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Wheat Production in North West region of Bangladesh

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Abstract

The present study was undertaken to investigate the changes of wheat production technologies and yield over time and to explore and analyze the opinion of the traditional and agro-forestry based wheat growing farmers during November 2014 to March 2015. The study was conducted at northwest region in Dinajpur sadar and Kaharul upazilas in Dinajpur district of Bangladesh. These areas were selected considering the high concentrations of wheat cultivation. One hundred and sixty wheat farmers were selected by using previously pre-tested interview schedules adopting multi-stage proportionate systematic random sampling technique. Most of the farmers of the study area had reported to use recommended varieties, optimum planting time and spacing, fertilizer doses and method of application. They also reported to irrigate their fields in appropriate time and do other management practices as and when necessary. Despite, farmers were not much aware on seed treatment and disease management of wheat. In order to get higher economic return and to avoid crop failure, some innovative farmers were found to practice mango and litchi based agro-forestry systems in association with wheat. These systems were also reported to conserve soil moisture by reducing air temperature and adding organic matter by decomposing tree leaves. The major points or suggestions were instance availability of good seed including drought tolerant varieties, availability of inputs at affordable prices especially irrigation water at reduced prices, improved management practices particularly disease management, credit with low rate of interest, improved marketing facilities and good prices of wheat during peak season. Based on the findings of the study it could be recommended to continue the present efforts of developing new varieties and technologies in view of future changing scenario of climate of Northwest region of Bangladesh and train up the wheat growers accordingly.

Keywords: Production technology, Wheat, Agro-forestry and Bangladesh

Introduction

The effects of climate change on crop production are global concerns, but these are particularly very important for the sustainable agricultural development of Bangladesh (Hossain and da Silva, 2013). This is because of variant climatic conditions of the country due to its' geographic position and physiographic status. The biggest mountain the Himalayas in the north and the funnel-shaped Bay of Bengal in the south have made Bangladesh a meeting point of eternal

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monsoon precipitations and the catastrophic devastation of floods, droughts, cyclones, storm surges, etc. (Ferdous and Baten, 2011). Agriculture plays a significant role in Bangladesh economy socially and culturally. It accounts for about 18% of the country's GDP and is a means of livelihood that engages more than 47% of the labour force (World Bank, 2013). It also supplies food and confers livelihood security for the Bangladeshi people. Over 75% of agricultural production takes place in rural areas where more than 80% people are engaged in farming activities and growing crops to meet the basic needs of the people. But this agriculture sector is susceptible to unfavourable weather conditions and climatic events. In spite of noticeable technological progress (such as improved crop varieties and irrigation facilities), weather and climate are still the key determinants for agricultural productivity and sustainability. Agriculture in Bangladesh is already under pressure, both from huge and increasing demands for food as well as from obstacles related to the degradation of agricultural land and water endowments (Ahmed and Ryosuke, 2000). Any internal and external threats(social, political, natural and environmental) to agriculture directly affects food grain production as well as in providing food security of the country (Rahman and Parvin, 2009). Sometimes, the relation between these key factors and production losses are obvious, but often the relations are less direct. In spite of the recent strides regarding gaining sustainable development, Bangladesh's ability to restore its development is experienced with significant challenges and confounded by climate change (Ahmed and Haque, 2002).

Bangladesh has been facing steadily increase of higher temperature over the last three decades (Sarker *et al.,* 2012). Moreover, it is forecasted to experience a rise in annual mean temperatures of 1.0°C by 2030, 1.4°C by 2050 and 2.4°C by 2100. The average temperature during winter season (December, January and February) also showed a similar increasing pattern of 1.1°C by 2030, 1.6 °C by 2050 and 2.7°C by 2100. The projected values are 0.8°C by 2030, 1.1°C by 2050 and 1.9°C by 2100 for the monsoon months (Agrawala *et al.,* 2003; Ahmed, 2006). However, the Global Climate Model (GCM) data estimated more warming for winter than for the summer months (FAO, 2007). Based on the above projections, Bangladesh is likely to face more hot days and heat waves, longer dry spells and higher drought risk. In contrast, almost 80 percent of rainfall in Bangladesh has been occurring during monsoon season (June-September). The remaining 20 percent covers eight months, including the winter months in which the high-yielding rice Boro is grown. Though monsoon season's rainfall is projected to increase; the rainfall variability may increase significantly causing more intense rainfall and/or longer dry spells. Most of the climate models estimated that precipitation will increase during the summer monsoon (Mirza, 1997; Ahmed and Alam, 1998; GOB, 2009). This erratic and unevenly distributed pattern produces extreme events, such as floods and droughts, which have remarkable harmful effects on major food crops' yield, especially on Aman rice. As a result, rice production is likely to decline by 8%–17% by 2050 (Sarker *et al.,* 2012, BBS, 2005 and IPCC, 2007). It is

noticed that Aman rice had dominated in Bangladesh from 1980–1981 and contributed to 57% of the total share. However, due to drought and flood events, the trend of share of Aman rice to the total rice production decreased to 40% by 2005–2006, even though the total cultivated area devoted to this crop is much higher than others to date (Rahman and Parvin, 2009). In spite of this, rice, considered the staple food in Bangladesh, has doubled in production in the last two decades due to use of high yielding varieties, fertilizer, irrigation and pesticide through green revolution. Nevertheless, at the present time an upward trend is observed in food grain production, but it is losing out in the race against growth of population and per capita availability of food remains almost unchanged. The present food grain production is not sufficient to meet domestic requirements.

Bangladesh is a predominantly rice-consuming country. Prior to independence in 1971, wheat was virtually absent from the Bangladesh market. The Bengal Famine of 1943 encouraged a "grow-more food" campaign, but wheat cultivation did not really begin to develop until after 1965, after Dr. Norman Borlaug and the International Maize and Wheat Improvement Centre (CIMMYT) successfully introduced two Mexican wheat varieties (Sonora 64 and Penjamo 62) into northern Bangladesh. The success of the CIMMYT program, however, was disrupted by Bangladesh's liberation war. A severe drought in 1973, followed by major floods in 1974, also led to widespread food shortages, prompting a massive international emergency relief effort to meet the country's basic food security needs. With the influx of food aid shipments, wheat became a regular feature in the Bangladesh diet, particularly among urban consumers seeking to supplement their rice-based diet. But as wheat imports rose to 2.3 million metric tons in 1972/73, the Government of Bangladesh began to institute policies to encourage domestic wheat production. Wheat cultivation quickly expanded around Khulna and the generally less flood-prone areas of the northern and western districts. According to Bureau of Statistics, starting with an area of 0.126 million hectares, and production of 0.103 million metric tons in 1971, the area and production increased to 4,29, 607 hectares and 13,02,998 million metric tons, respectively, in 2013 (BBS, 2014). Currently, Rajshahi and Rangpur Division contributed 36% and 30% respectively to total national wheat production. Wheat (*Triticum aestivum* L.) is the second staple cereal crop next to rice in Bangladesh. Wheat grain is rich in food value containing on an average of 12.1% protein which can go up to 21.1%. By the time of independence (1971), Bangladesh had become highly dependent on wheat imports while dietary preferences were changing such that wheat was becoming a highly desirable food supplement to rice. Now it is a common food next to rice.

The yield also increased from 0.86 t/ha to 2.21 t/ha during the period. This increased area, production, and yield of wheat spurred mainly because of the introduction of modern seed-water-fertilizer technologies. But still the yield of

wheat is low in comparison to the developed countries of the world like Japan, India, China, South Korea, Mexico, USA, EU-15 and Australia where yield were 3.17, 3.30, 3.90, 5.00, 4.44, 2.70, 6.36, 1.88, t/ha, respectively (Economic Research Service, 2007). However, the current climatic event especially drought has become the potential threat to wheat production that magnitude severe in near future. In spite of reaching its highest area (0.88 million hectares) and production of wheat (1.91 million tons) in 1999; the area and production were found to be decreasing during next seven years. In 2006, the area decreased to 0.48 million hectares and production to 0.74 million metric tons. Now, the climate change especially drought is the biggest issue for wheat production. Farmers are looking forward for technological and adaptation measures to continue or in increase wheat production by facing the climate change issues. Sporadically, it has been found that, trees have been planted in crop field or in boundary for keeping moisture in the field, reducing evaporation or evapo-transpiration.

Nevertheless, to meet the future food requirement and to check the drain of foreign currency for importing a huge quantity of wheat grain, more attention on technology and policy should be given for the intensive and extensive cultivation of wheat in the country in view of current changes of weather and climatic events. Therefore, it is needed to examine the past and present performances to explore the potentialities and possibilities of area and production expansion of wheat in Bangladesh. Keeping these in mind the objectives undertaken are as follows:

- To investigate the changes of wheat production technologies and yield over time under the changing scenarios in the study area
- To explore the wheat production in agro-forestry and traditional systems.

Methodology

The study was conducted among randomly selected 160 wheat farmers in two upazilas namely, Dinajpur sadar and Kaharul under Dinajpur district of Bangladesh based on highly concentrated wheat growing areas. Maps of two upazilas showing the study area have been presented in figure 1. It is done to determine the changes of wheat production technologies in agro-forestry and traditional systems during November 2014 to March 2015. For collecting primary data at household level, a pre-designed interview schedule was developed with balanced combination of both closed and open-ended questions, and the same was pre-tested before finalization. Participatory Rural Appraisal (PRA) tools and techniques like Focus Group Discussion (FGD), Direct Observation and case study were also applied for triangulation of data. In order to collect relevant information from the wheat farmers, three sets of instruments

(interview schedules) were carefully designed keeping the objectives of the study in view. Interviewer effect such as assuming the meaning of a response was then kept to a minimum (Hammersley and Atkinson, 1983). The selected variables were farmer's knowledge level, use of recommended seed, varieties, sowing time, methods of sowing. It also measured Average area (ha) coverage of balanced fertilizer and application method, irrigation, intercultural operation, plant protection, *etc*. Changes of wheat yield over time were also determined using secondary data from different sources. The SPSS package (Statistical Package for Social Sciences) was used to perform data analysis. All the collected data were then checked and cross checked, compiled, coded and entered into the computer for analysis and interpretation using this software. Descriptive statistical measures like range, mean, number and percentage distribution, standard deviation were used to describe and interpret the data. Statistical measures like number, range, mean and standard deviation were calculated in describing the changes of wheat production technologies over time.

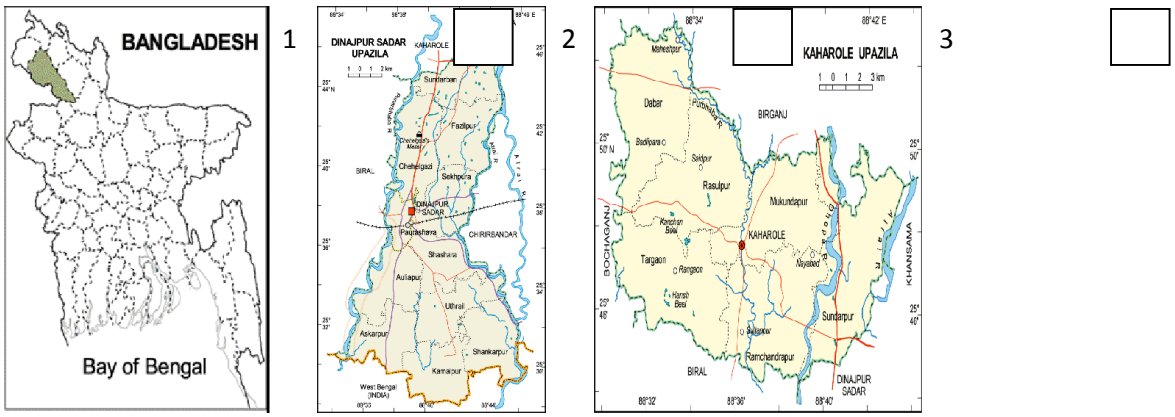

Figure 1: Map showing the study area (1), Dinajpur sadar (2), and Kaharole upazila (3) of Dinajpur district

Results and discussion

Farmer's knowledge on wheat cultivation

It is evident from table 1 that more than 70% of the respondent farmers possessed correct knowledge on wheat cultivation except 'name of heat tolerant varieties of wheat'. Of them knowledge about 'irrigation scheduling' (83.75%) ranked first followed by 'optimum planting time' (83.12%), 'name of HYVs of wheat' (82.5%) and 'local varieties' (81.2%), 'soil suitable for wheat cultivation' (78.12%), 'spacing of wheat'(76.87), 'urea application in wheat cultivation' (75%), and 'seed rate of wheat (73.75%).

Table 1. Farmer's knowledge level about wheat cultivation technologies

Knowledge area	Correct Response		Incorrect Response	
	Frequency	(%)	Frequency	(%)
Name of HYVs of wheat	132	82.5	28	17.50
Name of local varieties of wheat	130	81.25	30	18.75
Name of heat tolerant varieties of wheat	106	66.25	54	33.75
Soil suitable for wheat cultivation	125	78.13	35	21.88
Wheat seed production	118	73.75	42	26.25
Optimum planting time of wheat	133	83.13	27	16.88
Spacing of wheat	123	76.88	37	23.13
Urea application in wheat cultivation	120	75.00	40	25.00
Seed rate of wheat cultivation	118	73.75	42	26.25
Irrigation required for wheat cultivation	134	83.75	26	16.25
Diseases that cause damage to wheat cultivation.	114	71.25	46	28.75
Fungicides required to control wheat diseases	112	70.00	48	30.00

In spite of good knowledge regarding production technology of wheat, farmers had comparatively little awareness about name of disease and their management as well as stress tolerant cultivar. Virtuous knowledge regarding improved wheat cultivation technique of the respondents could be owing to regular training provided by Wheat Research Centre (WRC) as well as close supervision of their activities which will help them to upscale their knowledge level. Furthermore, different international NGOs such as CARE, USAID also provide training to the farmers.

Changes in wheat production technology

Wheat production technologies recommended by BARI (Annon. 2009) like quality seeds, varieties, planting time, methods of sowing, fertilizer application, fertilizer application method, irrigation, intercultural operation and plant protection were considered as improved wheat production technologies. In this section the present farm level status of wheat production technologies is done in comparison to the status that existed ten years before.

Quality seed of wheat

It was found that major area of the selected farmers is currently covered by the seed collected from WRC which was 2.5 times higher than 10 years back. In contrast, at present area under wheat production by reputed company seed, own stored seed, dealer provided seed and BADC seed decreased subsequently (Table 2). It might be due to BADC that cannot meet the requirement of growing demand of wheat seed. Therefore, farmers rely on Wheat Research Centre to get their seeds or due to existing seed regulation, they could not produce and preserve seeds of unreleased varieties though it provides higher yield. However, some farmers confidentially preserved those seeds and that quantity was good enough for seed increase in next season (Pandit *et al.,* 2007). It was observed from the relative change that the sources of quality seed has been changed significantly in the study area.

Table 2. Average area (ha) covered with quality seed in wheat production

Source	10 years back	Present time	Relative change
BADC seed	99 (34.85)	36 (16.51)	-52.62
Wheat Research Centre (WRC)	41(14.43)	103(47.24)	227.37
Dealer seed	57 (20.07)	27 (12.38)	-38.31
Reputed company seed	20 (7.04)	13 (5.96)	-15.34
Farmers own stored seed	67 (53.59)	39 (17.88)	-66.64

BARI recommended varieties

It is manifested from table 3 that currently average area cultivated with BARI Gom-26 (38.64 ha)is 3 folds higher than the past (12.84ha). Similarly currently average area cultivated with BARI Gom-27 is 2.96 times and BARI Gom-28 is 2.18 times higher than the past. On the other hand, use of BARI recommended variety, *viz*., Akbar, Sonalika, Prodiv is presently decreased concomitantly which might be due to changing climatic condition. Among the

new varieties, the area of BARI Gom27 was the highest due to farmers' higher preference and more availability of seeds. It was observed from the relative change that the use of BARI recommended varieties has been changed significantly in the study area.

Table 3. Average area (ha) covered with BARI recommended varieties in wheat production

Name of Variwety	10 years back	Present time	Relative change
Akbar	61.3 (27.66)	16.56 (9.30)	-66.38
Sonalika	40.48 (18.26)	14.72 (8.27)	-54.71
BARI Gom-24 (Prodiv)	75.44 (34.04)	27.68 (15.55)	-54.20
BARI Gom-26	12.84 (5.79)	38.64 (21.75)	275.64
BARI Gom-27	14.56 (6.57)	43.21 (24.28)	269.56
BARI Gom-28	16.97 (7.65)	37.13 (20.86)	172.67

Recommended sowing time

As shown in table 4, that 10 years back average major area was planted between5-14 November(115.93 ha) which is now decreased to 0.26 times. However, owing to shifting winter season, at present farmers sow their wheat seed around 15-30 November which was 2.08 times higher than the past followed by 1st week of December (1.81 times) and mid-December (1.66 times).Sowing time is very important for wheat yield in Bangladesh, because for each day delay of seeding after 30 November (optimum time), wheat yield reduces @ 1.3% i.e. 43 kg/ha (Saunders, 1988). It was observed from the relative change that the planting time of wheat has been shifted significantly in the study area.

Table 4. Average area (ha) covered with recommended planting time in wheat production

Planting time	10 years back	present time	Relative change
5-14 November	115.93 (56.54)	31.28 (15.03)	-99.11
15-30 November	59.64 (29.09)	124.08 (59.65)	105.01
1st week of December	23.92 (11.66)	43.44 (20.88)	71.53
Mid December	5.52 (2.69)	9.21 (4.42)	64.31

Methods of sowing

With regard to methods of sowing, broadcasting method gradually decreased from 153.17 ha to 63.33 ha while in contrast, line sowing tremendously increased from 51.84 ha to 144.68 ha over time (Table 5). It might be due to the fact that the line sowing is more suitable for intercultural operation as well as better management of fertilization. Corroborate findings were also reported by Pandit *et al.*(2007). It was observed from the relative change that the method of sowing of wheat has been changed significantly in the study area.

Table 5. Average area (ha) covered with methods of sowing in wheat production

Methods of sowing	10 years back	Present time	Relative change
Broadcasting	153.17 (74.71)	63.33 (30.44)	-59.26
Line sowing	51.84 (25.28)	144.68 (69.55)	175.12

Balanced fertilizer

It is evident from the table 6, that, 10 years before only 21.92 ha of land was fertilized by recommended dose of urea which has now become 71.51 ha which is about 3.26 times higher than the previous adoption level. Similarly, in the past use of TSP was lower than the recommended dose which has now gradually increased. About 21.34 ha of the field is presently fertilized by the suggested MOP dose which was previously only 19.84 ha. However, area under recommended gypsum, boric acid and DAP gradually increased with increasing level of knowledge regarding modern wheat production technology though recommended cow dung application is somewhat decreased. The probable reason for low use of chemical fertilizers in the past is due to the fact that the land was so fertile for producing good yield with low cost while owing to successive cultivation land gradually lost its fertility. Hence, the use of chemical fertilizers increased at the present time. The results are supported by the findings of Rahman and Haque, (2013). It is observed from the relative change that the use of balanced fertilizer in wheat production has been changed significantly in the study area.

Table 6. Average area (ha) covered with balanced fertilizer used in wheat production

Fertilizers used	10 years back	Present time	Relative change
Urea (220-250 kg/ha)	21.92 (10.69)	71.51(34.88)	226.29
TSP (120-150 kg/ha)	17.85 (8.70)	24.01 (11.71)	34.60
MOP (100-120 kg/ha)	19.84 (9.67)	21.34 (10.40)	7.54

Gypsum (100-120 kg/ha)	18.28 (8.91)	24.54 (11.97)	34.34
Boric acid (6-7 kg/ha)	12.67 (6.18)	16.21 (7.90)	27.83
Cow dung (8-10 ton/ha)	105.42 (51.42)	38.49 (18.77)	-63.50
DAP	9.03 (4.40)	11.91 (5.80)	17.06

Fertilizer application method

From table 7, it is evident that there was no distinct change in recommended basal doses of fertilizer application in the past and present years. However, second installment of fertilizer application after 17-20 days of sowing is increased1.02 times which might be due to losing of soil fertility. Rahman and Haque (2013) also reported the similar findings. It is observed from the relative change that the fertilizer application method has been changed significantly in the study area.

Table 7. Average area (ha) covered with fertilizer application methods in wheat production

Fertilizer application methods	**10 years back**	**Present time**	**Relative change**
Total cow dung, TSP, MOP, Gypsum, Boric acid and 2/3 Urea used as basal dose.	125.18 (61.06)	126.03 (60.58)	
Rest 1/3 Urea used after 17-20 days of sowing.	79.83 (38.93)	81.98 (39.41)	

Irrigation

The recommended number of irrigation in wheat crop is 2-3 times depending on the type of soil. The present study indicated that within 17-21 days of sowing area under 1st irrigation decreased presently as compared to the past. Second and third irrigation scheduling area were increased about 2.01 and 1.65 times respectively (Table 8). The feasible reason might be due to global warming of the atmosphere which increases the rate of evapotranspiration from the soil. Therefore, to fill the water demand of crop area under irrigation successively increased. Corroborate findings were also reported by Singh and Chahal (2009). It was observed from the relative change that the irrigation schedule has been shifted significantly in the study area.

Table 8. Average area (ha) covered with irrigation in wheat production

Irrigation schedule	10 years back	Present time	Relative change
Within 17 - 21 days of sowing	117.54 (57.33)	47.94 (23.04)	-59.81
Within 50-55 days of sowing	41.68 (20.33)	84.06 (40.41)	98.77
Within 70-80 days of sowing	45.79 (22.33)	76.01 (36.54)	63.64

Intercultural operation

In case of intercultural operation, little divergence was noticed between present and past year which was almost similar in case of weeding but little higher for herbicide application (Table 9).The probable reasons might be due to practicing of line sowing and good tillage of land before wheat sowing which hinder germination of weeds thereby reduced the cost of intercultural operation. Mahmood *et al.* (2006) also reported the similar findings. It was observed from the relative change that the intercultural operation has not been changed significantly in the study area.

Table 9. Average area (ha) covered with intercultural operation in wheat production

Intercultural operations	10 years back	Present time	Relative change
Weeding: 25-30 days after sowing	123.57 (60.27)	124.76 (59.97)	-0.50
Herbicide: 2, 4-D Amine, Affinity or Fielder (35ml/10L) (25-30 DAS)	81.44 (39.72)	83.25 (40.02)	0.75

Plant protection

It is seen from table 10 that seed treatments with provax and vitavax were almost similar compared to previous year. However, as similar to seed treatment, area under insect and disease control was also increased slightly. The probable reason of increased pest infestation might be due to increased temperature of the earth which triggers insect and pest emergence. Therefore, necessary adoption steps to overcome this situation was also undertaken which helped the farmers to boost wheat yield. Similar finding were also reported by Rahman and Haque (2013). It was observed from the relative change that the plant protection measures has not been changed significantly in the study area.

Table 10. Average area (ha) covered with plant protection measure in wheat production

Plant protection measures	10 years back	Present time	Relative change
Seed treatment (Provax, Vitavax)	49.84 (24.31)	50.07 (24.07)	-0.99
Insect control	72.68 (35.45)	74.07 (35.60)	0.42
Disease control	82.49 (40.23)	83.87 (40.32)	0.22

Changes of wheat yield over time

Wheat yield increased progressively though production area are tended to be reduced (Figure 2). Nevertheless, after 2005, wheat yield seemed to be reduced in the study area till 2012. Wheat yield and total production in the country have been decreasing mainly due to wide spread cultivation of disease susceptible variety (Sufian, 2005) and inadequate adoption of recommended management technologies. Interestingly, wheat yield increased enormously in recent years might be attributed to adoption of all modern technology including varietal development with changing climate, varietal diversity in a single field to curtail disease infestation as well as adoption of all modern technology as per recommendation,which help the farmers to increase wheat yield in spite of adverse climatic situation. Corroborate findings were also reported by Pandit *et al.* (2007).

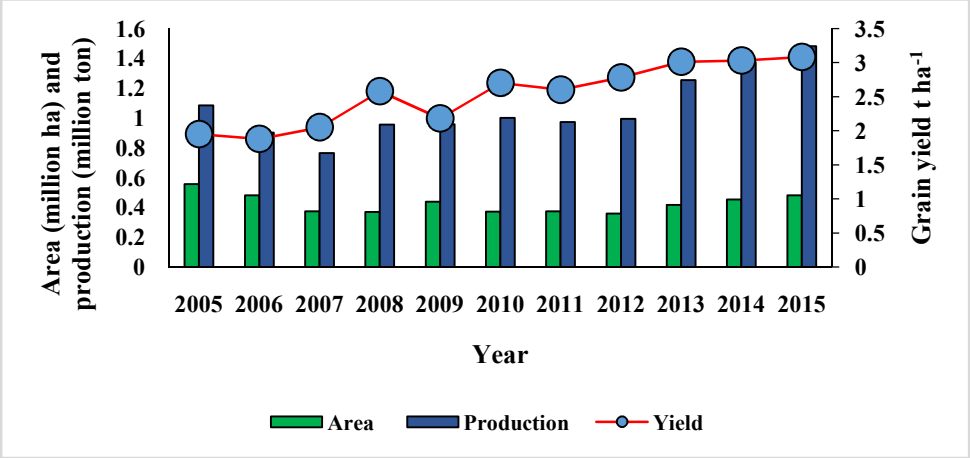

Figure 2: Area, production and yield of wheat during the year 2005 to 2015

Cultivation of wheat in agro-forestry and traditional systems

Data in figure 3a indicated that among 160 respondents, only 33.12% respondents practice agro forestry systems in association with wheat and rest of the respondents (66.87%) were engaged in traditional wheat cultivation. On the other hand, among agro forestry systems, around 60% farmers practice litchi based agro-forestry systems while only 40% farmers practice mango based (Figure 3b) systems. It implies that the GOs and NGOs should give emphasis to create scope and proper technical facilities regarding agro-forestry so that the farmers are encouraged to practice agro-forestry systems in association with wheat instead of traditional systems.

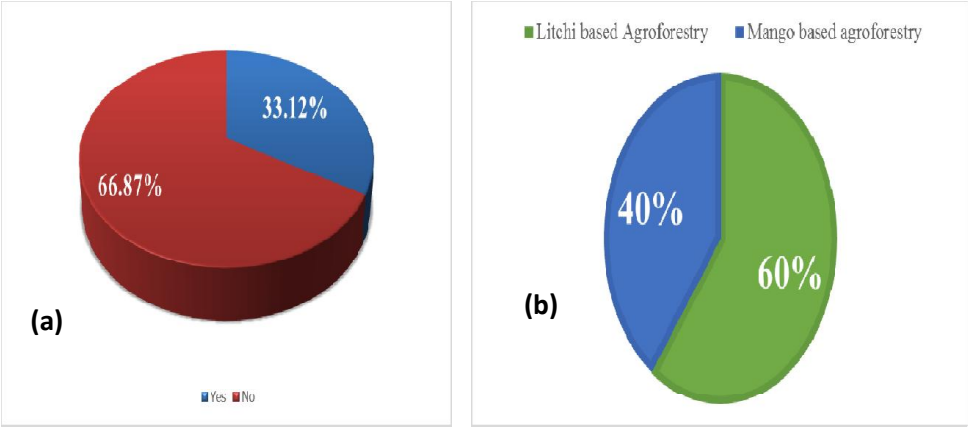

Figure 3: (a) Respondent percentage regarding practicing of agro-forestry and traditional systems.

(b) Percentage of people involved in two systems of agro-forestry

Suggestions

Respondents gave some suggestions to solve their problems (Table 11). In regard to irrigation facilities most of the farmers opined that shallow tube well establishment (65.74%) would be the best solution followed by deep tube well (23.69%), surface water use (7.18%), dew use (3.39%) respectively. As regards good quality seed and higher input price, most of them expected WRC take more initiatives to ensure good quality seed followed by BADC. Furthermore, some of them stored their previous year seed to reduce input cost. In our country, most of the farmers are very poor hence they have no money to initiate their cultivation. Therefore, they opined that regarding solving the problem government as well as NGOs should extend loan with small interest. For storage facility problems, they suggested that govt. should build more store house (79.23%) followed by traditional drum systems (20.77%). In view of soil fertility, most of them

expected to get more quantity of fertilizers (47.63%) cow dung (31.49%) and green manure (20.88%) respectively. For inadequate labours problem during peak period, most of the respondents worked in their own field, sometimes women and relatives helped them. Problems regarding communication with extension worker, they opined that they might get help from experienced farmer as well as dealer. In case of marketing problems and lower price of the product, majority of the respondents suggested that govt. should take initiatives to improve marketing channel as well as transportation systems. To make wheat production more profitable most of the farmers suggested that, WRC should give more training as well as technology of wheat. Being conscious about environmental pollution and exploration of agro-forestry systems, most of the respondents suggested that, govt. should broadcast more programme on television so that people could easily understand how they would keep environment safe as well as reap diverse benefit of agro-forestry systems. Nevertheless, they gave suggestions to apply zero tillage regarding big tree roots problems of agro forestry systems. Last of all, as regards rodent infestation, some of them opted for use of rodenticides while others wanted to use rodent trap.

Table 11. Proposed suggestions to overcome the problems as suggested by the respondents for their better livelihood in the study area

Sl. No	Nature of problem	Suggestions to overcome the problems	Percentage (%)
1	Lack of irrigation facilities	Shallow tube-well	65.74%
		Deep tube-well	23.69%
		Surface water use	7.18%
		Dew use	3.39%
2	Lack of good quality seed	BADC	33.59%
		WRC	66.41%
3	Higher price of inputs	Stored their own seed	40.11%
		BADC or WRC produce more seed	59.89%
4	Lack of cash money	Loan from friend	17.67%
		Govt. loan should be in easy process	57.23%
		Loan from NGO	25.10%
5	Poor storage facilities	Build more store house	79.23%

		Drum	20.77%
6	Declining soil fertility	Cow dung	31.49%
		Fertilizer	47.63%
		Green manure	20.88%
7	Lack of adequate labor in the production period	Self-working	76.28%
		Women	17.39%
		Relative assistance	6.33%
8	Poor contact with extension media/agents	Assistance form Dealer	37.13%
		Assistance form experienced farmer	62.87%
9	Marketing problems of the products	Improvement of market channel	73.29%
		Govt. directly bought their product	26.71%
10	Lower price of product during harvesting period	Storage facilities	29.57%
		Improve transportation systems	70.43%
11	Arranging practical training for farmers	Initiative needed from –DAE	26.23
		WRC	67.43%
		NGOs	6.34%
12	Increasing farmers' awareness on environment pollution	Campaign	9.15%
		Mass media	90.85%
13	Formation of effective organization for the farmers	FFS	31.67%
		Group discussion	35.82%
		Co-operative	16.39%
		Club	16.12%
14	Ensuring much more publicity of agro forestry practices through national media	TV	93.49%
		Radio	2.31%
		Newspaper	4.20%

15	Big trees root in agro-forestry field	Zero tillage	59.17%
		Root pruning	40.83%
16	Agro forestry create shade on wheat field	Shoot pruning	100%
17	Rodent problem	Trap	37.03%
		Rodenticides	62.97%

Conclusion

Wheat is an integral part of the global food system including Bangladesh. Its consumption is also expanding, increasingly in developing countries, which now account for more than half of the global harvest. Shorter cultivation period and high energy content have made it a valuable cash crop for the millions of people. In the context of high population growth rate, reduction of cultivable land and crop losses due to frequent climatic hazards, the livelihood situation of Bangladesh will be more acute in the coming years. Increased wheat production definitely will contribute to overcome this situation. In respect of knowledge level, most of the farmers provided correct answer regarding high yielding varieties (82.5%), local varieties (81.25%), optimum planting time (83.13%), and irrigation scheduling (83.75%), while providing incorrect answer about heat tolerant varieties (33.75%) and suitable fungicides for controlling disease (30.00). However, regarding changes in wheat production technology over time, for seed source, most of the wheat growing area were found to cover by seed from WRC while previously they had collected seed from BADC; for variety, major area of the selected farmers used "Prodiv" which was now replaced by BARI Gom-26, BARI Gom-27, BARI Gom-28; for planting time, major areas were planted in 5-14 November which now shifted to 15-30 November due to changing climate. Having good training, most of the respondents used line sowing instead of broadcasting for better intercultural operation. Nevertheless, due to continuous wheat cultivation, soil fertility status declined drastically, therefore, use of chemical fertilizers increased dramatically compared to 10 years back. The farmers of the study area were found to have well experienced about wheat cultivation due to close contact with WRC, therefore, area covered by recommended irrigation scheduling increased fascinatingly compared to previous 10 years. In addition, practice of optimum weeding and control of pests and diseases increased notably compared to previous years to obtain higher yield. Nevertheless, owing to adoption of modern technology of wheat, yield increased almost twice than the previous time.

Based on the findings of the study and keeping the objectives in mind, the following conclusions are drawn:

1. Farmers of the wheat growing areas were well aware about the modern technologies of wheat cultivation because of the advantages of close contact with the Wheat Research Center (WRC) located at Dinajpur Sadar. Adoption level of using quality seed, suitable planting time, seed rate, fertilizer application and irrigation scheduling were found to be very high, while there were minimum awareness among the growers about the different diseases and control measures. Nonetheless, yield of wheat in the study area increased over time in spite of changing climate due to adoption of modern technologies particularly new varieties and cultural management practices.

2. A good number of suggestions and recommendations were drawn from the study for gaining maximum outputs by the growers combating the recent changes of local climate. These were visiting and monitoring of wheat fields by extension personnel, dissemination of modern technologies, training to improve technical knowledge and skills, and providing credit with low interest rate. Besides, more research particularly for developing heat tolerant and diseases resistant varieties of wheat should be high priorities for the study areas of North-West region of Bangladesh.

Based on key findings of the study, the following recommendations are put forward:

1. Technology performance gap i.e. gap between technology use and productivity need to be minimized by increasing yield per unit.Technology adoption qualities need to be improved through knowledge and skill enhancement as well as through its proper application.

2. Awareness through demonstration and training are required to promote fruit based agro-forestry systems in the study area to minimize the disparaging effect of climate change.

References

Agrawala, S., Ota, T., Ahmed, A. U., Smith, J., and Van Aalst, M. (2003). Development and climate change in Bangladesh: focus on coastal flooding and the Sundarbans. *OECOD, France.*

Ahmed, A. U., and Alam, M. (1999). Development of climate change scenarios with general circulation models. In Vulnerability and adaptation to climate change for Bangladesh (pp. 13-20). Springer Netherlands.

Ahmed, A., and Ryosuke, S. (2000). Climate change and agricultural food production of Bangladesh: an impact assessment using GIS-based biophysical crop simulation model. Center for Spatial Information Science, University of Tokyo, 4-6.

Ahmed, A.U. (2006) Bangladesh Climate Change Impacts and Vulnerability. A Synthesis; Climate Change Cell, Department of Environment, CDMP, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Ahmed, A.U., and Haque, N. (2002) Climate Change and Sustainable Development. In Proceedings of the Dhaka Meet on Sustainable Development, Citizens' Perspectives on Sustainable Development, Bangladesh Unnayan Parishad (BUP), Dhaka, Bangladesh.

Anonymous (2009). (4 November 2012). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of Peoples Republic of Bangladesh, Dhaka.

Bangladesh Bureau of Statistics (BBS). (2005) Compendium of Environment Statistics of Bangladesh. Government of Bangladesh, Dhaka, Bangladesh.

Bangladesh Bureau of Statistics (BBS). Statistical yearbook 2014. Government of Bangladesh, Dhaka, Bangladesh.

Economic Research Service/USDA. (2007) International Agricultural Baseline Projections to 2007/AER - 767. 33- 49.

Ferdous, M. G., and Baten, M. A. (2011). Climatic variables of 50 years and their trends over Rajshahi and Rangpur Division. Journal of Environmental Science and Natural Resources, 4(2), 147-150.

Food and Agriculture Organization (FAO). (2007) Climate Variability and Change: Adaptation to Drought in Bangladesh. In A Resource Book and Training Guide; FAO: Rome, Italy.

Government of Bangladesh (GOB) and United Nations Development Program (UNDP). (2009). The Probable Impacts of Climate Change on Poverty and Economic Growth and Options of Coping with Adverse Effects of Climate Change in Bangladesh. Policy Study, Dhaka, Bangladesh.

Hammersley, M. and Atkinson, P. (1983). Ethnography: Principles in Practice. London: Tavistock.

Hossain, A., and Da Silva, J. A. T. (2013). Phenology, growth and yield of three wheat (Triticum aestivum L.) varieties as affected by high temperature stress. Notulae Scientia Biologicae, 4(3), 97.

IPCC (Intergovernmental Panel on Climate Change). (2007). Climate change 2007. Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Chang [Core Writing Team, Pachauri RK, Reisinger AJ, eds]. Geneva, Switzerland: IPCC, 104.

Mahmood, M. A., Sheikh, A. D., Hussain, A., and Abbas, M. (2006). Recommended technologies and production practices at farm level: Wheat scenario. Pakistan Journal of Life and Social Sciences, 4(1-2), 52-57.

Mirza, M.M.Q. (1997) Modeling the Effects of Climate Change on Flooding in Bangladesh. Ph.D. Thesis, International Global Change Institute (IGCI), University of Waikato, Hamilton, New Zealand.

Pandit, D. B., Baksh, M. E., Sufian, M. A., Harun-ur-Rashid, M., and Islam, M. M. (2007). Impacts of participatory variety selection in wheat on agro-economic changes of

wheat farmers in Bangladesh. Bangladesh Journal of Agricultural Research, 32(3), 335-347.

Rahman, M. S., and Haque, Z. (2013). Adoption of selected wheat production technologies in two northern districts of Bangladesh. International Journal of Agricultural Research, Innovation and Technology, 3(1), 5-11.

Rahman, M. W. and Parvin, L. (2009). Impact of irrigation on food security in Bangladesh for the past three decades. Journal of Water Resource and Protection, 3, 216-225.

Sarker, M. A. R., Alam, K., and Gow, J. (2012). Exploring the relationship between climate change and rice yield in Bangladesh: An analysis of time series data. Agricultural Systems, 112, 11-16.

Saunders, D. A. (1988). Crop Management Research Summary of Results, 1983-88. Monograph No. 5. Wheat Research Centre, Bangladesh Agricultural Research Institutes. Joydebpur, Gazipur.

Sufian, M. A. (2005). Sustainable wheat production in Bangladesh in relation to climate change. In A Key note paper presented at the workshop on "Sustainable Wheat Production, held at BRAC Centre Inn, Dhaka on October.

Singh, M., & Chahal, S. S. (2009). A study on the extent of adoption of various recommended technologies in wheat cultivation in Punjab.Agricultural Economics Research Review, 22(conf), 349- 354.

World Bank (2013). Bangladesh Poverty Assessment: Assessing a Decade of Progress in Reducing Poverty, 2000-2010. Bangladesh Development Series Paper No. 31.