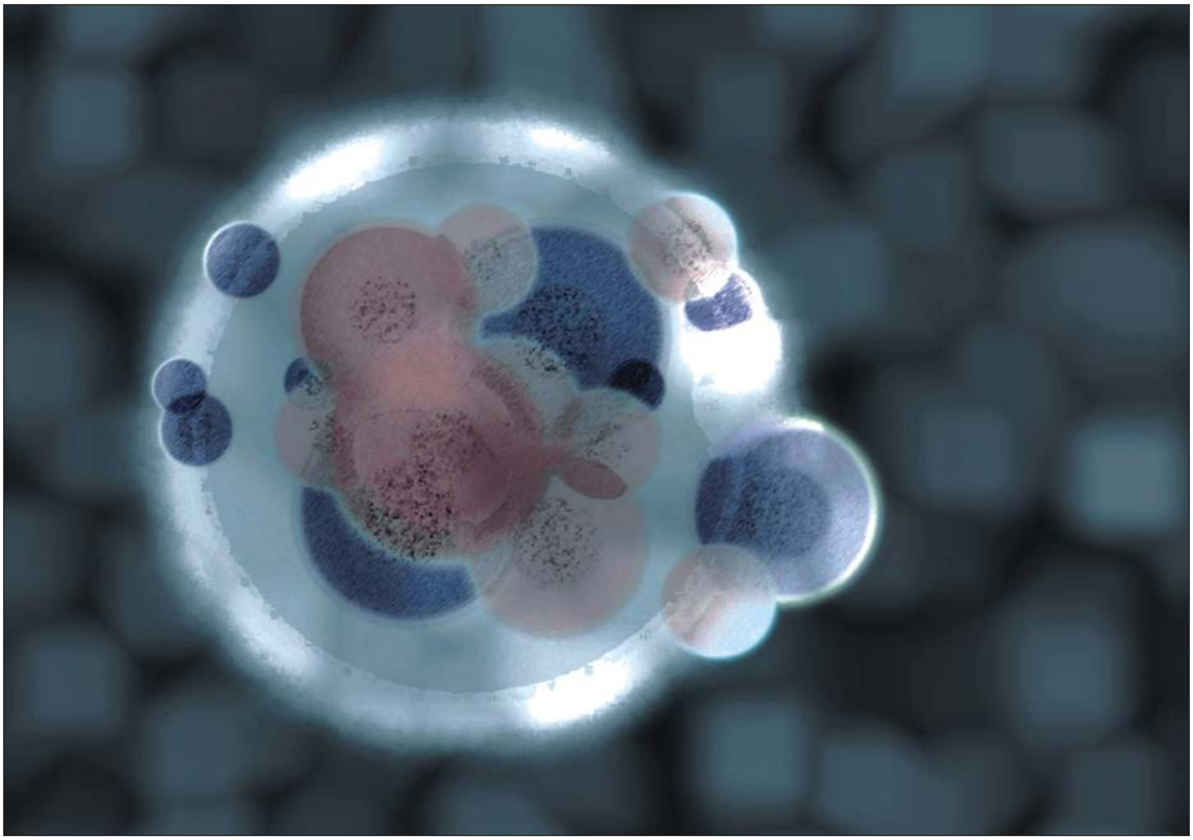

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Influence of Cracking on Rice Seasons and Irrigation in Bangladesh

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Abstract: Winter dry season is mainly depends on irrigation. Because, the rainfall in this season is almost zero. At the end of this season, ground water mainly remains at about 10-12 meter depth. On the other hand, the crop then remains at booting to flowering stages. During this period, a huge number of cracks developed on the puddled field due to shortage of water. Consequently, the size and number of cracks depend on the irrigation interval, the intensity and duration of drought spell. The sizes of the cracks are range about 10-30 mm wide. Normally, the major cracks goes below puddled layer of 70-100 mm and almost all the cracks are interlinked and remain active through the growing season. Therefore, a major portion of the irrigation water lost through this cracks. Hence, a large area remains fallow due to proper management and shortage of irrigation water. Therefore, irrigation application efficiency to be increased in cracking soils by reducing seepage and drainage losses in paddies. As a result, it is important to develop irrigation scheduling of rice for cracking soils on the basis of crack size rather than estimating crop water requirements based on evapotranspiration (ET) demand

Key words: Rice seasons, cracking puddled soils, irrigation scheduling, limited water resources

INTRODUCTION

Different soils are widely used for irrigated agriculture, but variations in physical properties poses problems for soil management; in the dry state vertical cracks aid surface infiltration, on the other hand, infiltration and vertical hydraulic conductivity are very slow in moist, uncracked soil (Jewitt *et al*., 1979). As a result, water management on cracking soils is a great problem to the user. When soil cracks in the field, structural shrinkage must affect plant growth and cultivation process. Contraction of a ped reduces internal pore size, hinders root penetration, and rapidly increases ped density needing more power for subsoil cultivation (Reeve and Hall, 1978). Cracks can tear and desiccate plant roots and cause the soil to dry to an extreme degree to considerable depths. Wide cracks permit the entry of turbulent air, which sweeps out water vapour from the deeper reaches of the soil profile. Moreover, the exposed vertical sides of the cracks become secondary evaporation planes, which increase the evaporating surface three or four times over the evaporating surface of a non-cracking soil (Adams and Hanks, 1964; Ritchie and Adams, 1974).

Accordingly, the cracks which form in the surface of rice fields in between intermittent irrigation intervals are connected with those of the subsoil, and the water in the paddy field may drain through these continuous cracks which are a major problem for rice farming. The formation of shrinkage cracks makes it nearly impossible to furrow irrigate such soils once they have been dried (Ravina, 1984). Moreover, in the winter cropping season, the rain or irrigation water which soaks into surface soil may be drained out through surface and subsoil cracks. So the surface soil dries after a short time of watering. Therefore, for efficient and effective management of irrigation water and crop production on cracking soils, a better understanding is needed in respect of infiltration, water movement, moisture retention capacity, soil moisture uptake pattern and root development in such soils.

Climate of Bangladesh: Among the climatic factors that influence crop production in Bangladesh, rainfall appears to have a paramount effect on the yield of upland and rainfed rice (Islam and Mondal, 1992). The average annual rainfall of Bangladesh is about 2150 mm (Manalo, 1976), but it is variable both spatially and temporally (Fig. 1). The rainfall distribution pattern greatly influences the growth and development of the rice crops, and the success or failure of the cropping pattern both in irrigated and rainfed agriculture (Sastry, 1976). The country receives about 95% of the total annual rainfall during the months from April to October. This quantity of water should support the safe yield of two rice crops (Aus and T.Aman). But the rainfall distribution pattern is such that both these crops suffer from a short duration of drought. After October, rainfall decreases sharply and the dry winter season begins.

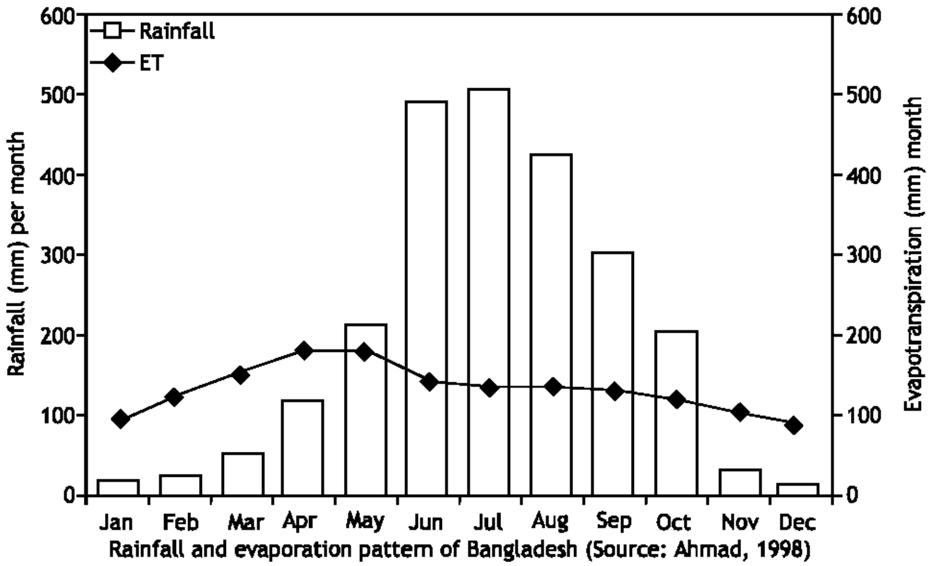

Fig. 1: Average (10 years) rainfall and evaporation pattern

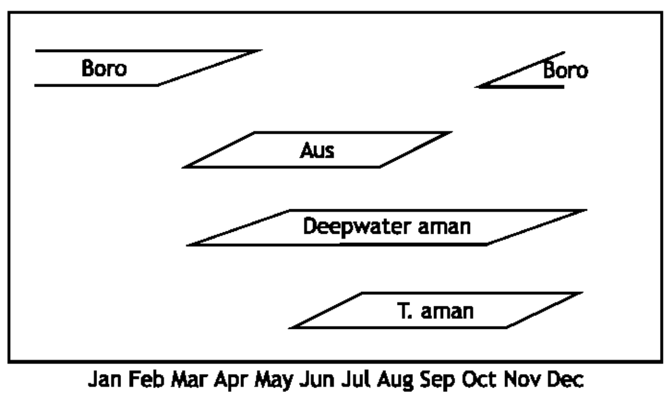

Fig. 2: Different rice growing seasons in Bangladesh

Rice production: Bangladesh is an agricultural country and rice is the main crop. Out of 14 million hectares of cultivable land, about 80% of the land has been planted with rice. Based on the topographical situation and seasonal variation rice is grown in four distinct seasons- Boro (Dry season/Winter rice, Nov-Apr); Aus (Upland rice, Mar-Jul); Broadcast Aman (Deep water rice, Mar-Dec); Transplanted Aman (Monsoon rice/T.Aman, Jul-Dec) as shown in Fig. 2. At present, only 40% of cultivable land in Bangladesh has access to some form of irrigation and 78% of the irrigated area is used to grow rice alone (BBS, 2000). But most (80%) of the rice irrigation is concentrated in the Boro season. Therefore, other rice growing seasons are mainly dependent on rainfall. In this regard, Barker (1970) states that about 50% of the rice area in South and Southeast Asia, which contributes approximately 42% to total rice production, is completely dependent on rainfall.

Lowland and upland rice: To retain the water in rice fields, the fields are enclosed with dikes or levees and the soil in the rice field is puddled. Fields prepared in this manner are called paddies and rice grown on paddies is termed lowland rice. Water for paddies may come from rainfall or irrigation. On plain areas without dikes or levees and sloping areas that are not terraced, rice may be grown during the rainy season without retaining the water in the field. Such culture is known as upland rice (Villegas and Feuer, 1970 and Singh and Bhattacharyya, 1989). However, most of the high yielding rice varieties are grown in paddies.

Boro season (Lowland rice): Among the different crop seasons, the yield during the Boro season is relatively stable and higher than other seasons due to the favourable radiation and flood free environment. Consequently, the area of Boro season rice is extending

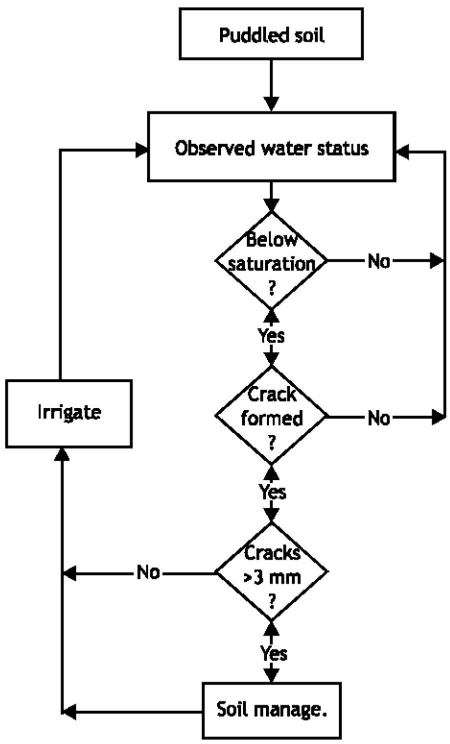

Fig. 3: Water management approach for puddled soils

very rapidly, so that it now accounts for about 34% of total rice growing areas. In this season, approximately 95% of the rice area is planted with modern high yielding varieties. In Boro, rice is transplanted after puddling the soil. Traditionally land preparation is done by a bullock driven country plough. So the till remains within 70-100 mm (Singh and Bhattacharyya, 1989). Generally, rice is grown under continuous ponded conditions. Consequently, large amounts of water (1520 mm) are required for rice production (Islam *et al.,* 1986).

On the other hand, rainfall is almost negligible in this season (Fig. 1). Therefore, the availability of surface and ground water is often quite limited. At the end of this season, ground water levels normally remain at about the 10 meter depth. Consequently, a lot of cracks develop on the puddled soil. On average, the sizes of cracks are about 10-30 mm wide. The size of cracks mainly depends on the irrigation interval, and the intensity and duration of drought. Most of the major cracks go below the puddled layer, and almost all cracks are interlinked through the surface and sub surface cracks as well as those that remain throughout the growing season. Often, the major portion of irrigation water from the cracking field is lost through drainage. Moreover, in this season, the irrigation system does not have enough water resource to irrigate the entire area. As a result, the cost of irrigation is higher in this season, so the response of the water managers is to reduce the potential command area. Hence, a large area remains fallow due to water shortage and proper management of the irrigation water. Therefore, other water management practices instead of traditional ponding are necessary for optimum and economic yield of rice.

Aus season (Upland rice): Upland rice is normally grown on both flat and sloping fields. Land preparation as well as seeding is done under dry conditions, and the crop depends on rainfall for moisture (De Datta, 1975). Estimates of upland rice in Bangladesh show it to cover 13% of the total rice area (Zaman, 1986).

The frequency and duration of moisture stress will be affected not only by rainfall distribution but also by the capacity of the soils to retain water. As a result, only 35% of the area of upland rice is planted with modern varieties and the remaining 65% with local (traditional) varieties due to their resistance to drought. But the yields of modern varieties are four times higher than local varieties (Zaman, 1986). Sometimes it is found that there is drought after seeding of the upland rice, so that the crop suffers from moisture stress and polygonal cracks may form on the drying soils. Reseeding is some-times necessary in the case of severe drought. Moreover, a major portion of the following rain water is passed through cracks.

Monsoon/T. aman season (Lowland rice): At present monsoon rice represents about 53% of the total rice growing areas. The growing season is shorter than others and rainfall is highly variable (De Datta and Vergara, 1979). At the end of this season rainfall decreases sharply. In most areas, incidence of drought toward the end of the monsoon is common and depending on duration it can significantly reduce rice yield. Yield reduction of monsoon rice mainly depends on the last rainfall of the season. If rainfall ceases during the first week of October and the rice is transplanted late, the crop will suffer from terminal drought and yield will be reduced to some extent and the soil will become cracked (Islam *et al.,* 1991). In rice fields, cracks start to form on the surface layer when the moisture goes below saturation level, even though there is adequate moisture at a few cm below the surface.

Potential for improvement: Today water is a valuable and costly input for crop production. Moreover, when it is limited, then every drop of water should be utilized properly for optimum and economic yield. Because, rice production is an important component of the agricultural economics of many countries like Bangladesh, there is the possibility that yields can be increased by improved cultural practices and soil water management in cracking soils. Efficient water management through appropriate practices will help to extract the potential yield of rice in different seasons, especially in lowland Boro and monsoon rice with supplemental irrigation. Moreover, it is important to understand the proper management of limited water and to explore technologies that can help efficient utilization of irrigation water in cracking soil to save this valuable resource. Technological advances in this regard would help to augment rice production in Bangladesh. Ultimately it will contribute to produce more yield by bringing a larger area under irrigation.

Scope to improve the rice production: The objective of this innovation is to increase the irrigation application efficiency in cracking soils by reducing the seepage and drainage losses in paddies. The ultimate objective of this review is to develop irrigation scheduling of cereal crops for cracking soils on the basis of soil parameters, especially crack size rather than estimating crop water requirements based on evapotranspiration (ET) demand. A simple flow chart (Fig. 3) for the water management model for rice production with limited water resource has been developed on the basis of above objective to increase water application efficiency in cracking field. The experimental findings of this approaches may help to develop a description of soil water status/soil cracking so that such descriptions may be included in irrigation scheduling (water management models) and in any cultivation system needed especially in limited water resources areas.

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