

## Ethnographic survey on cereal and pseudocereal in Bangladesh perspective

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### Abstract

Numerous studies have proven that cereal and pseudo cereal could be a great source of polyphenols that help to prevent different lifestyle diseases like hyperlipidemia. The ethnographic survey represents production, uses and consumption of cereal in Bangladesh due to well-developed agronomy. On the other hand pseudo cereal (buckwheat, quinoa, amaranth and chia) production, consumption and research actions are limited. This study aimed to conduct an ethno-graphic survey of local cereals and pseudo grains will provide the knowledge and current information of their availability and uses in Bangladesh for advance research. A qualitative, inductive, exploratory and longitudinal study was conducted. Bangladesh Institute of Development Studies (BIDS) and Bangladesh integrated Household Survey (BIHS) investigated that people intake maximum 459 g and 33.5 g per capita rice and wheat in National level. Approximately 85% of black rice, 80% of red rice and 99% of buckwheat were sold by local producers, identified by focus group discussion. On the other hand 100% of experimental quinoa and chia production were used for research purpose. Serious studies on Buckwheat, chia, millets, oat and sorghum are conducting for their excellent nutritional value. The government of Bangladesh conducted various developmental, agricultural, food and nutrition security programs which indicate a positive social and political impact on the farming system. In spite of having Governmental support, good agricultural practices, huge health and agro-economic benefits, pseudo cereal production, distribution, use and consumption data are very scanty in Bangladesh compared to other cereals.

## 1. Introduction

Ethnography is a qualitative adaptive measuring tool in order to face future challenges of agriculture by scientists and policymakers. Ethnographic study broadly frames out the production, social perceptions and acceptability, market situation, vulnerability overall social and political impact in the case of the agricultural sector (Kwame *et al.*, 2019). David *et al.* (2008) describe that the agricultural system can be influenced by the social and political environment. External factors, internal factors and political factors leave an impact on cultivation. A scientific analysis report of those factors could help to promote a guideline for policymaking and enhance agricultural sustainability. The uses of functional foods and their bioactive components have been considered as a new approach in the prevention and management of lifestyle diseases *viz.*, obesity. In search of biologically active enzyme inhibitors from natural resources, plant secondary metabolites have been

screened for their biological properties. For example, a growing number of literatures have suggested that polyphenols from vegetables, fruits, and cereals can inhibit digestive lipase *in vitro* (Garza *et al.*, 2011).

Humans consume 85% of rice, 70% of wheat and 15% of maize production over the world. In developing countries, 27% of per capita calories come from rice consumption (Regional Office for Latin America and the Caribbean, 2011). Chen *et al.* (1993) suggested that people in developing countries consume sorghum and millet as minor whole grains, which lower chronic disease incidences than wheat. On the other hand, the annual production of buckwheat in Europe is 56%, Asia 36% and America 7%, whereas Bolivia, Peru and Ecuador have grown the world's most quinoa production. The Andean region produces 70,000 tons of quinoa in 2009. Amaranth grain, consider a nutritious food from the early 1970s. Latin America mostly uses amaranth flour as inclusion of various bakery products

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(Rosentrator and Evers, 2018). An ethnographic survey of local cereals and pseudo grains can be beneficial for coping with lifestyle diseases.

## 2. Methodology

Ethnography considers a research methodology because it has a well-built foundation in experimentation and literalism (Hammersley and Atkinson, 2007). Methodological viewpoints of ethnography are fieldwork (interview, individual perception) and ethnohistoric study (reports, personal and organizational documents, journals, diaries).

### 2.1 Planning of access and ethics

Ethnographic studies require accomplishing approval from proper legal authorities for access to an experimental setting and ethical endorsement (Hammersley and Atkinson, 2007). Written applications were submitted to the in-charged authority of BARI, BRRI and Bangladesh National Herbarium for a visit, open discussion to participants, information and sample collection.

### 2.2 Interviews

Focused and in-depth interviews were conducted during the ethnographic survey that produced answers to many research inquiries unfounded in the literature. An unstructured questionnaire was the key tool for the interviews of selected resource personnel (Table 1). The main aim of the conversation was to engage the interviewee to evoke their perceptions and interpretations about particular research-related topics which was not available in literature search. Moreover, the respondents of the FGD were able to disclose the current agricultural practices of crops and their socioeconomic benefits. They also opined revitalization policies and priorities to ensure household level food security using pseudocereals in the crop diversification basket.

Table 1. Key questions for Focus Group Discussions (FGD)

Unstructured questionnaires	Expected Outcome
1. What is the pattern of cereal and pseudocereal farming in Bangladesh?	Pattern of comparative farming system.
2. Do farmers have interest in farming pseudograins?	Current scopes of pseudograins farming.
3. What kinds of cereals/pseudograins are cultivated more?	Pattern of significantly produced crops.
4. Why is pseudocereal cultivation undeveloped?	Problems of pseudocereal cultivation.
5. Do farmers know the health benefits of pseudograins?	Knowledge on the role of a healthy food.
6. Is there any socioeconomic and political impact of farming cereals/pseudocereals?	Socioeconomic and political policy revitalization on agroecological farming.
7. Are there any initiatives for encouraging farmers/researchers for pseudocereal cultivation?	Status of agricultural extension initiatives of pseudocereal research.
8. How many registered varieties of crops are there in Bangladesh?	Record of crop varieties released for field cultivation.

## 2.3 Data collection

Primary information was collected from focus group discussions with scientists, professors, technicians and people associated with agriculture. Secondary data were taken from internet websites, books, BBS, DAE, FAO stat, journal/ articles, research reports of different organizations, and annual reports of BARI and BRRI.

## 3. Results and discussion

### 3.1 Cereals

According to Table 2, farmers in Bangladesh grow rice (aus, aman and boro), and wheat as major crops and barley, jower, bazra, maize, cheena and kaon as minor cereals (Bangladesh Bureau of Statistics, 2020). Crops in Bangladesh are widely classified into two groups according to growing seasons; they are Kharif crops and Rabi crops (Table 3). From Table 3 it could be obtain that Kharif crops are cultivated in the spring or summer season and harvested in late summer or early winter. On the other hand, Rabi crops are sown in winter but

Table 2. Cereal production in Bangladesh

Crops	Yield kg/acre	
Rice (Aus)	Local	557
	HYV	1103
Aman	T. Local	588
	HYV	1136
Boro	Local	756
	HYV	1598
	Hybrid	1950
Wheat	1245	
Barley	333	
Jower	443	
Bazra	535	
Maize	3245	
Cheena and Kaon	400	
Other cereals	18	

Source: BBS (2019).

HYV: High Yielding Variety, T. local: Total local

Table 3. Farming seasons in Bangladesh identified by focus group discussion

Crop Name	Time of sowing	Time of harvesting
Aus rice (Local, HYV)	Mid March- Mid April	July to August
Aman rice (Local)	End June – Early September	December -early January
Aman rice (HYV)	Late June- Mid August	December- early January
Boro rice (Local)	Mid November- Mid January	April - May
Boro rice (HYV/Hybrid)	December – Mid February	Mid April-June
Wheat	November- December	March- Mid April
Maize	Mid October- Late December	Early April-End May
Jowar	Mid April- June	Mid August- Mid October
Kaon	November- December (Low land)	Mid March- Mid June
	Mid March- Mid May (Hilly Land )	Mid June- Mid August
Cheena	November-Mid December	Mid February- Mid April
Barley	Mid October-Mid December	Mid February- Mid April
Buckwheat	Beginning September-October	Late October-December
Chia	Beginning September-October	Late October-December
Quinoa	Beginning September-October	Late October-December

harvested in early summer or spring.

### 3.1.1 Rice (*Oryza sativa*)

Bangladesh Rice Research Institute (BRRI) developed 102 modern varieties of high yielding rice, which sustain in both favourable and unfavourable environments. Among them BR 5, BR 22, BRRI 34, BRRI 37, BRRI 38 and BR 7, BR 16, BRRI 28, BRRI 29, BRRI 50 are analysed for evaluating total polyphenolic content, IC<sub>50</sub> of DPPH radical scavenging activity and ferric reducing antioxidant power (FRAP). Comparatively higher total polyphenolic compounds and antioxidant property found in aman dhan BR 5 and boro dhan BRRI 28 than in other rice varieties (Alak *et al.*, 2012). Functional food such as whole grain brown rice is a popular tool for disease prevention. Both bran/embryo fraction and endosperm fraction of brown rice contains gallic acid, ferulic acid, syringic acid, coumaric acid, salicylic acid, 2-hydroxycinnamic acid as free and bound phenolic compounds (Ti *et al.*, 2014).

Shykh (2019), reported in The Daily Star (newspaper) that magnificent and nutritious black rice harvested 5.5 tons/hectare in Cumilla, Bangladesh. A farmer collected seeds from Vietnam, Indonesia, the Philippines, Japan, Thailand and Cambodia. According to Table 4 producers should be more conscientious on black and red rice farming and alternatively farmers over the country cultivated 10 acres of land and use 15 % for research purpose and sold 85% of total production of black rice (Table 5). Table 5 also represent that the local farmer harvested 13 mon/bigha red rice and sold 80% of total production but kept rest of the 20% for research purpose. Black rice flour, sieved with 140 µm showed

the highest value of anthocyanin, flavonoids, total polyphenolic content and antioxidant activity in the DPPH scavenging method (Carmen *et al.*, 2017). HPLC assay identified the presence of free Gallic (GA) and Ferulic acids (FA) in black rice, a potential source of lipase inhibitors (Rahim *et al.*, 2015).

### 3.1.2 Wheat (*Triticum aestivum*)

It is noticeable from Table 2 that the second highest calorie given cereal is wheat (*Triticum aestivum*) and harvesting in March to mid April (Table 3) in Bangladesh as well as in Asia. Bangladesh Agricultural research institute (BARI) developed 33 high yielding varieties of wheat and distribute the seeds among farmers (Table 4) across the country. Among them, 9 hybrid varieties of wheat were analysed for evaluating total polyphenol (TP), polyphenols oxidase activity (PPO) and antioxidant activity. The wheat variety named Shatabdi showed the highest (1.316 mg/g) and Akbar found in the lowest (1.269 mg/g) total phenolic content, whether PPO and antioxidant activity are less significant over nine varieties of wheat (Masum *et al.*, 2010).

### 3.1.3 Barley (*Hordeum vulgare*)

There are nine types of high yielding hybrid barley cultivated over 471 acres of the area of Bangladesh as a minor crop (Table 2) , harvesting mid February to mid April (Table 3) and BARI has developed seven high yielding varieties of barley for local farming and research (Table 4). Sixteen years (from 2004 to 2020) tremendous research studies by PubMed, CNKI, Bangladesh Wheat and Maize Research institute and ISI Web of Science have proved that the barley grain extract

Table 4. Opinion survey results of respondents identified by focus group discussion

Referred Cereal/Pseudograins	Opinion
1 Red rice, Black rice	Red and Black rice farming should be spread more.
2 Wheat, Barley, Corn	BARI will provide all available released grains varieties.
3 Antioxidant-rich rice, Red, and Black rice	Helpful for people to keep them in good health and boost immune system.
4 Pseudograins	a) Very scanty information about pseudograins, however, they are cultivated in scatter in several Agro Ecological Zone. b) Lipase inhibitor identification will be helpful for people.
5 Buckwheat	Buckwheat should be cultivated governmentally.
6 Quinoa	Quinoa should cultivate more
7 Chia	Chia is a easily grown grain, but it needs government support
8 Teel and Tisi	Chemical analysis of Teel and Tisi will help in research
9 Cheena, Kaon, Sorghum	Sorghum, Cheena and Kaon are popular seeds for consumption and research

Table 5. Case studies with cereal and pseudo cereal

Case study	Occupation	Area	Production	Use
Black Rice	Farmer and Entrepreneur	10 acres in Cumilla	17 mon/bigha	Self-15% Sell- 85%
Red Rice	Farmer and Entrepreneur	Cumilla	13 mon/bihga	Self-20% Sell-80%
Chia	Cereal Researcher	Dinajpur, Jashore Mymensingh, and Gaibandha	Not available	Research-100%
Quinoa	Cereal Researcher	Sher-E-Bangle AURF Kurigram, Lalmonirhat, Kuakata	700/800-1.5 ton/ hectore Sher-E-Bangla AURF 2 ton/hectore -Kurigram RF, 1.5 ton/hectore -Lalmonirhat RF, 1 ton/hectore -Kuakata RF	Research-100%
Buckwheat	Entrepreneur	Sayedpur, Jessore, and Potuakhali	15-20 mon/bigha	Sell-99% Research-1%

is rich in Phytosterols, polyphenols, arabinoxylan, tocopherols,  $\beta$ -glucans and resistant starch. More than 20 chronic diseases could be prevented by the referred ingredients of barley (Yawen *et al.*, 2020).

### 3.1.4 Maize (*Zea mays*)

BARI released 19 types of high yielding maize, including waxy corn, popcorn and sweet corn varieties. Among three white kernel maize varieties, the quality protein maize (QPM) is specifically developed for consumption as roti/ chapatti. Maize potentially yields higher (Table 2) in Rabi season than Kharif (Table 3) over 963 acres of land in Bangladesh. A Major cropping system of maize is Maize-*T. aman* (monsoon) rice, however, rice could be replaced by any other crops, such as potato, mung bean or mustard (Salahuddin *et al.*, 2017). Zhang *et al.* (2016) determined the free form of phenolics and flavonoids but found there were bounded forms of ferulic acid in nine varieties of sweet corn.

### 3.1.5 Cheena (*Setaria italica*) and Kaon (*Panicum miliaceum*)

According to Table 2 Bangladesh cultivates Cheena and Kaon on over 1063 hectares of land as minor crops

and their conjugal production are 1058 MT/year. According to Table 3, Cheena is in between crop of rabi and kharif but kaon is a rabi seasoned grain. Bangladesh Agriculture Research Institute (BARI) invented one hybrid cheena variety named 'Tushar' and two kaon varieties known as 'Titas' and 'Kaon-2' and are very popular for consume occasionally (Table 4). Cheena and kaon are grown on the unfertilized land of Char Anchal and used for making various local foods which could provide food security in the vulnerable social or environmental situation of Bangladesh (Bangladesh Agriculture Research institute, 2019). Nazma *et al.* (2012) showed 24 times higher lipophilic antioxidant L-ORACFL (19.40  $\mu\text{mol TEG-1}$ ) fraction than the hydrophilic (0.80  $\mu\text{mol TEG-1}$ ) of Cheena.

Table 6 presents that International Food Policy Research Institute (IFPRI) published statistical data on per capita major grains consumption validation survey report in the national perspective of Bangladesh (Mohammad, 2019). A survey summary from three reputed organizations showed that rice is the topmost-consumed grain in Bangladesh.

Table 6. Per capita daily food grain consumption (in grams) from HIES, BIDS and IFPRI-BIHS, 2016

Institute	Type	Rural	Urban	National
BBS (From HIES),	Rice	386.1	316.7	367.2
	Wheat	17.4	26.2	19.8
BIDS	Rice	540.5	249.5	459.4
	Wheat	23.8	89.0	41.5
IFPRI	Rice	447.8	367.3	425.9
BIHS	Wheat	29.4	44.3	33.5

BBS: Bangladesh Bureau of Statistics, HIES: Household Income and Expenditure survey

BIDS: Bangladesh Institute of Development Studies, IFPRI: International Food Policy Research Institute, BIHS: Bangladesh integrated Household Survey.

### 3.2 Pseudo-cereal

Buckwheat, quinoa and amaranth seeds are known as gluten-free and fabulous protein (amaranth 16.5 g/100 g, quinoa 14.5 g/100 g and buckwheat 12.5 g/100 g) content pseudocereal. Referred cereals are an excellent source of phytochemicals and have higher nutritive value. Pseudocereal flours are used as a nutritious ingredient in diversified bakery products, worldwide (Alencar and de Carvalho Oliveira, 2019).

#### 3.2.1 Buckwheat (*Fagopyrum esculentum*)

Buckwheat (*Fagopyrum esculentum*) is a tropical ancient crop that mainly originated in China. Europe produces the world's highest buckwheat (50%) production and the second-most production region is Asia (43%). Table 3 shows that buckwheat is a winter crop. In Bangladesh, Panchagarh Department of Agricultural Extension (DAE) informed that the buckwheat cultivation demand is graphically growing for its lucrative price, nutritional value and disease prevention functions. Buckwheat cultivated on five hectares of land in the Rajshahi district does not require fertilizer, but untrained and limited knowledge of farming decreased the production (Nishi, 2018). Table 4 suggested government support for buckwheat farming. An Entrepreneur of an organic farm has started cultivating buckwheat as an organic product since 2013 (Table 5). In his project buckwheat is cultivated as a winter-seasoned partner crop in Sayedpur and Panchagarh. From Table 5 it has been shown that every year 15-20 Mon/Bigha buckwheat has been produced and buyers bought 99% of them as rice while local people eat buckwheat leaves as a vegetable. Mondal (1992) evaluated buckwheat yields during different sowing dates with significant seed rates. In 1988-89 and 1989-90 during the dry season (November to March) highest crop yield was given due to the sowing of 20 kg seed/hac.

#### 3.2.2 Quinoa (*Chenopodium quinoa*)

In the 37<sup>th</sup> conference, FAO supported the submitted report that designated 2013 as an 'International year of quinoa' by Bolivia. Quinoa grain, stem, and leaves have frequent medicinal use in abscesses, bleeding, dislocations, nausea, insomnia and other vital diseases (Regional Office for Latin America and the Caribbean, 2011). Around the World, estimated quinoa production is almost 510 tons or 102,745 hectares. Rabi crop quinoa (Table 3) should farming seriously in Bangladesh (Table 4) due to public requirement and research purpose. A cereal researcher of Bangladesh collected quinoa seeds from Denmark and started research on cultivation in 2017. Bangladeshi quinoa seeds achieved registration from the Ministry of Seed Board, known as SAU-1. SAU-1 is a Rabi crop, with low moisture and salinity tolerance; needs no chemical fertilizers and pesticides (Porimal and Tanni, 2020). According to Table 5, 700/800-1.5 ton/ hector seeds produced in Sher-E-Bangla agricultural research field, 2 ton/hector in Kurigram, 1.5 ton/hector in Lalmonirhat and 1 ton/hector in Kuakata research field. 100% of quinoa production was used for research purpose (Table 5).

#### 3.2.3 Chia seed (*Salvia hispanica*)

Chia (*Salvia hispanica*) belongs to the Lamiaceae family and is a good source of omega-6, omega-3, fatty acids, proteins, soluble and insoluble dietary fibre, antioxidants and polyphenols (Anacleto *et al.*, 2018). Masudul *et al.* (2015), found higher seed production of chia in November and good potential for chia production in the local framework. Mohsin (2020) reported in UNB news (the online newspaper) that a Bangladeshi Professor in Bangladesh Agricultural University, Mymensingh collected chia seeds from Canada and started research on them in 2016. In 2017 chia grew successfully in Manirampur upozilla, Jashore. From Table 3, it has been showed that Bangladeshi chia is a Rabi crop (October-December) that needs one or two irrigations, fewer pesticides, natural fertilizer and also need government support (Table 4). Chia seeds are cultivated as an experimental crop in Dinajpur, Mymensingh, Gaibandha and Jashore and use 100% of production in research (Table 5).

### 3.3 Ongoing research on buckwheat (*Fagopyrum esculentum*), oat (*Avena Sativa*) and sorghum (*Sorghum bicolor*)

Table 2 presents 18 yield kg/acre of other cereals except for major and minor cereals. BARI experimented with genotypes of buckwheat, oat and sorghum for developing high yielding seed varieties and production growth (Tables 3 and 4). Four buckwheat genotypes

were collected from RCBD, Bogura, one oat genotype (BD-4271) and four foxtail millet genotypes received from Plant Genetic Resource Center (PGRC), Gazipur were analysed for a high yield rate. Among four genotypes germplasm gE3 found a promisingly higher seed yield (268.8 g) during Rabi 2018-2019 and a BD-4271 oat line produced 11.0 kg of seed. Three sorghum genotypes (IS-29468, IS-21891 and IS-9745) were experimented with for salinity tolerance and finally selected for advanced evaluation (BARI, 2018).

### 3.4 Social and political impact on agriculture

David *et al.* (2008) categorized three broad groups that affect the farming system are:

External social factors - consumer demands for locally produced foods, varieties and low prices, food safety and environmental concerns, genetically modified foods, fair market price and labour concerns.

Internal social factors - farm/field management policy (including risk management), safety strategies for workers, legal concerns of landowners and property rights.

Political factors - International trade policy, state-funded agricultural research and development programs, agricultural policy for commodity bills and others, food and nutrition security policy, and national dietary guideline policy.

The above reference and ethnographic survey indicate the positive and advanced social and political impact on Bangladesh's agriculture. Bangladesh Agricultural Research Institute (BARI) developed a total of 545 high yielding crop varieties and 505 evolving technologies for crop production. The Government of Bangladesh adopted different development and

implementation program for agriculture, food and nutrition security.

Table 7 shows that the government of Bangladesh (GoB) has serious concerns about agricultural policy-making, research and development. GoB work on fertilizer and seed distribution, bank loan for small stakeholders, agricultural diversification, storage and market trade, climate change strategy etc for achieving agricultural challenge.

## 4. Conclusion

Functional bioactive polyphenolic compounds of cereals and pseudocereals could prevent acute and chronic diseases like hyperlipidemia, Cancer, diabetes, atherosclerosis and many more. Developed and some developing countries have advanced research on both kinds of cereals, but scientific-analytical information is very scanty in Bangladesh. Ethnography is a qualitative, inductive and longitudinal study generated from observational data, documentation and interviews. From the ethnographic survey, it could be concluded that in spite of having Governmental support, good agricultural practices, huge health and agro-economic benefits, pseudocereal production, distribution, use and consumption are unpleasant in Bangladesh compared to other cereals. Pseudocereal production could be the most potential supplementary equipment for preventing nutrition and other health problems. Particular agricultural knowledge and technology should be acknowledged for the expansion and development of pseudocereal production.

## Conflict of interest

The authors declare no conflict of interest.

Table 7. Government programs for agriculture, food and nutrition security and their objectives

Sl. no	Program Name	Objectives
1	Vision 2021 and National perspective plan (2010-2021)	To achieve national level of nutritional requirements and self-competence in crop production.
2	Sixth Five Year Plan (6 <sup>th</sup> FYP 2011-2015)	Main goal was to increase agricultural production
3	Seventh five-year plan (7 <sup>th</sup> FYP 2016-2020)	Five-year future plan to achieve-
		a. sub-sector crop production development
		b. Ensure food and nutritional security
4	National Agricultural Policy (NAP-2013)	c. Make national and international market for farming community
		The aim was to ensure improved food and nutritional safety for the whole nation and enhance rural life through agricultural productivity and diversification
5	Country Investment Plan for Agriculture, Food Security and Nutrition (CIP, 2011-2015)	Mobilized internal and external funds for monitoring and evaluating agricultural investment and ensuring food safety.
6	National Agricultural Extension Policy (2015)	Service provider of extension programs for different agricultural departments
7	Strategic Plan for Health, Population and Nutrition Sector Development Program (HPNSDP 2011-2016)	To provide nutrition security and social protection.
8	Nutrition Policy (2015)	Nutrition and food security for a vulnerable group.

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