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Probable Causes of Rice Yield Gap in Chapainawabganj District

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ARTICLE INFO	ABSTRACT
Received date: May 15, 2022 Accepted date: August 25, 2022	The study was conducted to find out the probable causes of the yield gap in rice cultivation at Chapainawabganj district. Five contiguous upazila in Chapainawabganj district, such as, Chapainawabganj sadar, Nachol, Gamostapur, Bholahat and Shibganj upazila areas were the study area. A total of 50 farmers were selected across the study area covering 10 villages disrespected located. Structured questionnaires were designed together and required information from 50 respondents. The data were collected from face to face interviews with farmers who were related directly to rice cultivation in the study area. In the study area, 13 young (<35 years), 23 middle (36 to 50 years) and 14 old (>51 years) farmers were the age category. The result showed the highest respondents (23 farmers, 46%) were middle aged who were illiterate (18 farmers, 36%), medium experience (5 to 27 years) and were involved in business (48%) and having their own land. The probable cause of the rice yield gap was estimated that the listed weather affected by 70% of farmers. The yield gap was found at 2.608 t/ha in the Boro season (Shumon Swarna), 1.39 t/ha in the Aus season (Dharavador) and 0.706 t/ha in the Aman season (BRRI dhan 28). The present study will be helpful for the farmers involved in rice cultivation.

Keywords: Crop, Demographic characteristics, Perching operation, Rice, Yield gap

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1. INTRODUCTION

The concept of yield gaps in crops originated from different constraint studies carried out by International Rice Research Institute (IRRI) in the seventies (Mondal, 2011). The yield gap comprises at least two components. The first one is yield gap-I i.e., the difference between experiment/research station yield and the potential farm yield, is non exploitable. The second one is yield gap-II i.e., the difference between the potential farm yield and the actual average farm yield (Alam, 2006). The yield gap-II is exploitable and can be minimized by deploying research and extension approaches and

government interventions, especially institutional issues. Nhamo et al. (2014) reported the lack of integration of improved technologies, to increase synergies and alleviate socio-economic constraints, largely explained the existing yield gaps. Xinpeng et al. (2016) showed that the analyzing attainable yield (YA), yield gap (YG), and nutrient use efficiency (NUE) will help develop and inform agricultural policies and strategies to increase grain yield.

Despite the technologies developed by different National Agricultural Research System (NARS) institutes and extension agencies to disseminate the technologies, yield gaps exist in different crops of Bangladesh, such as rice,

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wheat, potato, oilseeds, pulses, etc. that may range from 19% to about 64% of the potential yield (Alam, 2006; Roy, 1997; Matin et al., 1996). The existence of yield gaps was also observed in rice, mustard, and cotton in India (Aggarwal, 2008). In India, yield gap varied from 15.5 to 60% with the national average gap of 52.3% in the irrigated ecosystem (Siddiq, 2000). Yield gaps in crops are real and the challenge needs to be addressed in the interest of increased and sustainable crop production. Yield gaps exist at different area base in crops of Bangladesh. Alam (2006) evaluate the yield gap in boro rice at Rajapur and Meghdubi villages in Bangladesh. Under farmer's practice, the yields of boro rice were 4.47 t/ha and 3.67 t/ha, while the potential yields with better management were 5.90 t/ha and 4.73 t/ha at Rajapur and Meghdubi villages, respectively. The yield gaps were thus 1.43 t/ha and 1.06 t/ha which were 24.24% and 22.41% of the potential yield at Rajapur and Meghdubi. Roy (1997) reported yield gaps of 44.44 and 60.00% in Aus and Aman seasons, respectively. A yield gap ranged from 1.1 to 3.5 Mg ha⁻¹ in rice yield in US observed Matthew et al. (2016). Audebert & Fofana (2009) conducted a study in lowland rice, notably in West Africa, the result showed that 43% reduced rice yields by iron toxicity intensity and crop management strategy. An average yield gap of 1000 kg ha⁻¹ was identified probably due to other factors such as management practices (Casanova et al., 1999). The yield gap observed between dry and wet seasons within six genotypes of rice (Woonho et al., 2008). Alam et al. (2013) showed the best management practices and two N management options reduced the yield gap of FP by 45%, with an average of 1.5 Mg ha⁻¹. Boling et al. (2010) conducted study in rain fed rice. The range in yield gap caused by water limitations was 0–28% and that caused by N limitations 35–63%, with large temporal and spatial variability.

In spite of this reality, some crop specialists, especially extension experts do not believe in the existence of yield gaps in the crops of Bangladesh. They tend to believe that the current strategy of the use of modern varieties and hybrid technology is sufficient to promote production and productivity of crops. From the above context, the present study was conducted to know the probable causes of rice yield gap in Chapainawabganj district of Bangladesh.

2. MATERIALS AND METHODS

The data were collected by face to face interview with farmers who were related directly in rice cultivation at the study area. Random sampling technique was used for data collection in selecting five contiguous upazila in Chapainawabganj district such as, Chapainawabganj sadar, Nachol, Gamostapur, Bholahat and Shibganj upazila. The study included questionnaire-based survey. A total of 50 farmers were selected across the study area covering dispersedly located 10 villages. Structured questionnaires were designed together required information of 50 respondents. Necessary coding of data was done after collecting the data and computing for analysis.

3. RESULTS

3.1. Socio-demographic Feature of Rice Farmer

Here the entire respondents were male rice producer in the present study. A demographic feature of rice growers was presented in the Table 1. The result showed highest respondent (23 farmers, 46%) were categorized in middle age category. The similar rate of responded was observed in young and old education categories that were 26% and 28% respectively. The education level showed that the maximum numbers of respondent (18 farmers, 36%) were categorized as illiterate. As the second position, high school level education was regarded as 26%. Higher level education regarded as lowest level. The family size of farmers showed the maximum rate at medium size (4-6 members). The medium experience (5 to 27 years) was highest percentage among three categories studied (Table 1). The occupation of rice growers was involved maximum in business and farming system that was 48%. Own land having farmers were utmost from the other categories rice growers in the study area.

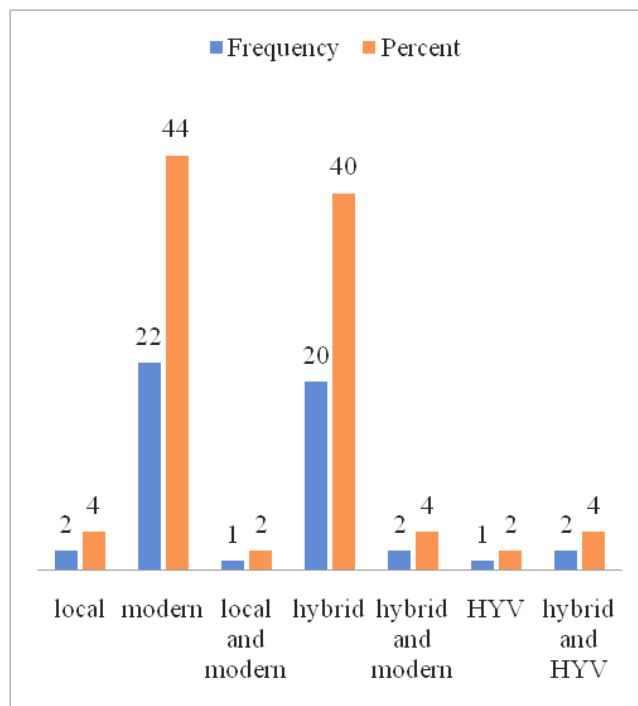


Fig. 1 The high yielding varieties through the respondent opinion.

3.2. Opinion of Respondents on Rice Varieties of Aman, Aus and Boro Seasons

The rice growers of study area were cultivated several varieties of rice among them Shumon swarna, Swarna 51, Swarna 5, Swarna 58 and Mohaka were common in Aman season (Table 2). The opinions of farmers were positive 44%, 34%, 72%, 28% and 18%, and negative 56%, 28%, 66%, 72% and 82% Shumon swarna, Swarna-5, Swarna-51,

Table 1 Demographic characteristics of farmers related to rice production (respondent number 50)

Categories	Ranges	Frequencies	Percentage
Age			
Young	<35	13	26
Middle	36 to 50	23	46
Old	>51	14	28
Education			
Illiterate	0	18	36
Primary	0 to 5	7	14
Secondary	6 to 10	13	26
Higher secondary	11 to 12	9	18
Graduation or above	>13	3	6
Family size			
Small	2 to 3	20	40
Medium	4 to 6	28	56
Large	>6	2	4
Farming experience			
Low	<4 yrs.	7	14
Medium	5 to 27yrs.	29	58
High	>28yrs.	14	28
Occupation			
Farming and wage earning		15	30
Farming and business		24	48
Farming and service		7	14
Farming as-sole profession		4	8
Land information			
Own		28	56
Lease		3	6
Borga		10	20
Own and Borga		9	18

Table 2 The opinion of respondent on rice variety in the Aman, Aus and Boro seasons (respondent number 50)

Season	Variety	No (%)	Yes (%)
Aman	Shumon Swarna	56	44
	Swarna 51	28	72
	Swarna 5	66	34
	Swarna 58	72	28
	Mohaka	82	18
Aus	Pariza	94	6
	Dharavador	92	8
Boro	BRRI dhan 28	14	86
	BRRI dhan 29	68	22
	BRRI dhan 34	98	2
	BRRI dhan 36	66	34
	BRRI dhan 58	90	10
	Zera	34	66

Swarna-58 and Mohaka, respectively (Table 2). The negative response in the rice cultivation for rice growers observed at 94% and 92% in Pariza and Dharavador growing in Aus season. The positive opinions were 86%, 22%, 2%, 34%, 10% and 66%, and negative were 14%, 78%, 98%, 66%, 90% and 34% for BRRI dhan 28, BRRI dhan 29, BRRI dhan 34, BRRI dhan 36, BRRI dhan 58 and Zera, respectively (Table 2).

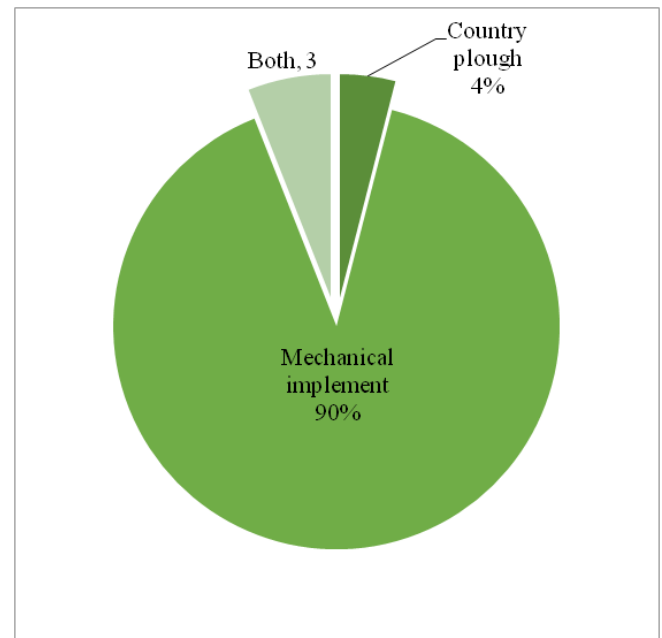


Fig. 2 The implement of land preparation of the respondent rice field.

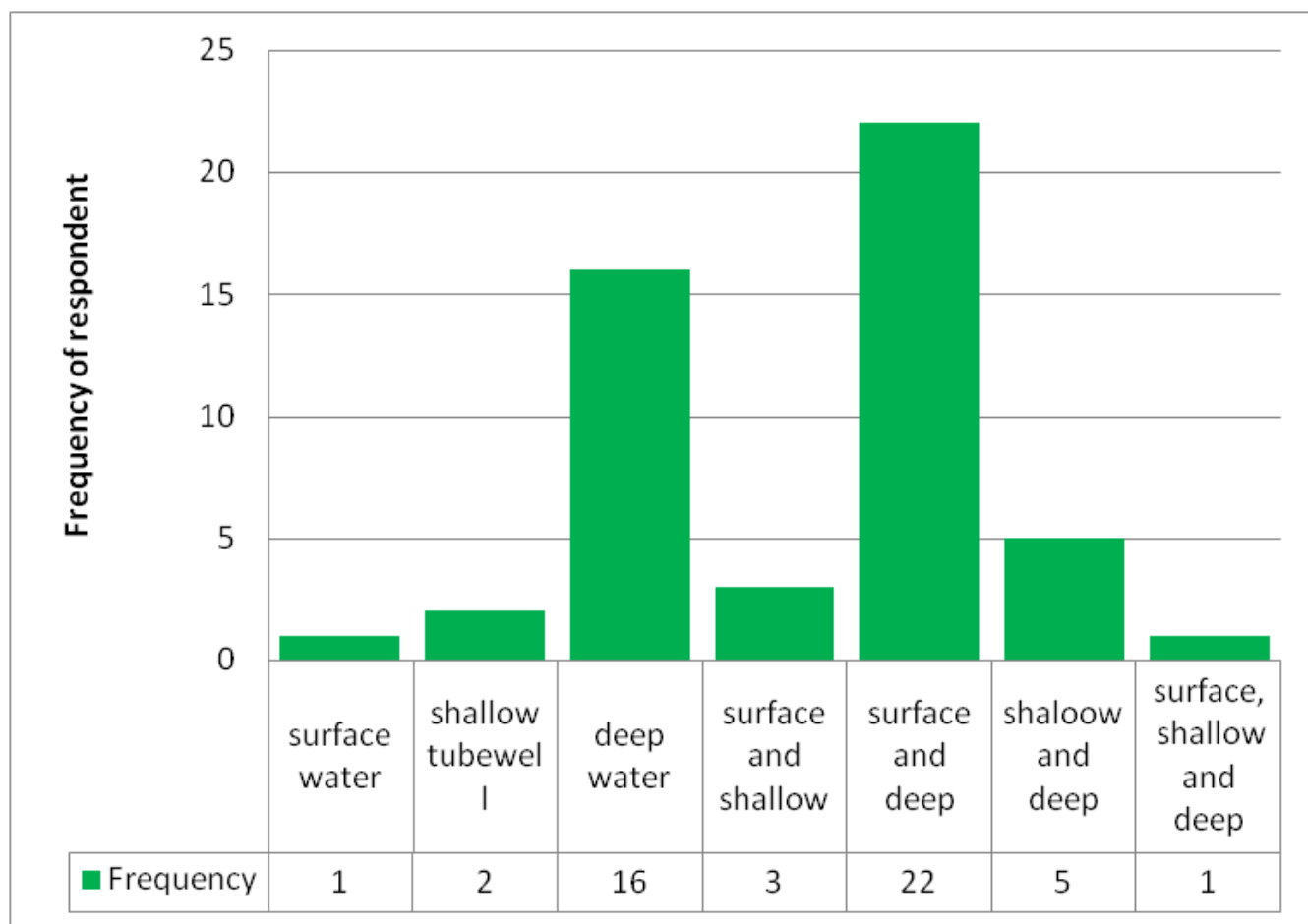


Fig. 3 The source of irrigation water of the respondent rice field.

Table 3 The source of seed collection of the respondent for rice cultivation (respondent number 50)

Source of seed collection	Frequency	Percentage
Government organization	2	4
Non- Government organization	12	24
Local source	21	42
Government organization and Non- Government organization	4	8
Government organization and local source	4	8
Non- Government organization and local source	4	8
Government organization and Non- Government organization and local source	3	6

Table 4 Sources of recommendation on fertilizer doses for rice cultivation (respondent number 50)

Follow fertilizer doses		
Category of followed fertilizer doses	Frequency	Percentage
Own experience	34	68
BADC recommended doses	8	16
AEO recommended doses	2	4
Own experience and BADC recommended doses	3	6
BADC recommended doses and under AEO recommended doses	2	4
Own experience, BADC recommended doses and AEO recommended doses	1	2

Table 5 Intercultural operations of farmers apply in the field (respondent number 50)

	Times	Percentage
Perching operation	No	38
	One time	58
	Two time	4
Weeding	One time	30
	Two time	62
	Three time	8
Rouging	No	16
	One time	74
	Two time	4
	Three time	6
Pesticide	Two time	12
	Three time	60
	Four	10
	Five	4
	Six	8
	Seven	6
Fertilizer application	Two time	36
	Three time	58
	Four	4
	Five	2

Table 6 The pest control methods of the respondent apply for rice cultivation (respondent number 50)

Control Method	Frequency	Percentage
Chemical control	27	54
Cultural method	1	2
Chemical control and IPM	7	14
Chemical control and cultural method	9	18
Chemical control, cultural method and IPM	6	12

Table 7 Harvesting time and methods of rice (respondent number 50)

Category	Frequency	Percentage
Time of harvest		
70% ripe	2	4
80% ripe	37	74
Above 80% ripe	11	22
Cutting operation		
Manually	47	94
Mechanically	1	2
Mechanically with manually	2	4
Threshing operation		
Mechanically	4	8
Manually with mechanically	46	92

3.3. Opinion of Farmers on Cultivation of High Yielding Varieties

The constitute of proportion of respondent said 44% fill in the modern variety show the better yield. The second opinion hybrid variety was 40%. It was found that hybrid and modern, and hybrid and high yielding variety showed 4% respondents (Fig. 1).

Table 8 Comparison of yield gap in the rice growing seasons

Season	Farmer's yield (t/ha)	Research yield (t/ha)	Yield gap (t/ha)
Aman (Shumon Swarna)	4.794	5.5	0.706
Aus (Dharavador)	2.98	4.37	1.39
Boro (BRRI dhan 28)	5.992	8.6	2.608

3.4. Opinion on Land Preparation System

Ninety percentage rice growers were supported to mechanical system for land preparation. The respondent cultivated their land with country plough, which was 4% of total. Secondly it was 45 numbers of respondents who cultivated their land by the use of only mechanical implement. The both cultivation methods were agreed 6% farmers (Fig. 2).

3.5. Source of Rice Seed Collection

This was referred as 21 respondents (42%) of total farmers collecting seeds from local source for rice cultivation (Table 3). It turned out that in most cases farmers were collected their seed from non-government organization which carried 12 respondents that was 24% total of farmers. In the same way only 4 numbers of respondents were collected their seed that was 8% of total farmers from three combined sources such as, Government organization and Non-Government organization, Government organization and local source, and Non-Government organization and local source. The seed collection from government organization was showed lowest percentage (4%). From government organization and non-government organization and local source, 3 respondents that were 6% of total farmers collected seeds (Table 3).

3.6. Source of Irrigation

Twenty-two farmers were used both surface and deep water for irrigation that was highest percentage among the sources of irrigation used (Fig. 3). Only deep water irrigation utilized 16 farmers. The considerable number such as, 5, 3, 2, 1 and 1 rice growers were used shallow and deep water, surface and shallow water, shallow water, surface water and surface, shallow and deep water, respectively.

3.7. Sources of Recommendation on Fertilizer Doses Rice Cultivation

The practice of the fertilizer doses in the rice field adversely. By the opinion taken of the respondents, own experience constituted 34 respondents (68%) who applied the fertilizer doses in the rice cultivation (Table 4). BADC recommended doses received 16% on the other hand another organization AEO provided recommendation

accepted 4% rice growers. The recommendation of combined organization received only a few numbers of farmers such as 3,2 and for Own experience and BADC recommended doses, BADC recommended doses and under AEO recommended doses and Own experience, BADC recommended doses and AEO recommended doses, respectively (Table 4).

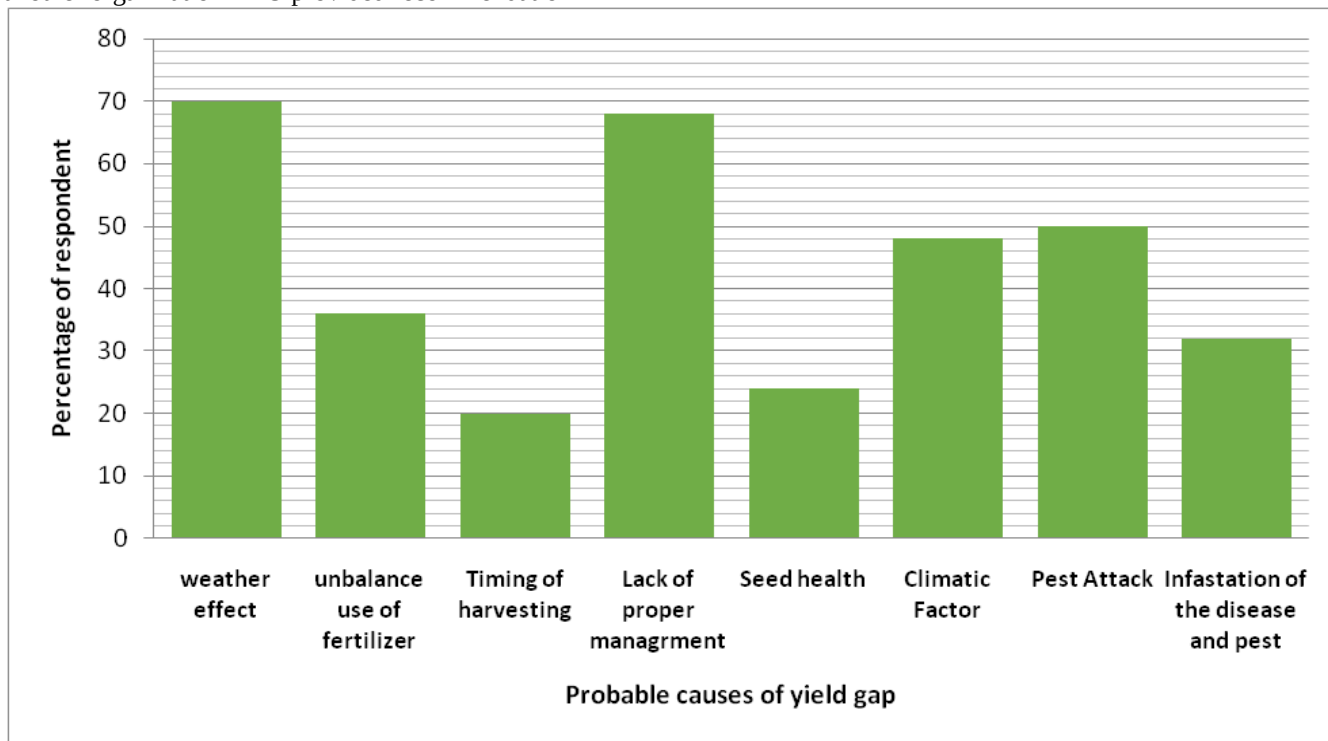


Fig. 4 The probable causes of yield gap through the respondent's opinion.

3.8. Intercultural Operation of the Respondent Rice Field

There were five intercultural operation maintained by the farmers in the rice field at the study area (Table 5).

Perching

The perching operation of the respondent in rice field was categorized three such as no perching, one time and two times. There were referred as 29, 2 and 19 respondents represent 58%, 4% and 38% farmers, respectively (Table 5).

Weeding

Weeding operations were one time, two time and "three time in the rice field at the study area. It was referred as 15, 31 and 4 respondents representing 30%, 62% and 8% of farmers, respectively (Table 5).

Roughing

At the study area, no roughing, one-time, two-time and three-time were found at the study area. The respondents were 8, 37, 2 and 3 representing 16%, 74%, 4% and 6% for no roughing, one-time, two-time and three-time, respectively (Table 5).

Pesticide

There were mainly one-time, two-time, three-time, four-time, five-time, six-time and seven-time pesticide

application used in the rice field of the respondents at the study area. It was referred as 6, 30, 5, 4, 2 and 3 respondents representing 12%, 60%, 10%, 8%, 4% and 6%, respectively (Table 5).

Fertilization

The farmers of the study area were applied fertilizer at two-time, three-time, four-time and five-time. Three-time application was available in the rice grower that was 58%. Thirty-six percent farmers were applied fertilizer two-time. The percentage of responded were 4% and 2% for four-time and five-time, respectively (Table 5).

3.9. Pest Control Method of Respondents Apply for Rice Cultivation

The chemical control for pest was applied 27 respondents, i.e., 54% (Table 6). The lowest (1 number, 2%) responded were achieved the cultural method. The combined methods such as, chemical control and IPM, chemical control and cultural method and chemical control, cultural method and IPM received 7, 9 and 6 representing 14%, 18% and 12%, respectively.

3.10. Harvesting Methods of Rice Apply by Respondents

The time of harvesting, 70% ripe, 80% ripe and above 80% ripe rice harvested were 2, 37 and 11 responded representing 4%, 74% and 22%, respectively. This result showed that the maximum number of the respondent harvest their rice during 80% ripe. During harvesting, the cutting operation of rice was used 47, 1 and 2 respondents representing 94%, 2% and 4%, respectively. The manually cutting implement showed the maximum number of users. In case of threshing operation, mechanically and manually with mechanically used 4 and 46 respondents representing 8% and 92%, respectively (Table 7).

3.11. The Probable Causes of Yield Gap

The opinion on probable causes of yield gap was conducted on the basis of weather effect, unbalance use of fertilizer, timing of harvesting, lack of proper management practices, seed health, climatic factor, pest attack and infestation of the diseases and pest though there are many causes of yield gap in the rice cultivation (Fig. 4). Seventy percentage rice growers were thought that weather effect was main reason for the yield gap. The causes of yield gap by lack of proper management were assumed 68% rice growers. The lowest percent of farmer's opinion was 20% that was found in timing of harvesting.

3.12. Yield Gap of Rice in Three Seasons

The most acceptable varieties such as BRRI dhan 28, Dharavador and Shumon Swarna for Boro, Aus and Aman seasons were studied in the present experiment (Table 8). The yield gap was 0.706 t/ha as lowest value in Shumon Swarna at Aman season. It was 2.608 t/ha as height value in BRRI dhan 28 at Boro season. The considerable value was 1.39 t/ha that was found in Dharavador at Aus season.

4. DISCUSSION

Socio-demographic characteristics of farmers relating rice cultivation, rice cultivation related activities and their opinions were studied in the present survey research. Highest respondents were middle aged among three age categories in the study area. The most of farmers were illiterate, medium experience and involved in business and having own land. Koukouli et al. (2002) described gender, age, level of education, employment status, profession, marital status, total number of persons living in the house and living arrangements as socio-demographic variables. Six important demographic features like age, education, family size, farming experience, occupation, and land information have been accounted in the present study. The socio-economic and demographic characteristics of the vegetable growers have been reported by other research (Lepcha et al., 2021; Pandit & Basak, 2013).

The present result suggested that the farmers were still in their active/productive age. Falola & Achem (2017) the middle age group of farmers between 21–50 years is considered to be active/productive age in farming activities. Participation of youth in agriculture in Nigeria is due to the high level of agricultural apathy by the youth as suggested in the studies on youths' participation in agriculture in

Nigeria conducted by (Falola et al., 2013; Adekunle et al., 2009). Education status of rice farmers was illiterate. The result was suggested that below secondary education was involved in agriculture and above secondary was thought for getting job. This indicated that those that attend above secondary education do not participate in farming activities due to the preference for white collar jobs, especially in developing countries (Falola et al., 2013; Muhammad-Lawal et al., 2009).

The highest percentage rice growers were medium experienced (5 to 27 years) when considered to three experience levels. High experienced (above 25) farmers were involved in other crop farming, suggesting that farmers are not benefitted financially. The similar observation has been recorded previously (Eliya et al., 2019).

The medium sized family (4 to 6 members) of potato farmers was noticed highest percentage among sizes of family studied. The average household size was 6.68 persons in the present study. This result was contrast to findings of Halliru et al. (2018), stated that the large sized family (11 persons) can be engaged more households in farming which can be positive impact for sustaining farming systems by the changing.

The rice cultivation related activities of rice farmers in the study area were sources of seed collection, sources of recommendation on fertilizer doses, intercultural operations, pest control methods, harvesting time and methods, land preparation method and source of irrigation water. The variations in the agricultural activities among the farmers were distinct. These variations should to be affected in the crop yield. Timely planting, irrigation, weeding, plant protection, and timely harvesting could account for more than 20% yield increase (Siddiq, 2000).

The probable causes of rice yield gap were estimated that the listed weather effect by most of the farmers. Climatic factors such as, flood, drought, salinity, etc. caused by climatic changes will be a vital cause for yield gap (Mondal, 2011). Several factors can cause yield gaps in crops. In general, factors causing yield gaps can be classified as biological factors, socio-economic factors, climatic factors and institutional/government policy related factors (RAP, 1999).

The yield gap was found 2.608 t/ha in Boro season (Shumon Swarna), 1.39 t/ha in Aus season (Dharavador) and 0.706 t/ha in Aman season (BRRI dhan 28). The seasonal effect in yield gap was found in the present study. Roy (1997) reported yield gaps of 44.44 and 60.00% in Aus and Aman, respectively.

5. CONCLUSION

In many countries of the world, yield gaps in crops between potential research yield and farmer's yield are still substantially high due to the combination of constraints, such as poor management and economic conditions of farmers and lack of resources, especially credit and knowledge and commitment of the government. In the present study, the strategies and probable causes of yield

gap of rice cultivation were studied. Efforts should, therefore, be made to minimize the yield gaps and increase and sustain production and productivity of crops by properly addressing the constraints. The total probable causes of rice yield gap are estimated that the listed that the weather effect, unbalance use of fertilizer, timing of harvesting, lack of proper management, seed health, climatic factor, pest attack and infestation of disease and pest. Among the weather effect was prominent opinion from farmers for the yield gap.

REFERENCES

- Adekunle, O. A., Adefalu, L. L., Oladipo, F. O., Adisa, R. S., & Fatoye, F. (2009). Constraints to youth's involvement in agricultural production in Kwara State, Nigeria. *Journal of Agricultural Extension*, 13(1), 102-108.
- Aggarwal, P. K., Hebbar, K. B. Venugopalan, M. V., Rani, S., Bala, A., Biswal A., & Wani, S. P. (2008). Quantification of yield gaps in rainfed rice, wheat, cotton and mustard in India. *Global Theme on Agro-ecosystems Report*, 43, 12-17.
- Alam, M. (2006). *Factors affecting yield gap and efficiency in rice productions in some selected areas of Bangladesh*. Jahangir Nagar University, Bangladesh.
- Alam, M., Karim, R., & Ladha, J. (2013). Integrating best management practices for rice with farmer's crop management techniques: A potential option for minimizing rice yield gap. *Field Crops Research*, 144(1), 62-68.
- Audebert, A., & Fofana, F. (2009). Rice yield gap due to Iron toxicity in West Africa. *Journal of agronomy and crop science*, 195(1), 66-76.
- Boling, A., Tuong, T., Keulen, H., Bouman, B., Suganda, J., & Spiertz, J. (2010). Yield gap of rainfed rice in farmer's fields in Central Java, Indonesia. *Agricultural Systems*, 103(5), 307-315.
- Casanova, D., Casanova, G. J., Bouma, J., & Epema, G. (1999). Yield gap analysis in relation to soil properties in direct-seeded flooded rice. *Geoderma*, 91(3-4), 191-216.
- Eliya, K., Paul, D., Ted, N., & Julius, O. (2019). Assessing factors influencing farmers adoption of improved potato varieties in Malawi. *International Journal of Economy, Energy and Environment*, 4(1), 1-10.
- Falola, A., & Achem, B. A. (2017). Perceptions on climate change and adaptation strategies among sweet potato farming households in Kwara State, North central Nigeria. *Ceylon Journal of Science*, 46(3), 55-63.
- Falola, A., Ayinde, O. E., & Ojehomon, V. E. T. (2013). Economic analysis of rice production among the youths in Kwara State, Nigeria. *Albanian Journal of Agricultural Sciences*, 12(3), 503-510.
- Halliru, S. L., Bichi, A. A., & Muhammad, A. S. (2018). *Effects of demographic characteristics for farmers to climate change in Bunkure, Nigeria*, Intech. Open Pub., USA.
- Koukouli, S., Vlachonikolis, I. G., & Philalithis, A. (2002). Socio-demographic factors and self-reported functional status: The significance of social support. *BMC Health Services Research*, 2, 225-235.
- Lepcha N., Mankeb, P., & Suwanmaneepong, S. (2021). Productivity and profitability of organic and conventional potato (*Solanum tuberosum* L.) production in West-Central Bhutan. *Open Agriculture*, 6, 640-654.
- Matin, M. A, A. S. M., Huq A., Hussain, M. S., Karim M. R., & Baksh, E. (1996). Farm level yield analysis of tomato cultivation in selected areas of Bangladesh: An economic profile. *Bangladesh J. Agric. Res.*, 21(1), 24-29.
- Matthew, B., Kenneth. G., Haishun. Y., Nicolas. G., Patricio. G., Justin. V., Merle. A., & Donn, B. (2016). Yield gap analysis of US rice production systems shows opportunities for improvement. *Field Crops Research*, 196(1), 276-283.
- Mondal, M. H. (2011). Causes of yield gaps and strategies for minimizing the gaps in different crops of Bangladesh. *Bangladesh J. Agric. Res.* 36(3), 469-476.
- Muhammad-Lawal, A., Omotesho, O. A., & Falola, A. (2009). Technical efficiency of youth participation in agriculture. A case study of the Youth-Agriculture programme in Ondo state, Southwestern Nigeria. *Nigeria Journal of Agriculture, Food and Environment*, 5(1), 20-26.
- Nhamo, N., Rodenburg, J., Zenna, N., Makombe, G., & Kihupi, A. (2014). Narrowing the rice yield gap in East and Southern Africa: Using and adapting existing technologies. *Agricultural Systems*, 131(1), 45-55.
- Pandit, J. C., & Basak, N. C. (2013). Constraints faced by the farmers in commercial cultivation of vegetables. *J. Bangladesh Agril. Univ.*, 11(2), 193-198.
- RAP (Regional Office for Asia and the Pacific), (1999). *Report of the expert consultation on bridging rice yield gap in the Asia- Pacific Region*. FAO, Italy.
- Roy, I. (1997). *Stagnating productivity in crop agriculture. the quest for sources of growth. environment and agricultural productivity in Bangladesh*. Bangladesh Academy of Agriculture (BAAG), Dhaka, Bangladesh.
- Siddiq, E. A. 2000. *Bridging rice yield gap in India: Expert conference on bridging the rice yield gap in the Asia-Pacific Region*, RAP, FAO, India.
- Woonho, Y., Shaobing, P., Rebecca, L., Romeo, V., & Maribel, D. (2008). Yield gap analysis between dry and wet season rice crop grown under high-yielding management conditions. *Agronomy Journal*, 100(5), 1390-1395.
- Xinpeng, X., Ping. H., Shicheng. Z., Shaojun. Q., Adrian. M., Johnston. A., & Wei. Z. (2016). Quantification of yield gap and nutrient use efficiency of irrigated rice in China. *Field Crops Research*, 186(1), 58-65.