)	1	3.8	
Land Size	a) Landless farmers (<.20 ha)	1	3.8	-
	b) Marginal farmers (0.21-0.6 ha)	5	19.2	
	c) Small farmers (0.61- 1.00 ha)	5	19.2	
	d) Medium farmers (1.1- 2.5 ha)	13	50	
	e) Large farmers (> 2.5 ha)	2	7	
Land Ownership	a) Own	7	26.9	-
	b) Shared	0	0	
	c) Leased	9	34.6	
	d) Own+ Shared	0	0	
	e) Own+ Leased	8	30.8	
	f) Shared +Leased	0	0	
	g) Own+ Shared +Leased	2	7.7	
Annual Income (BDT)	a) Low (<83676 00 BDT)	2	7.7	552500
	b) Medium (83676 to 330000 BDT)	16	61.5	
	c) High (>330000 BDT)	8	30.8	
Farming Experience (years)	a) no experience	1	3.8	8.92
	b) <5 years	11	42.3	
	c) 5-10 years	6	23.1	
	d) 11-16 years	5	19.2	
	e) 17-22 years	0	0	
	f) >22 years	3	11.5	
Extension Contact	a) Frequently (1-2 time/month)	14	53.8	-
	b) Occasionally (once/2 month)	4	15.4	
	c) Rarely (1-3 times per year)	4	15.4	
	d) Not at all	4	15.4	
Training	a) Yes	9	34.6	-
	b) No	17	65.4	
Source of income	a) Agriculture	12	46.2	-
	b) Business	0	0	
	c) Job	4	15.4	
	d) Agriculture+Business	7	26.9	
	e) Agriculture +Job	3	11.5	
	f) Agriculture+Business+Job	0	0	
Cosmo-politeness	a) Frequently (once in a week)	21	80.8	-
	b) Occasionally (once a month)	4	15.4	
	c) Rarely (Once in 6 months)	1	3.8	
	d) Never	0	0	

About 53.8% of the respondents reported having frequent extension contact. The percentages of the respondents for occasional, rare, and no extension contact were 15.4% for each. From table 1 we observe that the majority of the respondents were highly educated and they were aware about extension services that is why they contacted with extension officers when they face any problem.

The majority of respondents (65.4%) did not receive any kind of training on growing dragon fruit, while the remaining 34.6% did. The respondents who got training on

dragon fruit cultivation, they got their training from the government horticultural center.

Agriculture is the main source of income for most of the polled participants (46.2 %). Agriculture and Business both were second source of income for 26.9 % of the farmers. About (15.4%) were Job holder. Agriculture and job both were source of income for rest (11.5 %).

Most of the respondents (80.8%) have frequent cosmopolitaness followed by occasionally (15.4%), rarely (3.8%) and never (0%) respectively.

Source of Information About Dragon Fruit

The pie chart (Figure 3) displays the respondents' primary sources of knowledge, from which they learned about dragon fruit. The majority of farmers (42%) learned about dragon fruit primarily from other farmers and the media.

Followed by this, 35% of the respondents learned about dragon fruit from their fellow farmers. About 15% of the respondents mentioned mass media as their primary source of information and only 8% of them said that they acquire their information from their neighbors and other farmers. Among the mass media Mobile apps and YouTube were popular among the respondents. About 30% of the respondents used mobile app on daily basis and 15.40% of the respondents used YouTube regularly.

Knowledge of Farmers on Dragon Fruit Cultivation

To accept dragon fruit as a business, farmer must have knowledge on its cultivation. Without the right level of knowledge, farmers will not be benefited by it. Farmers were given a series of statements to evaluate their degree of expertise, and their responses were recorded for further analysis.

Table 2 demonstrates that the majority of farmers (73.1%) had a high degree of knowledge on dragon fruit. They began growing this fruit after gaining the necessary information. Following this, 15.4% of the participants possessed knowledge that was average level. About 7.7% of farmers had a poor level of knowledge and the remaining 3.8 % of respondents had low levels of expertise on dragon fruit cultivation. They simply heard that people were making good money and had begun to grow dragon fruit without looking for more information. Maximum percentage of farmers having high knowledge on dragon fruit may be because most of them were highly educated and educated people search more about a produce before adopt it to avoid production loss. As dragon fruit is a new

crop of the study area people try to get maximum knowledge about the fruit.

Status of Dragon Fruit Cultivation

As shown in table 3, the majority of the respondents (65.3 %) have been growing dragon fruit for one to three years. About 19.2% of them have been cultivating this fruit for the past four to six years. Following this, 11.5 % of farmers have been cultivating this fruit in recent months. In the previous year, they began growing dragon fruit. Only 3.8% of them have been growing this fruit for more than six years. Therefore, this fruit has not been grown in this area for a very long time.

The highest percentage of farmers (53.9%) were growing dragon fruit on land below 0.67ha . Between 0.68 ha and 1.34 ha of land were used for cultivation by 23.1% of them and 15.4% of the respondents were growing this fruit on land between 1.35ha to 2 ha, and the remaining 7.7% were doing it on more than 2ha of land.

Planting materials that have been gathered from other farms was used by the majority of dragon fruit growers (53.8 %). The other 30.8% of farmers obtained it from various nurseries, while 15.4% obtained it from government horticulture center. Most of the farmers selected ground water as a source of irrigation in. In the remaining 7.7% of cases, farmers irrigated their fields using pond water. About 11–15 tons/ha of dragon fruit were produced annually by 30.8 % of the respondents. The production of dragon fruit ranged from about 1 to 5 tons per hectare per year for 23.1 % of the participants. About 3.8 % of the farmers produced this in quantities of about 6 to 10 tons/ha while 19.2% of them produced this fruit in quantities more than 15 tons/ha/ year. Growing companion crops with dragon fruits was reported by 46.2% of respondents. Among them guava, orange and mango were mostly cultivated.

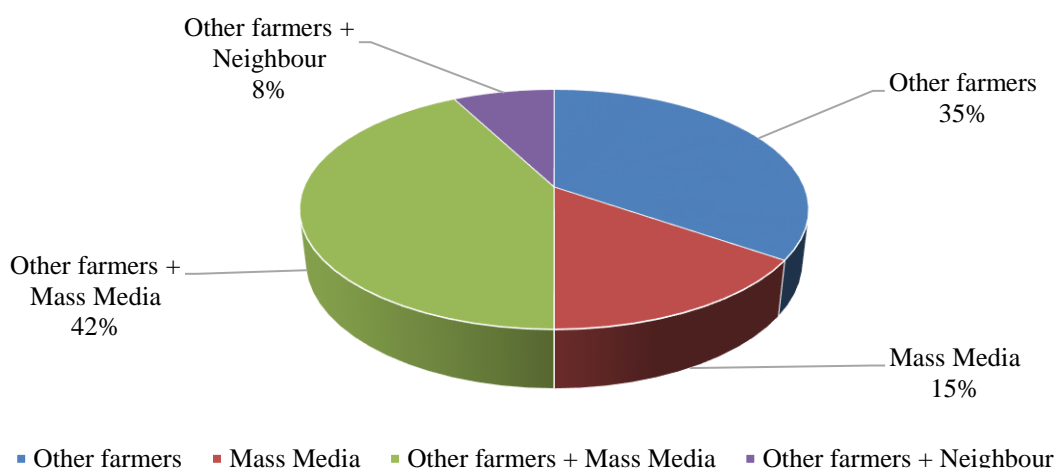


Figure 3. Distribution of the respondents according to the source of information

Table 2. Distribution of the respondents on the basis of knowledge of dragon fruit

Variable	Categories	Frequencies	Percentage
Knowledge	a) High (>80%)	19	73.1
	b) Average (60%-79%)	4	15.4
	c) Low (40%-59%)	2	7.7
	d)Very Low (<40%)	1	3.8

Table 3. Distribution of the respondents according to the status of dragon fruit cultivation

Variable	Categories	Frequencies	Percentage
Year of cultivation	a) Below 1-year	3	11.5
	b) 1-3 years	17	65.4
	c) 4-6years	5	19.2
	d) Above 6 years	1	3.8
Area of Cultivation	a) below-.67 ha	14	53.9
	b) 0.68-1.34 ha	6	23.1
	c) 1.35-2 ha	4	15.4
	d) Above 2 ha	2	7.7
Source of Planting Materials	a) Nursery	4	15.4
	b) Horticulture center	8	30.8
	c) Other farmers	14	53.8
Source of Irrigation Water	a) Rain water	0	0
	b) River water	0	0
	c) Pond water	2	7.7
	d) Ground water	24	92.3
Production (per ha/year)	a) Below 1 ton	6	23.1
	b) 1-5 ton	6	23.1
	c) 6-10 ton	1	3.8
	d) 11-15 ton	8	30.8
	e) Above 15 ton	5	19.2
Companion Crops	a) Yes	12	46.2
	b) No	14	53.8

Determination of possibilities of dragon fruit cultivation

During this study we found some advantages of dragon fruit cultivation that was mentioned by the producers (table 4). According to the table, more than 80% of the growers agreed that dragon fruit is less susceptible to pest and diseases. Similar information was found in a hand book of dragon fruit named “BARI Dragon Fol 1 er Adhunik Utpadon Koushol” released from BARI (Bangladesh Agricultural Research Institute). Numerous insects attack dragon fruit plants like scales, mealybugs, aphids, ants, beetles etc. However, only a small number of insect species populations have grown to the point where they may be regarded as pests. The farmers mentioned only three diseases which were anthracnose, stem rot and fruit rot but according to them they had not face any economic loss because of these diseases. They also added that they can easily manage these pest and diseases by different cultural practices and by local pesticides. But a different scenario was noticed in a study by Zainudin & Hafiz (2015) in Malaysia. In that study the authors found that the main obstacles to the development of dragon fruit are thought to be bacterial and fungal infections. Stem and collar rots, which are brought on by *Xanthomonas campestris*, are the main opponent. Numerous farms that produced dragon fruit failed due to this disease, which also caused a sharp decline in output.

“Dragon fruit consumption can lead to good health”, 69.2 % of survey participants mostly agreed and 30.8% of them somewhat agreed with that claim. According to studies, dragon fruit helps the formation of good gut bacteria and the antioxidant betacyanin, a red or purple pigment (Liaotrakoon, 2013). Dragon fruit is regarded as the “Powerhouse of Nutrition” among all fruits. Due to its low calorie, cholesterol-free, and antioxidant content, it reduces heart disease risk and keeps blood pressure stable (Patel & Ishnava, 2019). Betalains have the potential to

decrease cancer cells and can fight oxidative stress. It has the power to support weight loss, enhance digestion, lower blood LDL cholesterol, and boost the immune system. (Verma et al., 2017). Omega-3 and omega-6 fatty acids, which are abundant in dragon fruit seeds, reduced triglycerides and the risk of cardiovascular diseases (Sonawane, 2017). Consuming dragon fruit regularly, which has a high vitamin C content, can help prevent cough and asthma, improve wound healing and speed up the healing of cuts, boost immunity, and encourage the body’s other antioxidants to work more effectively (Cheah et al., 2016; Duarte & Lunec, 2005). High quantities of phosphorus and calcium found in dragon fruit contribute to the production of strong bones, healthy teeth, and vital tissue growth (Choo and Yong, 2011). Due to the high iron content of red dragon fruit, pregnant women’s levels of hemoglobin and erythrocytes are increased (Nurliyana et al., 2010).

Another advantage is “Yield for long period of time” was admitted by most of the survey participants (69.2%). They saw it as a benefit because they did not have to put in the initial effort or spend the money on it every year.

“Dragon fruit propagation method is easy”, about 61.5% farmers noted the point. It can be grown from both seed and cutting. While plants that are vegetatively propagated develop flowers in three years, seedlings from seeds need 4-5 years to produce flowers and fruit (Rao & Sasanka, 2015). The respondents preferred cutting as a propagating material. They mentioned that they just had to cut the apical portion of the stem and they used this part for planting.

The majority of them (61.5 %) acknowledged the “High price of dragon fruit in the market”. The farmers claimed to receive a decent price for their dragon fruit sales. They claimed that they received varying prices for dragon fruits of various sizes. Based on their weight, dragon fruits were divided into three different categories. A fruit that weighed 500-600 gm fell into the A quality

category and cost 600 BDT per kg. The B quality category contained dragon fruit, which weighted 400-450 gm per fruit and cost 450–500 BDT per kg. The C quality category contained dragon fruit which weighted 350-400 gm per fruit and cost 300-350 BDT per kg.

“Dragon fruit cultivation generates an income source for people”, about 46.2% respondents mostly agreed with this claim. They stated that the fruit was picked in three stages from April to October. The majority of farmers claimed that growing dragon fruit provided them with income that they were unable to obtain from any other crop. From the study it is found that farmers spent on an average of 19 lakh BDT for 1 ha of land and return was on an average 34 lakh BDT/ha. So, the average profit from 1 ha of land was about 15 lakh BDT which indicates that dragon fruit cultivation is more profitable. According to a study, farmers made a profit of BDT 145978 from 1 ha mango production. (Khandoker et al., 2017). Another study conducted by Mia et al. (2019) showed that farmers got 26861 BDT profit from per ha BRRRI 29 rice production which are much lower than dragon fruit profitability.

“Dragon fruit cultivation is profitable as it has a higher shelf-life” and this statement was approved by more than 80% of the growers. One of them noted that the fruit can be stored in ambient environment for 3 days without losing its quality. A study held in Philippines also supported the farmers opinion. Fruits can be kept after harvesting for 3–4 days at room temperature and for 1–2 weeks at 20°C or 14°C, respectively. Since dragon fruit is non-climacteric, its physical, chemical, and sensory qualities begin to deteriorate significantly after harvest. At 10 ° C. (50 ° F), dragon fruit can be stored for around 14 days, whereas at 5° C. (41°F) and 90% relative humidity, it can be stored for 17 days if it is picked 30 to 35 days after flowering (Teddy, 2019).

Most of the farmers (about 60%) were agreed that “Dragon fruit cultivation reduces migration from rural to urban areas”. According to the farmers, agricultural labor is moving toward the city for a regular income. Due to this,

the producers did not get labor at the right time or in the right quantity. Dragon fruit requires different types of cultural practice, which can provide an income source to the farmers and minimize their rate of migration towards big cities.

“Dragon fruit processing has a great prospect in future” and the producers expressed support for the claim. About 53% of the respondents agreed with this statement. The fruit’s worth can be increased through processing into a number of products. The processed foods include energy and fruit bars, ice cream, jelly, cookies, juice, croissants, soft drinks, and yoghurt. Processing is required to produce goods with additional value from both edible and inedible parts of the fruit and plant, as well as to lessen perishability and waste disposal difficulties.

“It can be a source of foreign exchange earning”. This point was agreed upon mostly to somewhat by most of the respondents. One of the respondents said that he was in the process of selling his product in a foreign market. Then he added that he could not fulfill local market demand, which is why he had to cancel the deal to sell his product abroad. According to data from Vietnam’s ministry of industry and trade, the country’s exports of dragon fruit brought in more than \$906.7 million in the first 10 months of 2020, accounting for 36.3% of all fruit and vegetable exports during that time (Irani, 2020). So, in near future we can increase the production of dragon fruit and earn foreign exchange which may contribute to our GDP.

Another possibility was mentioned by the respondents was “Local industrialization can be done by dragon fruit cultivation”. Among the respondents, about 30% agreed that it is possible to develop regional industries for the processing of dragon fruit. They believe it will enable them to enhance the value of their product.

According to the opinion of the farmers regarding advantage of dragon fruit cultivation, the overall possibility is determined which is shown in the following figure (Figure 4).

Table 4. Distribution of the respondents according to their agreement regarding the benefits of dragon fruit cultivation

SL No.	Statements	Mostly agree %	Somewhat agree %	Do not agree%	Mean
1	Dragon fruit is less susceptible to disease and pest	80.8	19.2	0	2.81
2	Dragon fruit consumption can lead to good health	69.2	30.8	0	2.69
3	Yield for long period of time	69.2	30.8	0	2.69
4	Dragon fruit propagation method is easy	61.5	34.6	3.8	2.57
5	High price of dragon fruit in the market	61.5	34.6	3.8	2.57
6	Dragon fruit cultivation generates an income source for people	46.2	30.8	23.1	2.23
7	Dragon fruit cultivation is profitable as it has a higher shelf-life	23.1	53.8	23.1	2.00
8	Dragon fruit cultivation reduces migration from rural to urban areas	23.1	38.5	38.5	1.85
9	Dragon fruit processing has a great prospect in future	19.2	34.6	46.2	1.73
10	It can be a source of foreign exchange earning	11.5	30.8	57.5	1.54
11	Local industrialization can be done	3.8	26.9	69.2	1.35

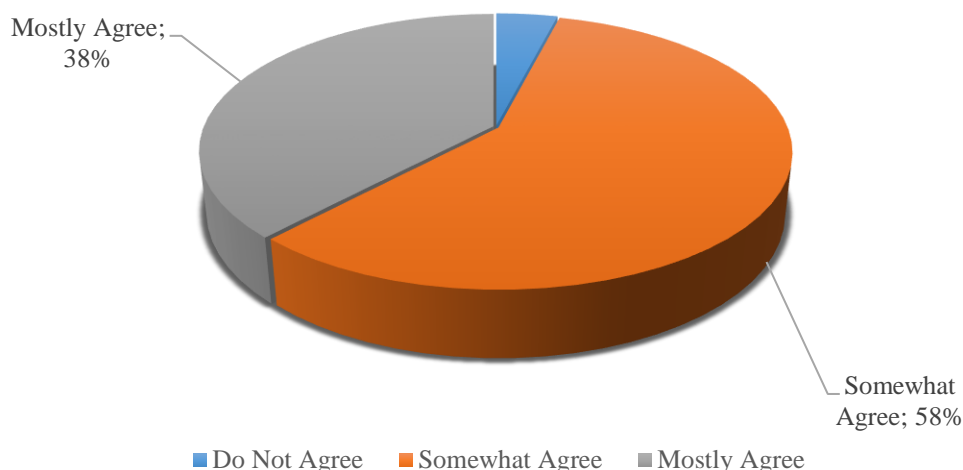


Figure 4. Distribution of the respondents according to their agreement regarding the possibility of dragon fruit

Table 5. Distribution of the respondents according to their opinion regarding the problems of dragon fruit cultivation

Possible issues	Number of respondents			Total PCI	Rank
	Mostly agree= 2	Somewhat agree= 1	Do not agree=0		
1. Lack of Soil fertility due to climate change	2	13	11	17	9 th
2. Lack of roads for vehicles to enter the market	3	5	18	11	12 th
3. Lack of technical knowledge of farmers on dragon fruit cultivation due to less training	9	15	2	33	3 rd
4. Scarcity of improved varieties of dragon fruit	7	18	1	32	4 th
5. High price of improved dragon fruit planting materials	2	18	6	22	8 th
6. High price of farm inputs	8	14	4	30	6 th
7. High cost of labor	12	11	3	35	2 nd
8. Unavailability of labor on right time	13	5	8	31	5 th
9. Ineffective service of extension officers	9	10	7	28	7 th
10. Lack of processing and preservation	7	2	17	16	10 th
11. Invasion of bird	12	11	3	35	2 nd
12. Weed problem in dragon fruit field	15	6	5	36	1 st
13. High interest on agricultural loans	4	2	20	10	13 th
14. Incidence of pests and diseases	1	11	14	13	11 th
15. Lack of storage facilities	4	5	17	13	11 th

This pie chart indicates that almost 96% of the respondents agreed with the possibilities of dragon fruit cultivation. We might infer from this that the majority of respondents believe dragon fruit has a promising future because it offers so many benefits. Our country's GDP may be significantly impacted by the cultivation of dragon fruit.

Determination of Dragon Fruit Cultivation Challenges

Table 5 lists the issues that vital to the cultivation of dragon fruits along with their priority given by the growers. Weed problem in dragon fruit field was the most significant problems mentioned by the farmers. Some prominent weeds of dragon fruit field are *Agrotis gigantean*, *Digitaria setigera*, *Eleusine indica*, *Amarantus luvidus*, *Eclipta prostrate*, *Portulaca oleracea*, *Oxalis barrelieri*, *Oxalis corniculata*, *Phyllanthus sp.* In the dragon fruit farm, shrubs and herbs predominated over grass weeds, which were significantly less common. Due to their strong competitiveness and ability to survive in dry or lightly shaded soil, shrubs dominated the landscape. In

addition, while growing side by side with dragon fruit, which has a root system that can squish the nearby weeds, their structure is more resilient (Sancayaningsih et al., 2017).

High labor expense was another important problem of dragon fruit cultivation. According to the producers, labor costs could occasionally exceed 600 BDT/person/day, which was high for this region.

Bird invasions was also a significant issue. The survey participants noted that some of their produce is lost because of birds attacking mature dragon fruit.

Next problem mention by the farmers was lack of technical understanding of farmers on dragon fruit farming due to limited training. The majority of farmers grow this fruit based on information they got from other farmers and from the media, which leaves gaps in their expertise. According to the farmers, the scarcity of better varieties of dragon fruits were prominent in the area. They said that the cultivars they were growing lack the quality they had hoped for. Smaller fruit leads to cheaper prices in the market, they claimed throughout the study.

The next issue was labors were not readily available throughout the year. When farmers were busy with rice harvesting in May and June, this issue was particularly noticeable. Followed by this “High price of farm input”, ‘Ineffective service of extension officers’, ‘High value of improved dragon fruit planting materials’, ‘Lack of soil fertility due to climate change’, ‘Loss of production due to lack of processing and preservation’, ‘Many fruits are wasted due to lack of storage facilities’, ‘Invasion of pests and diseases’, ‘Lack of roads for vehicles to enter the market’ and ‘High interest on agricultural loans’ were the major issues highlighted by the respondents.

Wakchaure et al. (2021) conducted a study in India and found some of the similar challenges as the present study. They experienced serious weed problems, especially during and after the rainy season, in all types of soil. During the ripening period, dragon fruit is prone to predators like rats and birds, which can result in losses of up to 5–8%. In their research, they mentioned the lack of knowledge and experience among nursery owners and farmers regarding ideal nursery procedures for dragon fruit, especially in areas with damaged soil and rainfed regions. They claimed in their research that the private nursery operators, who are primarily from neighboring cities, supply poorer seedling materials. Non-uniform sized fruit is a common issue there. Many farmers, notably in older orchards (after 5–6 years), experience this at least once every two years, particularly between the first and second harvesting.

Relationships

Coefficient of correlation was computed in order to explore the relationships between the selected socio-demographic characteristics of the farmers and their knowledge about dragon fruit. Relationships between the selected characteristics of the farmers and their knowledge have been presented in table 6.

Table 6. Relationship between the selected characteristics of the farmers and their knowledge on dragon fruit cultivation

Selected personal attributes	Co-efficient of correlation (r)	P value
Age	.421*	.032
Family size	-.052	.803
Education	.020	.924
Annual Income	-.109	.596
Land Ownership	-.240	.238
Farming experience	.383	.053
Extension contact	.432*	.027
Cosmo politeness	.523**	.006
Training	-.173	.399

*Correlation is significant at the 0.05 level (2-tailed),

**Correlation is significant at the 0.01 level (2-tailed).

Table 6 represents that the age of the respondents had positive significant relationship with the respondent’s knowledge level when ‘r’ value was 0.421 at 5% level of significance. So, the null hypothesis, “There is no relationship between age and knowledge of the respondents” was rejected. Which suggests that older farmers had better knowledge on the fruit and the relationship between farmer’s age and knowledge was

moderate. This could be the case because older farmers were more mature and had the resources to launch a new fruit production than younger farmers. When people wished to adopt a new fruit, they research it more. Older farmers had better knowledge because of this.

Extension contact also had positive significant relationship with knowledge. When the “r” value was 0.432, which is significant at the 5% level of significance. So, the null hypothesis, “There is no relationship between extension contact and knowledge of the respondents” was rejected. The respondents’ extension contact had a positive moderate connection with their knowledge of dragon fruit. It implied that farmers who interacted more with extension agents knew more about dragon fruit.

Similarly, cosmopolitanism of the respondents had positive significant relationship with their knowledge of dragon fruit when ‘r’ value was 0.523 at 1% level of significance. It means that the higher the level of cosmopolitan nature of the respondents, the higher knowledge they had. So, the null hypothesis, “There is no relationship between cosmopolitanism and knowledge of the respondents” was rejected. Cosmopolitanism and respondent’s knowledge were moderately correlated with each other.

However, education and farming experience had positive relationship with the knowledge level of the respondents but not significant while family size, annual income, land ownership and training had negative but non-significant relationship with the knowledge level.

In a study in Zashuke, KwaZulu-Natal Province, South Africa the farmer’s varying age had a beneficial impact on the adoption of no-till CA and was statistically significant at the 5% significance level. As a result, farmers who receive more frequent visits from extension agents are more likely to adopt the farming methods or technology to which they have been exposed. In this instance, regular extension assistance improved a farmer’s chances of implementing conservation agriculture (Ntshangase et al., 2018).

Conclusion

According to the findings of the study, majority of respondents were middle-aged, educated, and had small families. They had a medium income and land. Most respondents had little farming experience, frequent extension contact, and high cosmopolitanism.. Farmers demonstrated significant knowledge in growing dragon fruits. They had just recently started growing dragon fruit in their field, and they were receiving a satisfactory crop every year. From the growers’ perspective, the fruit’s future prospects were clear because of all the benefits it provides. Growers also brought up problems like weeds, expensive labor, a lack of training, and other things in addition to the potentials. Pearson’s correlation analysis revealed that farmers’ knowledge of dragon fruit showed a positive significant connection with their age, extension contact, and cosmopolitan behavior. To sum up, dragon fruit is a novel crop that has recently been introduced to Bangladeshi agriculture, and the study’s results demonstrated its possibilities from the viewpoint of the farmers. Therefore, in order to address potential hazards to the crop and provide better results, efforts from both the government and non-government sectors are required.

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References

- Agricultural Resources of Bangladesh. 2022. Jhotpotinfo. Retrieved July 18, 2022, from <https://www.jhotpotinfo.com/2022/03/agricultural-resources-of-bangladesh.html>
- BBS. 2019. Yearbook of Agricultural Statistics. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.
- BBS. 2020. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh.
- BBS. 2022. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh.
- Cabinet Division, a. B. D. B. 2022. Population and Housing Census. [Online] <http://www.bbs.gov.bd/site/page/47856ad0-7e1c-4aab-bd78892733bc06eb/Population-and-Housing-Census>
- Cheah LK, Eid AM, Aziz A, Ariffin FD, Elmahjoubi A, Elmarzugi NA. 2016. Phytochemical Properties and Health Benefits of *Hylocereus undatus*. Nanomedicine & Nanotechnology, 1(1):1-10. Doi:10.23880/NNOA-16000103
- Choo WS, Yong WK. 2011. Antioxidant properties of two species of *Hylocereus* fruits. Advances in Applied Science Research, 2(3): 418-425.
- Dhakar AR, Mahatara B, Parajuli S, Budhathoki S, Paudel S, Regmi S. 2021. Farmers' Knowledge Level and Readiness in Adoption of Dragon Fruit (*Hylocereus* sp.) Chitwan District Nepal. Food and Agri Economics Review (FAER), 1(1): 57-63. Doi: <http://doi.org/10.26480/faer.01.2021.57.63>
- Duarte TL, Lunec J. 2005 Review: When Is an Antioxidant Not an Antioxidant? A Review of Novel Actions and Reactions of Vitamin C. Free Radical Research, 39: 671-686. Doi: <http://dx.doi.org/10.1080/10715760500104025>
- Ghosh MK, Shoily AA, Islam MS, Misu UM, Khatun MA. 2020. Assessing the Participation of Indigenous Santals People in Chapainawabganj District of Bangladesh in Income Generating Activities. The Agriculturists, 18(1), 137-143. DOI: <https://doi.org/10.3329/agric.v18i1.49466>
- Hunt DR. 2006. The new cactus Lexicon illustrations. Vol. I & II. DH Books, Milborne Port, UK.925 p. ISBN: 9780953813445.
- Hasan SS, Roy S, Saha S, Hoque MZ. 2021. Assessment of the Farmers' Perception on Vermicompost as Waste Management Practice and Economic Return in Some Areas of Bangladesh. European Journal of Agriculture and Food Sciences, 3(3), 14-20. <https://doi.org/10.24018/ejfood.2021.3.3.287>
- Hasan MR, Kalam MA, Miah MAM. 2020. Assessing the profitability and problems of langra mango variety marketing in Chapainawabganj district of Bangladesh. Journal of Agriculture, Food and Environment (JAFE)| ISSN (Online Version): 2708-5694, 1(4): 169-173. Doi: 10.47440/JAFE.2020.1425
- Hossain, F. M., Numan, S. M., Akhtar, S. 2021. Cultivation, nutritional value, and health benefits of dragon fruit (*Hylocereus* spp.): a review. International Journal of Horticultural Science and Technology, 8(3), 259-269.
- Irani B. 2020. Dragon fruit has a bright future in the global market. Can Bangladesh grab a slice? <https://archive.dhakatribune.com/business/2020/11/26/dragon-fruit-has-a-bright-future-in-the-global-market-can-bangladesh-grab-a-slice>
- Jaganathan D, Bahal R, Burman RR, Lenin V. 2012. Knowledge level of farmers on organic farming in Tamil Nadu. Indian Research Journal of Extension Education, 12(3): 70-73.
- Jiang YL, Liaon YY, Lin TS, Lee CL, Yen CR, Yang WJ. 2012. The photoperiod-regulated bud formation of red pitaya (*Hylocereus* sp.). HortScience, 47: 1063-1067. Doi: <https://doi.org/10.21273/HORTSCI.47.8.1063>
- Jahan H, Rahman MW, Islam MS, Rezwani-Al-Ramim A, Tuhin MMUJ, Hossain ME. 2022. Adoption of agroforestry practices in Bangladesh as a climate change mitigation option: Investment, drivers, and SWOT analysis perspectives. Environmental Challenges, 7: 100509. Doi: <https://doi.org/10.1016/j.envc.2022.100509>
- Khandoker S, Miah MM, Rashid MA, Khatun M, Kundu ND. 2017. Comparative profitability analysis of shifting land from field crops to mango cultivation in selected areas of Bangladesh. Bangladesh Journal of Agricultural Research, 42(1): 137-158. Doi: <https://doi.org/10.3329/bjar.v42i1.31986>
- Kikon PL. 2021. Investment feasibility analysis of dragon fruit farming. International Journal of Agricultural Sciences, 17(2): 265-270. Doi:10.15740/HAS/IJAS/17.2/265-270
- Liaotrakoon W. 2013. Characterization of dragon fruit (*Hylocereus* spp.) components with valorization potential. PhD thesis, Ghent University, Belgium, 217 p.
- Mercado-Silva EM. 2018: Pitaya - *Hylocereus undatus* (Haw). In: Rodrigues S., de Oliveira Silva E., de Brito E.S. (eds): Exotic Fruits Reference Guide. 1st Ed. Academic Press. eBook ISBN: 9780128031537.
- Mia MS, Kaysar MI, Kausar AG, Islam MS. 2019. Profitability Analysis of BRR1 Dhan 29 in Some Selected Areas of Bangladesh, 12(2): 1-6 Doi: 10.9734/AJEB/2019/v12i230149
- Ntshangase NL, Muroyiwa B, Sibanda M. 2018. Farmers' perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in Zashuke, KwaZulu-Natal Province. Sustainability, 10(2): 555. Doi: <https://doi.org/10.3390/su10020555>
- Nurliyana R, Syed Zahir I, Mustapha Suleiman K, Aisyah MR, Kamarul Rahim K. 2010. Antioxidant study of pulps and peels of dragon fruits: a comparative study. International Food research journal, 17(2): 367-375.
- Patel SK., Ishnava KB. 2019. In-vitro Antioxidant and Antimicrobial activity of Fruit Pulp and Peel of *Hylocereus sundatus* (Haworth) Britton and Rose. Asian Journal of Ethnopharmacology and Medicinal Foods, 5(2): 30-34.
- Patwary MMA, Rahman MH, Barua H, Sarkar S, Alam MS. 2013. Study on the Growth and Development of two Dragon Fruit (*Hylocereus undatus*) Genotypes. The Agriculturists, 11(2): 52-57.n Doi: <https://doi.org/10.3329/agric.v11i2.17487>
- Rashid MHA, Islam ABMJ, Shirazy BJ, Shahidullah SM. 2017. Cropping systems and land use pattern in Rajshahi region. Bangladesh Rice Journal, 21(2): 237-254. Doi: <https://doi.org/10.3329/brj.v21i2.38209>
- Rao CC, Sasanka VM. 2015. Dragon Fruit 'The Wondrous Fruit' for the 21st century. Global Journal for Research Analysis, 4(10): 261-262.
- Sancayaningsih RP, Sanjaya WT, Supriyanto W, Laksono IM, Shara DA. 2017. Weed Vegetation around Red Dragon Fruit Plants: *Hylocereus polyrhizus*. Modern Environmental Science and Engineering, 3(9): 661-666. Doi: 10.15341/mese (2333-2581)/09.03.2017/007

- Saediman H, Mboe IS, Budiyanto B, Sarinah S, Hidrawati H. 2021. Smallholder adoption of horticultural crops: the case of dragon fruit in Southeast Sulawesi. In IOP Conference Series: Earth and Environmental Science (Vol. 819, No. 1, p. 012043). IOP Publishing. Doi: 10.1088/1755-1315/819/1/012043
- Sonawane MS. 2017. Nutritive and medicinal value of dragon fruit. Asian Journal of Horticulture, 12(2): 267-271. Doi: 10.15740/HAS/TAJH/12.2/267-271
- Saha SM, Pranty SA, Rana MJ, Islam MJ, Hossain ME. 2022. Teaching during a pandemic: do university teachers prefer online teaching? Heliyon, 8(1): e08663. Doi: 10.1016/j.heliyon.2021.e08663
- Teddy FT. 2019. Problems and Opportunities of Dragon Fruit Production in the Philippines. FFTC Agricultural Policy Platform (FFTC-AP).
- Tinker, H. Russell, Husain, Syed Sajjad. 2022. Bangladesh. Encyclopedia Britannica. <https://www.britannica.com/place/Bangladesh>.
- Verma D, Yadav RK, Rani MYB, Punar S, Sharma A., Maheshwari RK. 2017. Miraculous Health Benefits of Exotic Dragon Fruit. Research Journal of Chemical and Environmental Sciences 5(5): 94-96.
- Wakchaure GC, Kumar S, Meena KK, Rane J, Pathak H. 2021. Dragon Fruit Cultivation in India: Scope, Constraints and Policy Issues. Technical Bulletin, (27), 47 <http://niam.res.in/sites/default/files/pdfs/DragonFruitBulletin-27.pdf>
- Wikimedia Foundation, I. 2022. Chapainawabganj District. [Online] Available at: https://en.wikipedia.org/wiki/Chapai_Nawabganj_District#Geographical_location [Accessed 12 June 2022].
- Xiang G, Rui W. 2004. Study on the producing of pitaya ice cream. China Dairy Ind, 32: 9-11.
- Zainudin M, Hafiz BA. 2015. Status of dragon fruit production in Malaysia. In Proceeding of Improving Pitaya Production and Marketing Workshop (pp. 13-15).