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Application of Weather Forecasting Apps for Agricultural Development in Bangladesh

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Abstract

Agriculture is governing the rural as well as national economy of Bangladesh. Agricultural production closely depends on weather phenomena such as sunlight, temperature, rainfall, humidity, etc. These weather conditions have both positive and negative impacts on the agricultural productivity. Lack of modern technology such as weather forecasting tools influence to decrease agricultural productivity as well as product quality. This study was conducted to find out ways to minimize negative impacts and boost up positive impacts of weather phenomena. Associated problems were summarized analyzing historical information and case studies. To solve these problems modern technology as mobile application was searched. When farmer had no forecasted data regarding rainfall, sunlight etc. they faced different problems such as harvested rice washed out by rain, seeds from seedbed washed out due to rain, rainfall occur just few hours after irrigation as a result loss energy, seeds wet and damage due to rainfall when drying as a result decrease seed quality, washed out fertilizer and pesticide just after applied and so on. These problems could be solved very easily and increase agricultural productivity by using simple weather forecasting tools. Nowadays we can predict such weather conditions monthly, daily as well as hourly by a mobile application with accurately. When farmers will know the weather condition using mobile weather forecasting application before their desire task, they will able to decide properly. Using this apps benefit would come several ways such as protection of ripe crops in the field; protection of crops from rain when drying; save water and energy from irrigation and so on. To apply this simple technology, it is necessary to train selected farmers from farmers' community.

***Keywords**:* Weather forecasting app, Agriculture, Development, Bangladesh

Introduction

Agriculture is governing the rural as well as national economy of Bangladesh. Crop is the dominant sector that contributes 77 per cent to the total value addition of agriculture and 27 per cent to gross domestic product (GDP) of Bangladesh (Hashem *et al*., 1996). Weather plays an important role in agricultural production. Agricultural production closely depends on weather phenomena such as sunlight, temperature, rainfall, humidity, solar radiation, due, fog etc. It has a profound influence on crop growth, development and yields; on the incidence of pests and diseases; on water needs; and on fertilizer requirements. These weather conditions have both positive and negative impacts on the agricultural productivity. The quality of crop produce during movement from field to storage and transport to market depends on weather. Weather aberrations may cause physical damage to crops and soil erosion. Bad weather may affect the quality of produce during transport, and the viability and vigor of seeds and planting material during storage. Lack of modern technology such as

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weather forecasting tools influence to decrease agricultural productivity as well as product quality.

Weather forecasting is the prediction of the state of the atmosphere for a given location applying variety of statistical and empirical techniques and technology. In addition to predictions of atmospheric phenomena themselves, weather forecasting includes predictions of changes on Earth's surface caused by atmospheric conditions (Cahir, 2013). Weather forecasts are important because they are issued to protect life and property, to save crops and to tell us what to expect in our atmospheric environment. Therefore, human beings have tried to predict the weather informally since millennia and formally since the 19th century, an economic value resides behind weather forecasts and tried to estimate it through different methods (Craft, 2010). Recent advances in climate forecasting technologies have raised the intriguing prospect of reasonably accurate forecasts of coming seasons' rainfall patterns (Luseno *et al*., 2003).

Furthermore, weather forecasting is essential in agricultural production for preventing and controlling negative impact of weather phenomena such as rainfall, humidity etc and for predicting conditions for the boost of positive impacts of these phenomena. The ability to predict climate has improved in recent years and there have been significant and increasing efforts devoted in various parts of the world to apply climate information for improving agricultural systems (Jagtap *et al*., 2002).

This study was conducted to find out ways to minimize negative impacts and boost up positive impacts of weather phenomena for the agricultural production in Bangladesh.

Methodology

This study was conducted based on case studies and conceptual methods. Associated problems regarding weather and agricultural production were summarized analyzing historical information and case studies. After analyzing these data a concept was made to minimize the problems. Modern technology as mobile application for weather forecasting was found to solve these problems. A conceptual chart was made showing use of the technology by the stockholders specially farmers.

Results and Discussion

Weather forecast places its focus on day-to-day agricultural activities that require real time information on prevailing weather conditions, and expected conditions over the next 2 to 3 days in the future. Timely and accurate climate forecasts and agro meteorological warnings are useful tools for policy and decision-making, but can only be achieved if executed and applied in close and continuous cooperation with the "data users". Short range temperature, humidity and wind (2 to 3 days) forecasts allow meteorologists and agriculturists to evaluate the risks of the spread of plant diseases, and risks associated with outbreaks of large–scale insect attacks that only occur under specific meteorological conditions. Rainfall forecasts are also used by planning institutions to conduct crop yield assessment, in the framework of food security.

Problem Analysis

Historically the agriculture of Bangladesh have been facing a lots of problems associated with weather phenomena. It

causes a huge loss of agricultural production as well as national economy but there is no data regarding how much loss in yearly. Some of the problems and their consequences identified in this study have been shown in table-1. When farmer had no weather forecasted data such as rainfall, temperature, humidity, cloud cover, sunlight, due, wind direction etc. they faced different problems such as harvested rice washed out by rain when these laid on the field for drying (Fig.1), seeds from seedbed washed out due to rain, rainfall occur just few hours after irrigation as a result loss energy, seeds wet and damage due to rainfall when drying as a result decrease seed quality, washed out fertilizer and pesticide just after applied and so on.

Table 1 Problems related to weather and their consequences in agriculture

Identified Problems	Results / consequences
Harvested rice washed out by rain when these laid on the field.	Damage crop and ultimate loss of economy.
Seeds washed out from seedbed just after seedling due to rain.	Loss of agricultural production and economy.
Rainfall occur just few hours after irrigation.	Loss water resources and loss energy (electricity, diesel oil etc.)
Seeds wet and damage due to rainfall when drying.	Decrease seed quality and finally loss crop production.
Washed out fertilizer and pesticide just after applied due to rain	Loss fertilizer, pesticide as well as money and finally decrease production.
Rice, corn etc. wet and damage by rainfall when drying.	Damage the crop, reduce quality and ultimate loss of nation economy.
Chilly, and other spices damage by rain when drying.	Reduce quality and loss of money.

Figure 1 Harvested rice laid on the field for drying

Problem Solving Technology

These problem associated with the loss of agricultural productivity could be solved very easily and increase agricultural productivity by using simple weather forecasting tools. Nowadays we can predict such weather conditions monthly, daily as well as hourly by a mobile application with accurately (Fig. 2). When farmers will able to know the weather conditions using mobile weather forecasting application before their desire task, they will able to decide properly (Fig 3). Using this apps benefit would come several ways such as protection of ripe crops in the field; protection of crops from rain when drying; save water and energy from irrigation and so on.

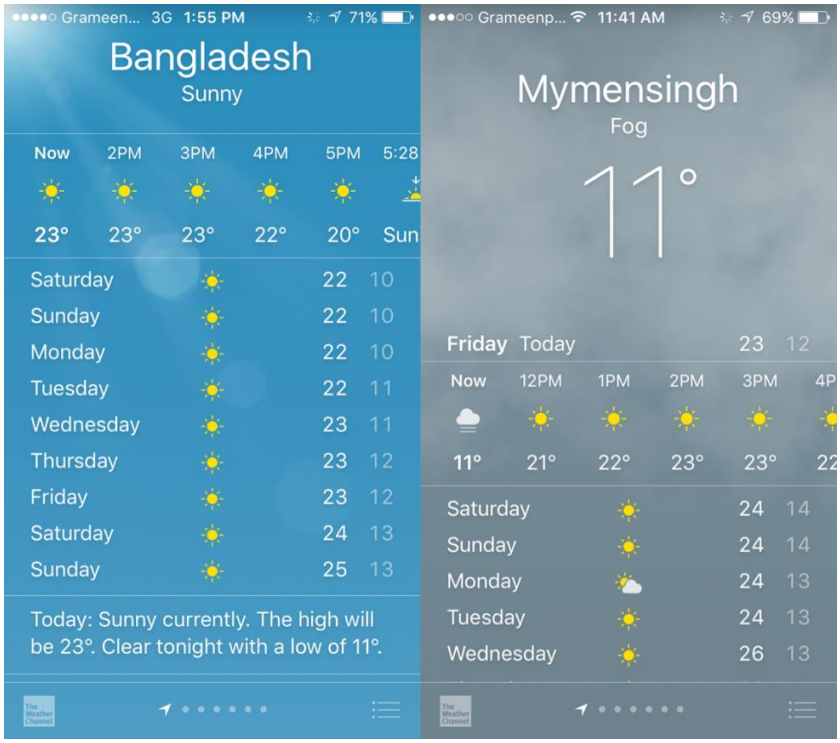

Figure 2 Showing weather forecast on mobile apps

Potential Applications of Weather Forecasting Apps

Agricultural weather forecasts provide the necessary meteorological information to aid farmers in making certain special "crop and/or cost saving" decisions on farm operations. For the same temporal distribution of weather parameters, different crops will react differently. Again, the effects of weather or weather-induced stresses and incidence of pests and diseases are critically dependent on the state and stage of crops during which they occur. The effects of anomalies of a weather element on a given crop are location-specific. Again, the crop fetches may range from large areas of mono-crops to small, dispersed areas of variegated crops Thus the requirement for these special forecasts will vary between and within the seasons, from place to place, from crop to crop and with the kind of operation i.e., cultivation, post-harvest processing etc.

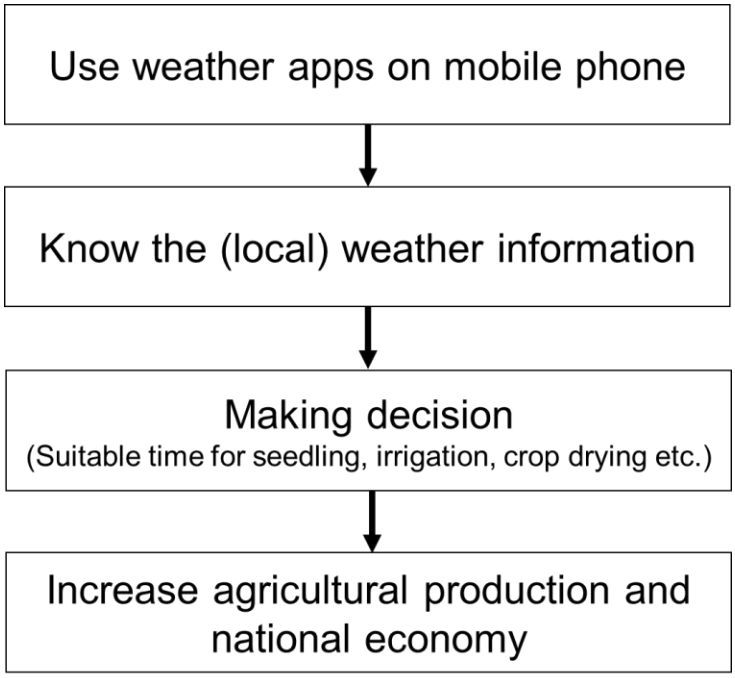

Figure 3 Flowchart shows the benefits using mobile apps

Weather forecasts are normally issued once every day for a specific operation and generally cover the next 12-24 hours, and also cover next 7 days accurately. They are normally issued for planting, irrigation, applying agricultural chemicals, cultivation, harvest and post-harvest processing, as well as for serving other weather related agricultural problems associated with the crop, its stage and location.

Field preparation: Field preparation for rainfed crops is weather dependent. In any dry land areas the amount of rainfall is very meagre and farmers should take advantage of even minimum showers. Otherwise the moisture is lost. The prediction of the exact time of occurrence of rainfall in a particular location helps to initiate field preparation as well as save the water from irrigation and save energy. For example: "Pre monsoon showers are expected in 12th standard week of this year and farmers are requested to initiate field preparation activities before this week".

Sowing/planting: Seed germination is dependent upon proper light and moisture besides, soil temperature. Even with no nutritional or soil moisture constraints rot foraging capacities vary amongst crops in the same soil and of the same crop in different soils. Alternating temperatures assist the germination of many species of seeds and do not unfavorably affect the germination of those that do well under constant temperatures. When farmer will able to know the weather information regarding temperature as well as light and rainfall they will make a right decision which could be possible by weather apps.

Saving irrigation and energy: Irrigation water is costly to farmers in most of the agro ecosystems nowadays. Over-use can be both expensive and detrimental to the crop, while under-use can result in loss of crop quantity as well as quality. Consumptive use rate can be estimated not only from evaporation pan losses, but also from evaporation and shade temperature measurements, or from formulae deduced from the energy balance equation. With these values a farmer can be informed of the field water loss occurring after the last rain or irrigation and taking into consideration the expected rainfall advised on the timing and quantum of irrigation.

Examples of water loss forecasts are :"Rain is likely to occur in the next 24 hours in most of the areas in this region and so farmers may postpone their irrigation for this period".

Application of agricultural chemicals: Use of agricultural chemicals is inevitable in crop production. However, over-use of agrochemicals like fungicides and pesticides, especially of the systemic types and inorganic nitrogenous fertilizers lead to contamination of food produce and soil, pollution of air, aquifers and water reservoirs, and development of chemo-resistant strains of pests, diseases and weeds. Weather forecasts as detailed in the ensuing sections on control of insects, diseases and weeds can not only help minimize the quantum of application of agrochemicals but also make the applications effective. Agrochemicals constitute a sizeable fraction of the farmer's total cash out lay in any given production system. Minimization of use of agrochemicals will reduce the cost of cultivation to the farmer and help in increasing the property of assured protection and nutrition of crops even with available resources.

The critical weather elements governing the judicious application for efficient utilization are atmospheric temperature, precipitation, soil moisture content during the past and succeeding 24 hours and the speed and direction of winds, with emphasis on any changes in speed or direction during the forecast period. Precipitation can dilute or wash off the chemicals. So, agrochemical should be applied in forecasting sunny and no rain next 24 hours weather condition.

Soil application: Precipitation is the most important factor that decides efficiency of the chemical applied through soil. Precipitation in the succeeding 24 hours is the critical limit. Limiting the amount of treatment through the effective use of weather information also leads to minimum pollution of ground water and run off. For example "Heavy rain is expected in the next 24 hours and so foliar application of chemicals may be postponed".

Foliar application: Choice of agrochemicals for application to soils has to be carefully done to avoid contamination of soil, leaching to groundwater aquifers, and running off to water reservoirs. If the same effects can be achieved by aerial sprays foliar application is to be preferred. Many times soil conditions preclude application of chemicals to soils. Under those circumstances foliar applications have to be resorted to. Temperatures and rainfall at the time of application and immediately following are extremely important and can determine effectiveness of foliar application of nutrients and herbicides. For certain herbicides like Glyphosate, the effectiveness is more if the atmospheric temperature is high at the time of application and the succeeding 2 to 4 hours. On the rainfall immediately after the foliar application washed out and loss money. So,

sunny and no rainfall for next 24 hours weather forecast is advised for foliar application.

Weeding: Weeds are one of the most major afflictions for farming and successful farming includes weed management also. There are two methods of weed management viz., hand/mechanical weeding and chemical weeding. Herbicides are generally used for chemical weed management. Herbicide should be non-toxic to crop plants and the indication is that over-use of herbicides for a long period of time will lead to chemo-resistance in weeds. So herbicide applications must be minimal but effective. Rain immediately after chemical weeding will render the operation infructuous and amount to wastage of money. Rains will help in the germination of dormant weed seeds or help in better growth expression of weeds. Thus clear weather following rain will assist hand/mechanical weeding. Examples of weeding forecasts are: "Rain is likely to occur in the next 24 hours in most of the areas in this region and so farmers may postpone application of chemical herbicides and hand/mechanical weeding operations". Or, "Following rain spell of last 3 days, weather will remain dry for the rest of the week. Hand/mechanical weeding and chemical weeding in 2 to 3 days' time is recommended."

Crop harvest and post-harvest operations (including crop curing/drying): Harvest of the agricultural produce and immediate processing of the same before storage assume utmost significance than any other field operations as a few days of fickle weather at the end of the crop season can be ruinous. The forecast for such activities should be of high order to ensure that whatever yield is possible to be saved on the field is saved, and what is gained on the field is not lost off it. While the general agricultural weather forecast should supply the meteorological information necessary for harvest operations, post-harvest operations such as curing and storage require special forecasts of certain elements. The primary weather factors for crop harvest are rainfall and atmospheric temperature, while for post-harvest operations besides the above, sunshine, wind, relative humidity and dew are also important. Precipitation may increase the moisture content in the straw of rice crop, which may delay harvest operation. Besides, low temperature may also delay the same. Precipitation may leach the quality of forages.

Simple postharvesting operations include simple drying, example in case of medicinal plants. . Light winds assist in the winnowing operations that separate grain from chaff. In absence of wind, blowers have to be used. Low temperature in the atmosphere may delay drying and subsequent conversion of certain valuable medicinal compounds in to less preferred products. In crops like tobacco, this may involve complex processes involving enzyme reactions that are influenced by humidity and temperature. It is worthwhile here to mention that to ensure high quality end product either from crop or meat and fish, accurate weather forecast of curing and action based on the same are highly essential. An example of rice harvest forecast: "Rain is expected in the ensuing week. Accordingly harvest may be done earlier." Another example of fish or spice drying forecast: "Maximum temperature is expected to be around 30^0 C in the next 3 days. Farmers should take advantage of this period for fish or spice drying."

Control of plant diseases: Most plant diseases set in under conditions of wet

vegetation and develop and spread when the wet weather clears. The rate of development of a disease depends on temperature. The cardinal and optimal temperatures for development vary with the disease organisms. Therefore, effective and economic control of most diseases primarily requires a vegetative wetting forecast. This forecast will include the number of hours during which vegetation was wet from rain, fog or dew during the preceding 24 hours, the temperatures during this period and a prediction of the hours of wetting and of the temperature and sky conditions during the succeeding 24 hours. With this information the farmer can be advised to obtain maximum control with a minimum number of chemical applications. An example of root diseases forecast: "Excess moisture prevailing in the root zone of vegetable crops, in the past 7 days, may develop root diseases like root rot etc. Farmers are advised to go for soil drenching with suitable fungicides to avoid heavy crop loss".

Transportation of agricultural products: Most agricultural products must be transported fairly long distance from the place of production to the market place. During transportation the temperatures of the produce of many crops must be held within very narrow limits to prevent deterioration and spoilage. Therefore, the heating and cooling of containers transporting them may be required. An accurate forecast of the maximum and minimum temperatures along the normal transport route is needed to plan the type of transport equipment and its utilization. For example of transport of onions forecast: "The low temperature prevailing in the past 7 days may lead to deterioration in the quality of harvested onion for transport through germination. Farmers are advised to make package arrangement to counteract the low temperature."

Conclusion and Recommendations

Problem associated to the weather phenomena which decrease the agricultural production could be minimize very easily with mobile apps as simple technology. If this mobile weather app could be applying, agricultural production will be increase and finally national economy will grow up. However, weather forecast warnings can only achieve their full value if conceived, executed and applied in close and continuous cooperation with the "data users". Thus, successful policies require precise information on the weather and how it affects harvests.

To apply and disseminate this technology to the farmer following measures would be taken -

1. It will necessary to aware farmers where farmers are not aware regarding the weather apps
2. To apply this simple technology, it is necessary to train selected farmers from farmers' community
3. A pilot project would be taken to measure the feasibility of the application of the technology.

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