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IMPACT OF DROUGHT ON HATCHERY FISH SEED PRODUCTION IN WEST BENGAL - A CASE STUDY

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Alteration in seasonal and annual variability in rainfall resulting in drought and flood will be significant drivers of change in aquaculture and inland fisheries for the coming years in India. West Bengal a major producer of inland fish seed and consumable fish , is likely to be affected by the climatic changes.With this background the present study was undertaken to assess the impact of drought in the year 2009 on fish seed production in hatcheries of two major fish seed producing districts of West Bengal *viz.*, N 24 Parganas and Bankura. During 2009 the mean minimum air temperature in N 24 Parganas and Bankura, during January-April and May-September was higher by 0.34°C and 0.54°C and by 0.26°C and 0.28°C respectively. The corresponding mean minimum water temperature during the same period in the two district also increased by 0.39 and 0.62°C and by 0.30 and 0.32°C respectively. The optimum fish breeding months, June-September had a deficiet rainfall of 24% in N 24 Parganas and 15% in Bankura. Majority of the hatcheries investigated (68%) were affected by cumulative effect of high temperature and water deficiency. In N 24 Parganas the major factor for low spawn production was high larval mortality (45%) while in Bankura low demand of fish seed due to inadequate water area for stocking (80%) compelled restriction in purchase of seeds from the hatcheries. Economic analyses of spawn production in the two hatcheries one each in N 24 Parganas and Bankura indicated 61% and 73% loss in income respectively compared to the year 2006. The adaptation options practiced by 90% of the farmers were diversification to culture of alternate species like *Pangasius* sp., *Puntius javanicus*, *Clarias gariepinus* and *Piractus brachypomus* (paku) and cross breeding of the Indian Major Carps in 55% of the hatcheries.

Key words : Drought, climate change, hatchery, adaptation, breeding season, Indian major carps

Introduction

The increased seasonal and annual variability in precipitation resulting in flood and drought are likely to be the significant drivers of change in inland aquaculture and fisheries in recent years. In India trends are observed in multi decadal periods of drought, followed by less severe droughts (INC 2004, NATCOM). These changes are likely to have implications for the aquaculturist whose typically smaller ponds existing in the eastern region of the country. These static ponds retain less water, dry up faster and are therefore more likely to suffer during climatic short term extremes like drought with less water availability. India relies on fisheries for around 13.5% of its national animal protein intake and the average per capita fish protein consumption is 0.5 kg/capita/yr. But the contribution of fish to total animal protein consumption for the non-vegetarian population is much higher than the overall Indian average (Dey *et al.,* 2005), thus the impact of extreme events like drought will have immense implication on regional food security especially in the eastern Indo-Gangetic states of India. In 2009 the monsoon in India got delayed by 2 weeks, this resulted in the deficit rainfall of 54% of the long term average for the period. The impact of drought (defined as a season with deficit in the all India June to September rainfall of more than 10% of the long term average) has been felt across the country (Francis and Gadgil, 2010). The state of West Bengal during this year also recorded deficient rainfall in 12 districts. The

implications are important because the state possesses 37% of the pond resources in India, of which 70% are utilized for fish culture. The state is the highest fish producer in the country and is also a major supplier of fish seed to other states of India (Morrice *et al.*, 1998). With this background a study was conducted in two drought affected fish seed producing districts North 24 Parganas and Bankura of West Bengal in 2009 to assess i) the alteration in air and water temperature and rainfall during the fish breeding months of March-September, 2009 and ii) their impact on fish seed production and economics.

Materials and methods

Temperature and rainfall assessment

Annual maximum and minimum air temperature, total monthly and annual rainfall data of the districts surveyed were collected from the Regional Meteorological Centre, Kolkata and were statistically analysed. The water temperature of the districts surveyed was derived from the recorded air temperature of the periods January-April and May-September during 1999-2009 based on the worked out relationship between air and water temperature (monthly means), the equation $y = 1.150 x - 3.7305$ ($R^2 = 0.9634$) (Dey *et al.*, 2007 and Vass *et al.*, 2009).

Impact study on fish seed production

The survey covered fish seed hatcheries affected by drought in the districts of Bankura and North 24 Parganas of West Bengal, India (Fig 1). A total of 50 operative hatcheries, running and sustaining for the last 10 years were surveyed randomly. The selection was done based on the State Fisheries Department list as well as local information as the source of survey contact. Two

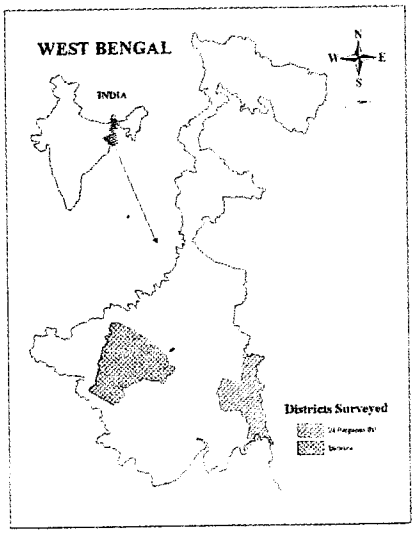

Fig. 1 Study area

questionnaires (for hatcheries and fishers) were prepared based on preliminary survey of the hatcheries and also based on earlier survey (Dey *et al.*, 2007). The questionnaires were pre tested and finalized for data collection, a total of 34 hatcheries responded to the survey and 27 responses which fitted our objectives with respect to size and fish species cultured were analysed. The parameters taken into consideration were fish species, brooder management, breeding procedure and techniques, breeding season duration, cost of spawn production and marketing. Data prior to 2009 was collected from available recorded data and through personal interview. The data was analysed through simple tubular analyses.

Results

Seasonal alteration in temperature and rainfall

Air temperature - In North 24 Parganas the mean maximum air temperature increased by 1.97 °C during the period January to April and by 1.37 °C during May to September in 2009

compared to the 1999-2008 during those months (Fig. 2). The mean minimum air temperature increased by 0.34 °C and 0.54 °C in January to April and May to September respectively during 2009 as compared to 1999-2008 (Fig. 3).

In Bankura district the mean maximum air temperature increased by 3.26 °C between January to April and by 2.26 °C during May to September (Fig. 4) whereas the mean minimum air temperature increased by 0.26 °C and 0.28 °C during January to April and May to September respectively in 2009 as compared to 1999-2008 during these months (Fig. 5).

Water temperature - Based on the derived relationship between air and water temperature the mean minimum water temperature in North 24 Parganas increased by 0.39°C during January-April and by 0.62°C during May-September (Fig. 6) and in Bankura it increased by 0.30°C during January-April and by 0.32°C during May-September (Fig. 7).

Rainfall

Deficient rainfall was recorded in 12 districts of West Bengal during 2009. During monsoon period June to September rainfall was deficit of 15%. Fish breeding practices in districts of West Bengal usually starts just after winter 1st week of February with spawn becoming available by mid March. Thus rainfall from March to September is important as it is the breeding season of fishes. During the year 2009 rainfall in March was 20.6 mm (-25%), April : 2.0 mm (-96%), May : 229.2 mm (+146%), (cyclone "AILA" occurred during the month of May), June : 69.6 (-71%), July : 278.7 (-11%), August: 329.6 (+6%) and September: 293.9 (+9%) respectively (IMD 2009). In North 24 Parganas district during 2009 rainfall deficit

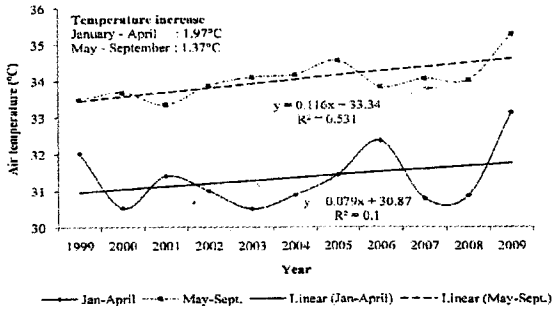

Fig. 2. Mean maximum air temperature at North 24 Parganas.

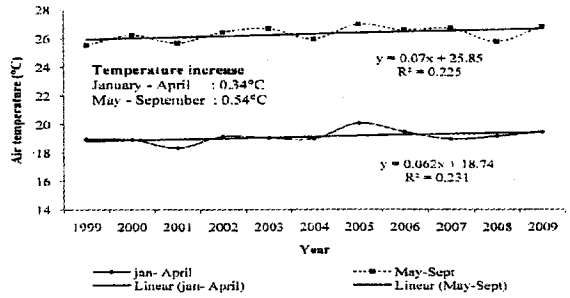

Fig. 3. Mean minimum air temperature at North 24 Parganas.

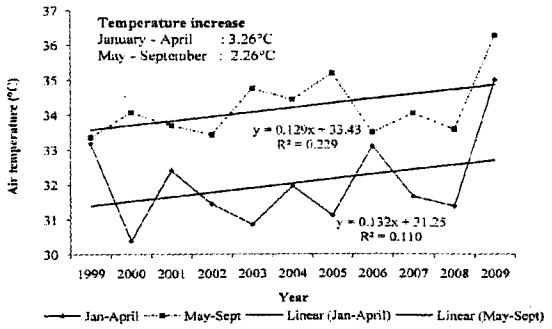

Fig. 4. Mean maximum air temperature at Bankura during 1999-2009.

was 20.15% and in Bankura it was 10.43% compared to the years 1999-2008 in the fish breeding months of March to September (Fig. 8 and 9). During the optimum fish breeding months June-September the rainfall deficit was 24% in N 24 Parganas and in Bankura it was 15% (Fig. 10 and 11).

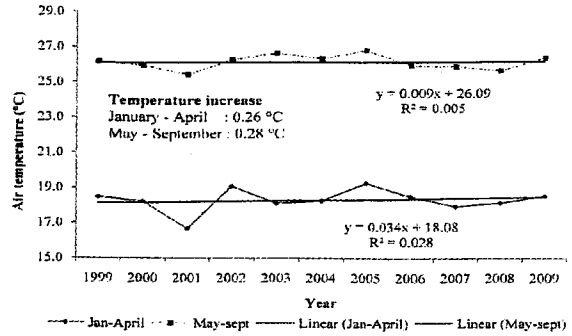

Fig. 5. Mean minimum air temperature at Bankura during 1999-2009.

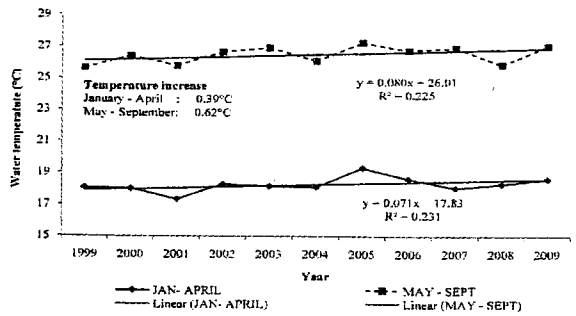

Fig 6. Mean minimum water temperature at 24 Parganas (N) during 1999-2009.

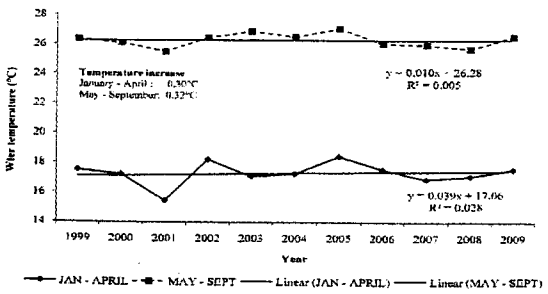

Fig. 7. Mean minimum water temperature at Bankura during 1999-2009.

Impact on fish seed production

The survey of the hatcheries in the two districts indicated that out of the total 34 hatcheries 23 were affected by the drought condition created by alteration of the climate variables *viz.*, temperature and rainfall. Of the attributes

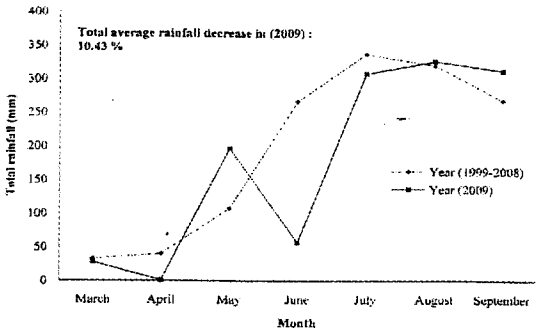

Fig. 8. Total average rainfall distribution in North 24 Parganas during 1999-2008 & 2009.

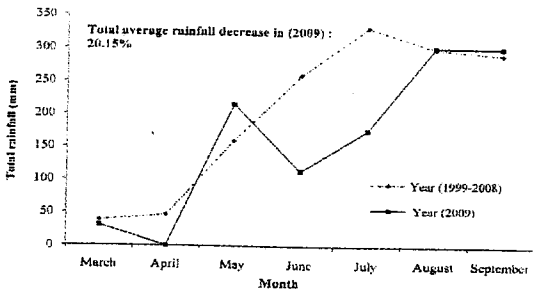

Fig. 9. Total average rainfall distribution in Bankura during 1999-2008 and 2009.

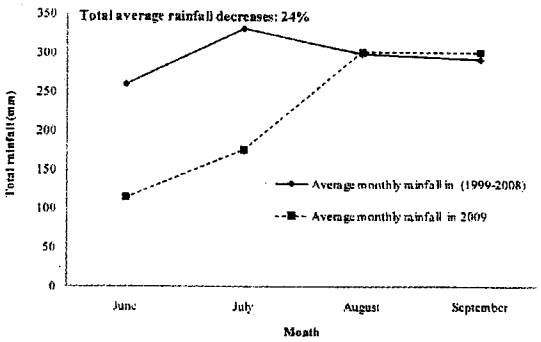

Fig. 10. Total average rainfall distribution in North 24 Parganas (June - September) during 1999-2008 and 2009.

affecting seed production 20% of the hatcheries were affected by high temperature, 12% were affected by water scarcity and 68% were affected by cumulative effect of high temperature and water scarcity (Table 1).

IMPACT OF DROUGHT ON SEED PRODUCTION

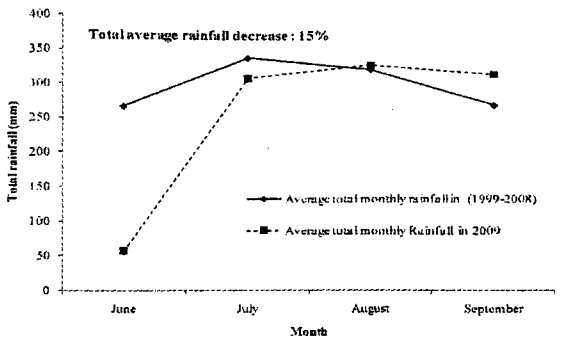

Fig. 11. Total average rainfall distribution in Bankura (June - September) during the year 1999-2008 and 2009.

Impact on spawn production

North 24 Parganas - Three factors contributed to low production of spawn in the fish seed hatcheries in this district during 2009. Low milting of the male brooders resulting in breeding failure during the pre monsoon season of March-May contributed maximum 45%. Spawn death after fertilization because of enhanced temperature contributed 35%. Low demand of fish seed because of scarcity of adequate water in nurseries and rearing ponds during June-September contributed 20% (Fig. 12).

Bankura - In Bankura the factors contributing to low fish seed production in hatcheries was low demand (80%) both during advanced breeding months March-May and seasonal months of Jun-July. This is because of scarcity of adequate water in nursery and rearing ponds due to deficient

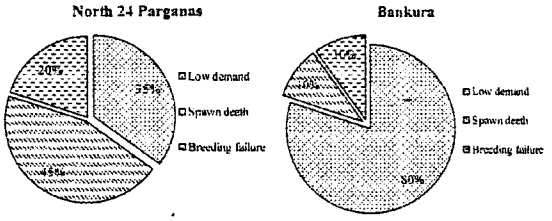

Fig. 12. Percentage attributes for impact due to drought condition in four districts.

rainfall. Although the sale of fish seed increased during August-September but low sale price could not offset the low demand during March-May when price of spawn was high Spawn death due to enhanced temperature contributed 10% and breeding failure due to low milt of male brooders contributed 10% (Fig 12).

Three attributes *viz.* spawn death, breeding failure and low demand for fish seed were taken into consideration for assessment of impact of scanty rainfall and high temperature in these two districts of West Bengal. Among the attributes, loss due to spawn death was maximum (45%) in North 24 Parganas while in Bankura the maximum loss was due to low demand of fish seed which was 80% among the other three attributes (Fig. 12).

Economic impact

In the years 1999-2008 during the fish breeding months March-April the price of fish seed was Rs. 600/measure (bati) whereas during 2009 the price dropped down to Rs.450-500/bati. During

Table 1. Weather factors and their resultant impact on fish seed hatcheries

Weather factors	Affected hatcheries (%)	Resultant impact
Deficient rainfall	12	Low demand due to water scarcity in nurseries and ponds.
High temperature	20	High temperature caused fish spawn mortality in incubation tank, unknown disease and inadequate milting.
Both low rainfall and high temperature	68	Low demand as well as low survival rate.

the months April-September the price per measure (bati) ranged between Rs.220-250 during 1999-2008 but it dropped down to Rs.100-120 per bati during 2009 (Table 2 and 3). The deficient rainfall created a situation of water scarcity resulting in either dry up of water or inadequate water level in nursery and rearing ponds. As a result the demand came down.

The comparative economic loss analysis of fish seed production in selected hatcheries of these two districts indicated that 61% and 73% loss in income occurred during 2009 as compared to 2006 in Naihati (North 24 Parganas) and Ramsagar (Bankura) hatcheries respectively.

Discussion

It is evident from the impact assessment result that elevated temperature and deficient rainfall and resultant inadequate availability of water areas in nursery and rearing ponds for spawn and fry production during the fish breeding months affected spawn production of Indian Major Carps. This is reflected by a significant drop in the IMC spawn production in the major producing districts of West Bengal during the drought period of 2009. The implications are quite serious for the country. The production in the district also suffered with fish seed production coming down from 4532 million during 2008 to 4368 million spawn during 2009 (Fig. 13) (Department of Fisheries and Aquaculture. Government of West Bengal 2008-09).

West Bengal being the prime spawn producing state in India, any decrease in its production will affect effective implementation of fish enhancement

Table 2. Comparative economic analysis (for 30 kg brooder/set) of hatcheries in Naihati (North 24 Parganas)

Season	Expected number of spawn/set (1)	Average rate/bati (Rs.) (2)	Total Number of sets (3)	Total (in Rs.) (1) ×(2)× (3)
Scenario in 2006				
March-April	15 Bati × 75,000	600	16	1,44,000
May-September	60 Bati × 75,000	250	40	6,00,000
Total earning during 2006				7,44,000
Scenario in 2009				
March-April	9 Bati × 75,000	500	16	72,000
May -September	45 Bati × 75,000	120	40	2,16,000
Total earning during 2009				2,88,000

Table 3. Comparative economic analysis (for 30 kg brooder/set) of hatcheries at Ramsagar (Bankura)

Season	Expected number of spawn/set (1)	Average rate/bati (Rs.) (2)	Total Number of sets (3)	Total (in Rs.) (1) ×(2)× (3)
Scenario in 2006				
February-March	9 Bati × 70,000	550	16	79,200
April-September	90 Bati × 70,000	250	48	10,80,000
Total earning during 2006				11,59,200
Scenario in 2009				
February-March	6 Bati × 70,000	600	16	57,600
April-September	60 Bati × 70,000	90	48	2,59,200
Total earning during 2009				3,16,800

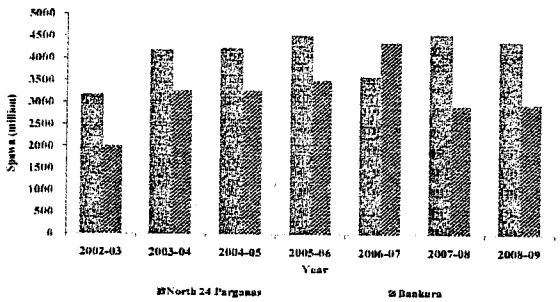

Fig 13. Fish seed production (Million) in districts of Bankura and North 24 Parganas.

technologies in the country through inadequate supply of seed. Further the water stresses created due to drought have the potential of creating conflicts with other agricultural, industrial and domestic users. The impact is likely to be felt most strongly by the poorest aquaculturists in the eastern region of the country possessing smaller ponds. These ponds retain less water, dry up faster, and consequently will have shortened growing seasons, reduced harvests and a narrower choice of species for culture. However, the drought provided the farmers with adaptation options to culture alternate species capable of withstanding water stress. 90 % of the hatcheries diverted to culture of species other than IMC like *Pangasius* sp., *Puntius javanicus*, *Clarias gariepinus* and *Piractus brachypomus* (paku), which are comparatively more adaptable to the changed weather conditions with satisfactory market demand (Fig. 14 and 15). The practice of rearing such species in fish seed hatcheries have increased from 60% to 80 % during 2009 as compared to our previous survey in 2006. Cross breeding of the Indian Major Carps has been another option practiced by farmers. 55% of the hatcheries (Table 4) were involved with such practice. These farmers reported better survival and growth of cross bred species under water stress conditions and better transportable to distant places with less mortality. Alikunhi and Chaudhuri 1959;

Table 4. Species combination in cross-breeding

Male species	Female species	Hybrid (local name)
C. catla	*L. rohita*	Bullet
L. rohita	*C. catla*	Bullet

Fig. 14. Culture and marketing of *Clarias gariepinus* (African catfish) at Naihati.

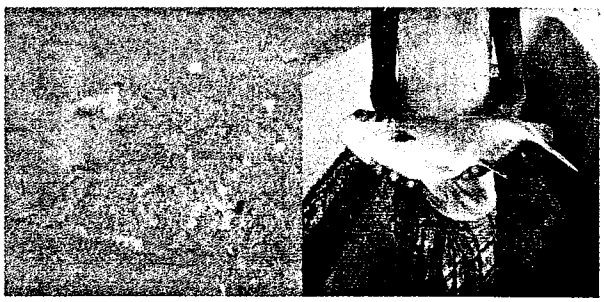

Fig. 15. Culture of Paku at Naihati.

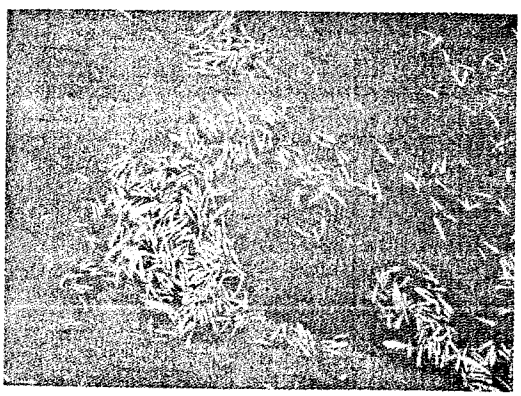

Fig. 16. Fry mortality in hatcheries of North 24 Parganas.

Chaudhuri 1963 have opined that hybrid of better strain, more hardy and more resistant to disease, is obtained by crossing different species or different races of fish.

Acknowledgements

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