Valuation of Weather Manifested Rice Cultivation in Bangladesh: A Way Forward

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Abstract  
Good crop yield entirely depends on good management practice and quality management of crops allied with authentic weather forecasting can reduce risk, crop damage, cost of production and increase the yield as well. Bangladesh Rice Research Institute (BRRI) had aimed this study for quantifying the financial benefit of forecasting and validating micro climatological factors and their impacts on paddy production through experimentation and arranging for weather based agro meteorological advisory service delivery to the farmers applying the tools of ICT. A next-generation meso-scale numerical weather prediction system, WRF (Weather Research and Forecasting) model was used for generating atmospheric simulations based on real data (observations, analyses or idealized conditions). Field experiment was conducted in the areas of five different agro microclimatological conditions for Boro rice production, namely; Gazipur, Habiganj, Rajshahi, Barishal and Satkhira. Then the experimental fields were managed according to the weekly management advisory based on weather forecasts. Results obtained suggest that the application of weather predictability accrued a comparative rice yield benefit of 9-12% and a 3-5% reduction in the cost of cultivation. Countrywide application of agro-meteorological advisory service may pave the way for averting adverse climatic effects on agriculture.

Keywords: Agro-Meteorological Advisory, Rice Cultivation, Weather Forecasting, Yields Benefit.

1. Introduction  
Good crop yield entirely depends on good management practice and quality management of crops allied with authentic weather forecasting can reduce risk, crop damage, cost of production and increase the yield as well. The development of response strategy helped farmers realize the potential benefits of using weather-based agrometeorological information in minimizing the losses due to adverse weather conditions, thereby improving yield, quantity and quality of agricultural productions. In fact, short and medium-range weather forecasts play a significant role in making short-term adjustments in daily agricultural operations (Maini & Rathore, 2011). Some of the early works that appeared in the late 1960s concentrated on effectiveness of agrometeorological information (Bagrov, 1966). Studies have also been carried out to determine the potential benefits in agricultural farm decisions from long-range weather predictions (Hansen et al. 2006). However, very little work has been done on the economic impact of medium-range weather forecasts on farm-level decisions in Bangladesh.
1.1 Impact of Weather Risks on Rice Production
Weather risks; namely; high temperature and droughts, cold spell, heat waves and prolonged or irregular rainfall can affect agricultural productivity significantly (Rosenzweig et al., 2002; Thakur et al., 2010; Chakrabarti et al., 2011). The varied nature of weather threats leads to diverse effects on different aspects of the crop growth and field management. These risks can impact crops both via negative impacts on plant physiological processes and direct physical damage, as well as by affecting the timing and conditions of field operations. Rice cultivation continues to be a risky enterprise, despite advances made in modern technologies. Among the abiotic stresses, weather plays the dominant role in influencing the growth and yield of rice. The most important weather elements that influence growth, development and yield of rice are solar radiation, temperature and rainfall. Relative humidity and wind velocity influence the crop growth to some extent (Sridevi & Chellamuthu, 2015).

1.2 Agrometeorological Research in Bangladesh
Crop responses to climatic variation have remained very little on focus in Bangladesh. Systematic studies on extreme weather risks and their impact on agricultural sector of Bangladesh are very few. Bangladesh Rice Research Institute (BRRI) is the pioneer in this field as it established country’s first Agrometeorology and crop modelling lab in 2014. BRRI aims at forecasting and validating micro climatological factors and their impacts on paddy production through experimentation and arranging for weather based agro meteorological advisory service delivery to the farmers applying the tools of ICT. A next-generation meso-scale numerical weather prediction system, WRF (Weather Research and Forecasting) model is being used for generating atmospheric simulations based on real data (observations, analyses or idealized conditions).

2. Research Objectives
The present study aimed at quantifying the financial benefit of forecasting and validating weather based agro meteorological advisory service delivery to the farmers applying the tools of ICT.
- To explore the potentials of weather manifested rice cultivation in the socio-cultural context of Bangladesh
- Developing an effective framework for the financial valuation of weather manifested rice cultivation

3. Field Experiment
Field experiment was conducted in the areas of five different agro microclimatological conditions for Boro rice production, namely; Gazipur, Habiganj, Rajshahi, Barishal and Satkhira. A multi-disciplinary team of rice science experts including data scientists, geologist, agronomist, soil scientist, plant pathologist, entomologist, and plant physiologist and irrigation expert provided weekly management advisory based on weather forecasts. Then the experimental fields were managed according to the weather based management advisory. On the other hand, five conventionally cultivated farmers’ fields were identified in the respective locations. Thirty seven days old seedling of BRRI dhan28 was planted on the same date of 22nd January, 2019. For making a fair comparison between the conventional fields and weather manifested experimental fields, both the fields were managed under same supervision.

4. Result Discussion
Incorporating weather based advisory in rice cultivation helps increase yield and save money in many ways. Acting according to the advisory helps avoiding insect and pest infestation.

4.1 Valuation of Weather Manifested Rice Cultivation in Terms of Yield Advantage
Yield obtained from weather manifested experimental fields was compared from that of Conventional farmers’ fields. Results obtained suggested that the application of weather predictability accrued a comparative rice yield benefit of 9 to 12 percent in different locations. Highest yield advantage of 12 percent was obtained in Gazipur while lowest yield advantage of 9 percent was obtained in Rajshahi.
Table 1. Valuation of weather manifested rice cultivation in terms of yield advantage

| Locations | Yield obtained | Yield advantage (%) |
|-----------|----------------|---------------------|
|           | Weather manifested experimental fields (mt/ha.) | Conventional farmers’ fields (mt/ha.) |             |
| Gazipur   | 5.66           | 4.98                | 12          |
| Habiganj  | 5.24           | 4.72                | 10          |
| Rajshahi  | 6.37           | 5.79                | 9           |
| Barishal  | 5.27           | 4.69                | 11          |
| Satkhira  | 4.88           | 4.39                | 10          |

4.2 Valuation of Weather Manifested Rice Cultivation in Terms of Cost of Production

Acting according to the weather based advisory helps save supplementary irrigations. But the irrigation system prevailing in Bangladesh is faulty. Saving supplementary irrigations provides benefits to the pump owners as they charge farmers on the basis of seasonal contract. For these reason, one can get a partial picture of benefits in terms of cost of production what can be obtained from weather manifested rice cultivation. However, present study obtained a 3 to 5 percent reduction in the cost of cultivation in different locations by acting according to the weather based advisory. Highest reduction in the cost of cultivation of 5 percent was obtained in Gazipur while lowest reduction of 3 percent was obtained in Rajshahi and Satkhira.

5. Conclusion

In the socio-cultural context of Bangladesh, weather manifested rice cultivation has a great potentials. Results obtained suggested that the application of weather predictability accrued a comparative rice yield benefit of 9-12% and a 3–5% reduction in the cost of cultivation. Countrywide application of agro-meteorological advisory service may pave the way for averting adverse climatic effects on agriculture.

Limitation

It is very difficult to convince farmers to act according to the weather advisory provided. In the study period, cyclone warning asked farmers to harvest paddy early on 80 percent ripening stage. But farmers did not consider the weather forecast trust-worthy and decided to take risk. Moreover, the irrigation system prevailing in Bangladesh is faulty. Saving supplementary irrigations provides benefits to the pump owners as they charge farmers on the basis of seasonal contract. For these reason, one can get a partial picture of benefits in terms of cost of production what can be obtained from weather manifested rice cultivation.

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