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*Short communication*

# Cyclonic flood management for rice crop in Cauvery Delta Zone, Tamil Nadu

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Floods and cyclones are the two weather related disasters causing heavy losses in terms of human lives and property and disrupting normal life every year. A cyclone brings high wind with it, and contributes substantial percentage of rainfall. However, a severe cyclone, when it crosses the coast, causes floods, tidal waves, which inundate low lying areas leading to enormous loss of life and damage to property. An area is categorized as having experienced flood if departure of rainfall from normal over the area is more than + 25 %. Further, an area where flood occurred in 20 % of the years examined as defined above, is considered as flood prone and where it occurred in more than 40 % of the years the incidence is regarded as "chronic".

## *Cyclones over Tamilnadu*

Most cyclones originate in the Bay of Bengal due to prevalence of higher sunface temperature. The annual average frequency of total number of cyclonic disturbances is seen to be around 12, out of which 5 develop into cyclones. The predominant cyclone activity is in the post-monsoon period of October and November followed by the pre-monsoon months of April and May. Table 1 indicates the frequency distribution of the cyclones over east coast of Tamilnadu (Jayanthi, 2002). As regards Tamil Nadu, the coastal area south of 10° between Pamban and Nagapattinam is highly vulnerable to storm surges of the range 3 to 5 m on several occasions (Jayanthi, 2002). Table 2 gives the month wise frequency of the cyclonic storms that crossed the Tamil Nadu coast during the period 1891-2000 (Jayanthi, 2002).

## *Excess flood water management in the Cauvery Delta Zone*

Rice is the major crop, in Cauvery Delta region, grown in four seasons viz., kuruvai (June-Septemebr), samba (August-January), thaladi (September-January) and navarai (February-May). Rice crop is severely affected by cyclonic floods during northeast monsoon consequent to high receipt of rainfall in inland catchments areas. The strategies for improving the productivity areas, which are subjected to frequent flooding, can be of two kinds viz., i) development related and ii) management related strategies. Development related strategies: the provision of infrastructure facilities for protection against flooding should be considered basin wise and in a long-term perspective. These should include measures for conserving soil and water in the upper catchments of the basin in order to minimize the severity and frequency of occurrences downstream.

**Table 1** : Frequency distribution of the cyclones over east coast of Tamilnadu (1891-1995)

| East coast district | Number of Cyclones |
|---|---|
| Chengalput including Chennai | 21 |
| S.Arcot including Pondicherry | 13 |
| Thanjavur including Pudukottai | 14 |
| Ramanathapuram | 6 |
| Tirunelveli | 3 |
| Kanyakumari | 4 |
| Total | 61 |

**Table 2** : The month wise frequency of cyclonic storms that crossed the Tamilnadu during the period 1891-2000

| Month | Frequency CS | Frequency SCS |
|---|---|---|
| January | 3 | 1 |
| February | 1 | 1 |
| March | 1 | Nil |
| April | 2 | 1 |
| May | 3 | 1 |
| June | Nil | Nil |
| July | Nil | Nil |
| August | Nil | Nil |
| September | Nil | Nil |
| October | 6 | 2 |
| November | 34 | 22 |
| December | 14 | 8 |
| Annual | 64 | 36 |

Note: (C.S-Cyclonic Storm, S.C.S-Severe Cyclonic Storm)

Management related strategies include rehabilitation programs, improving the control of water upstream and the drainage facilities downstream. The effects of man-made structures such as roads and canals on drainage systems should be studied carefully because in many instances the inadequate provision of water passing (crossing) facilities in the structures is responsible for prolonged flooding of the upstream side of the roads and canals.

One of the major ailments in Cauvery Delta is the poor drainage system and the consequent submersion problems. Fortunately the problems are not much of water logging as that of mere flooding and submergence. The most dominant natural cause of major drainage problems in the low-lying lands is high-intensity rainfall. In Cauvery Delta, high seepage loss, over -irrigation and use of vast areas for growing high water-requiring crops, with attendant high percolation losses, resulted in a steady rise of water table in the command areas of many irrigation systems. The problem is severe mainly during the northeast monsoon period when the delta and the upland receive heavy intensities of precipitation and the drainage carriers are unable to discharge freely into the sea as the sea is mostly rough and rises in high tides during this cyclone weather (Morachan and Rethinam, 1972).

The historical daily rainfall data were collected from the Agrometeorology observatory at Tamil Nadu Rice Research

Institute, Aduthurai, which is located in the heart of Cauvery Delta, for the past 60 years (1932-91). The data had showed the mean monthly rainfall of 195.5 mm with daily rainfall ranged from 2.2 to 13.8 mm comprising 18.2 % of annual rainfall during October. November received a mean monthly rainfall of 280.3 mm with daily rainfall ranged from 4.4 to 17.8 mm contributing 26.1 % of annual rainfall. The mean monthly rainfall during December was 165.2 mm contributing 15.4 % of annual rainfall. The daily rainfall variation is low during October month and is high in December. The highest one day rainfall ranged from 30.5 to 148.6 mm in October; from 41.4 to 251.4 mm in November and from 16.2 to 235.0 mm in December occurring between the third week of October and the first week of December. These factors are to be taken into consideration while planning for drainage projects and flood control programme (Jeyaraman *et al.*, 1998).

### *Flood management in rice crop*

Flood water either moving, stationary, nutrient-rich, nutrient poor, of short or long duration have important implications for the survival strategy of the adapted plants. There are varietal differences in the response of the rice plant to excess water conditions and duration. Crop yield is generally unaffected if the submergence is for less than three days (Agua *et al.*, 1988). De Datta *et al.* (1973) indicated that flooded rice can tolerate a depth of at least 15 cm if improved varieties are grown. Water levels in the rice fields should be prevented from rising by more than 20 cm for optimum plant growth and yield. Modern rice variety plants are completely damaged (rotten) if full submergence continues for 6 days or longer (Agua *et al.*, 1988). Most lowland, irrigated or deepwater rice cultivars can stand complete submergence for at least 6 days before 50 % death occurs (Mazaredo and Vergara, 1982), while 100 % death occurs in most cultivars within 14 days. Rice elongation is required in areas where water depths generally exceed 50 cm for more than 14 days, while submergence tolerance is required where water depths only rise transiently such as during flash floods or in tidal wetlands (HilleRisLambers and Seshu, 1982). The panicle initiation and flowering stages of the rice crop are most sensitive to full submergence. The allowable submergence depth and time differ greatly according to the crop growing stage. For example, the greatest flood damage occurs at the panicle formation stage (submergence for 2 days seriously affects crop growth). Excessive water depth in the paddy field for a prolonged period will significantly reduce yield. Table 3 shows the relationship between flooding conditions and yield of rice.

### *Effect of excess water conditions on rice*

Maintenance of a permissible water depth on the soil surface is one of the most important aspects of good water management for lowland rice areas. Rice plants are not able to perform their normal physiological functions when water depth in the field exceeds a certain level. Water depth in the field generally may not be allowed to exceed about 15 % of the crop height. One-day submergence at the panicle initiation stage can reduce IR-30 rice yield up to 75 % during this stage; the young stalks of rice plants appeared to be easily weakened by flooding. The panicle initiation and flowering stages of the rice crop are most sensitive to full submergence i.e., when the entire crop canopy is under water (Undan, 1978). Partial submergence of "Jaya" variety at 25 % of plant height during any of the three major stages of rice plant growth, i.e., seedling establishment to maximum tillering, maximum tillering to flowering and flowering to maturity, can result in about 20 to 30 % yield reduction in the "Aman" (July - Nov) or "Boro" (Jan - Apr) season in India (Pande *et al.*, 1979).

Submergence of rice plant above the tolerable depth results in reduced tillering and low dry weight (Mazaredo and Vergara, 1982); chlorosis (Jackson *et al.*, 1987) and death of crop. These effects are likely to arise from slow exchange of gases, because gases diffuse 10,000 times more slowly through water than through air and hence the process of photosynthesis may be reduced (Setter *et al.*, 1989). Also, muddy or turbid water inflicts a greater damage to the plants than clear water because sediments in turbid water block the pores in the plant body and hamper the respiration and photosynthesis processes ((Fukuda and Tsutsui, 1968; Pande *et al.*, 1979; Bhuiyan and Shani, 1987).

***Pre-cyclone management practices for rice crop***

The productivity of rice growing areas, which have no protection against

**Table 3 :** Submergence damage (% yield reduction) of rice at different growth stages (Tsuitsui, 1972).

| Growth Stage | Duration of submergence | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Clear water | | | | Muddy water | | | |
| | 1-2 | 3-4 | 5-7 | 7 | 1-2 | 3-4 | 5-7 | 7 |
| 20 days after | 10 | 20 | 30 | 50 | - | - | - | |
| transplanting Young panicle formation, | 10 | 30 | 65 | 95/100 | 20 | 50 | 85 | 90/100 |
| partly inundated Young panicle formation completely | 25 | 45 | 80 | 80/100 | 70 | 80 | 85 | 90/100 |
| inundated | | | | | | | | |
| Heading stage | 15 | 25 | 30 | 70 | 30 | 80 | 90 | 90 |
| Ripening stage | 0 | 15 | 20 | 20 | 5 | 20 | 30 | 30 |

Note: Partly inundation means leaves (9 to 15 cm long) remain above water surface flooding, may be improved through different practices. Drain the flood water from fields. Adjust the cropping schedule to reduce risk to flooding so that flowering should not coincide with the cyclone / rainfall period. The cropping calendar should be adjusted to allow crops to be grown within the period of less risk of flooding damage (Jeyaraman *et al.*, 1993).

***Post cyclone management practices for rice crop***

Double transplanting of seedlings taken from densely populated area to thin populated flood affected areas, quartering of seedlings in dense area and planted in thin populated areas are certain cultural practices. Midseason drainage of rice fields: Fukuda and Tsutsui (1968) in Japan have reported beneficial effects in yields from draining the ponded water of the rice fields at the end of the productive tillering and keeping it unwatered for 7 to 10 days. Their reported benefits are attributed to the removal of toxic substances produced in the plant root zone due to aeration through midseason drainage i.e., a change in the prolonged reduced condition of the soil, higher soil potassium absorption by the plant, increases strength in plant clump and lodging resistance, etc.

Ramanathan and Rubapathi (2002) suggested cyclone flood management at various growth stages for rice crop which can be followed to minimize me cross and thereby maximizing the ecomonic benefits.

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