Application of Epidemiology to Support Better Health Management in Black Tiger Shrimp Penaeus monodon Aquaculture: An Experience from India

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ABSTRACT

In 2001, a longitudinal epidemiological study on 365 randomly selected shrimp ponds was carried out in two districts of Andhra Pradesh, India to identify risk factors for shrimp disease outbreaks (emphasizing the economically devastating white spot disease) and low pond production. Risk factors significantly associated with disease outbreaks were then used to develop locally relevant better management practices (BMPs). During 2002, demonstration sites were established in the two districts to support and evaluate the practical implementation of these BMPs on private farms. In this paper, experiences from the demonstrations in two villages in West Godavari district (8 ponds on 4 farms) are presented. Risk and protective factors identified from 184 epidemiological study ponds in this district were used to design and implement BMPs relevant to the local modified extensive farming system. Although farmers experienced disease outbreaks, demonstration ponds had better performance, in terms of days of culture (DOC), mean body weight (MBW) and production compared to 2001 in the same ponds and with nearby non-demonstration ponds during 2002. The average DOC, MBW, production was 93 d, 17.3 g and 417 kg/ha respectively. The demonstrations provided further understanding of risk factors, BMPs, shrimp disease

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occurrence and farm performance. Timely implementation of BMPs by farmers was a major factor in crop performance, which was dependent on farmers' understanding and willingness to adapt BMPs and their financial status. Experiences from this study show the epidemiological approach provided understanding of shrimp disease risks, but constraints to implementation of BMPs at the farm level need to be understood and addressed in research and extension if such findings are to contribute to adoption of better health management practices by small holders.

INTRODUCTION

Shrimp aquaculture has become an important economic activity in maritime states of India, particularly in the state of Andhra Pradesh, since the early 1990's. Production loss due to various diseases especially white spot disease (WSD) caused by white spot syndrome virus (WSSV) is of major concern to this Indian shrimp farming sector, since its first occurence in 1994 (Manohar *et al*.,1996; Karunasagar *et al*., 1997; Mohan *et al*., 1998; Shankar and Mohan, 1998; Madhavi *et al*., 2002). According to the estimates by Marine Products Export Development Authority (MPEDA), on average, 10,000 to 15,000 metric tonnes of shrimp production, worth about US$ 60-70 million is lost annually due to disease problems. Recognizing this critical situation, the national agency MPEDA, India's Ministry of Commerce and Industry undertook a project called ùShrimp Disease and Coastal Management' during 2000-2002 with technical assistance from the Network of Aquaculture Centres in Asia-Pacific (NACA), Bangkok, Thailand. The main objectives were to identify risk factors for disease outbreaks and to develop practical measures for containing and preventing shrimp disease outbreaks on farms in selected areas.

In 2001, a longitudinal epidemiological study was conducted involving 365 randomly selected shrimp ponds in two districts of Andhra Pradesh to identify risk factors for shrimp disease outbreaks (emphasizing the economically devastating white spot disease) and low pond production. The identified risk factors were then used to design locally relevant better management practices (BMPs). During 2002, demonstration sites were established in the study area to support and evaluate the practical implementation of these BMPs on private farms. In this paper, outcomes and constraints in implementing BMPs in two villages of West Godavari district (8 ponds on 4 farms) are presented.

MATERIALS AND METHODS

Selection of demonstration villages

Two villages, Mogalthur and Losari, were selected in the study area (Fig. 1) based on the salinity levels in the source water. Mogalthur was a low saline area and Losari was a high saline area with source water salinity ranges of 2-20 ppt and 10-40 ppt, respectively. In the study area, most of the shrimp farmers are small holders using an improved traditional farming system in which stocking densities are less than 6 shrimp/m^2 and average production is about 200 kg/ha.

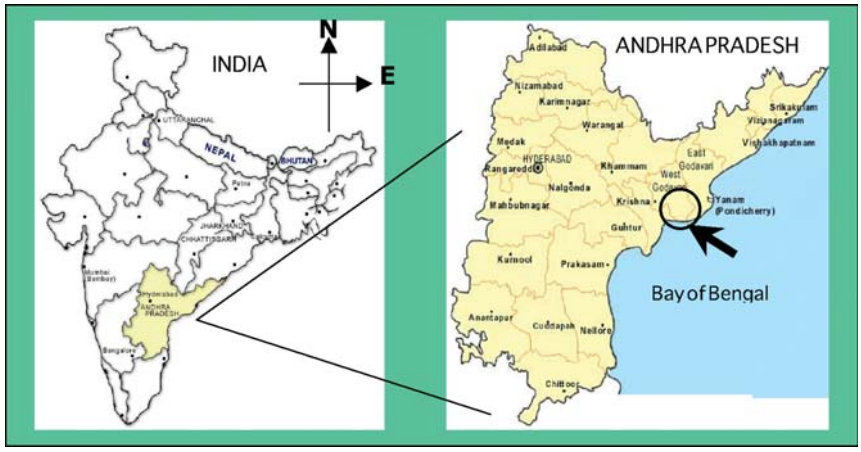

Figure 1. Map of India showing the demonstration area (arrows).

Farm selection

From each village, two farms were selected which were owner-operated and relatively small in area with few ponds representative of most local farms. Farmer willingness to co-operate with the study team also influenced the selection. From each farm, two ponds were selected for culture and one extra nearby pond in the same farm set aside as a water storing. Thus total farms and ponds in the demonstration program were 4 (A-D) and 8 (A1-D2), respectively. The average pond size was 0.8 ha.

Recommended better management practices

Identified risk factors from a longitudinal epidemiological study conducted during 2001 in 184 randomly selected ponds from West Godavari district (MPEDA/NACA, 2001), were used to design locally relevant risk management practices (Boxes 1-3). Also some relevant BMPs were used (marked with *) from existing information (Chanratchakool *et al*., 1998).

Box 1: BMPs for pond bottom and water preparation

1. Sludge removal and disposal away from pond site.
2. Ploughing on wet soil if the sludge has not been removed completely.
3. Water filtration using twin bag filters of 300 m mesh size.

Box 2: BMPs for seed selection and stocking practices

1. Uniform size and colored PLs, actively swimming against the water current.
2. Nested-PCR negative PLs for WSSV (using batches of 59 PLs pooled together). If test turns negative it means that the prevalence of WSSV infected PLs is less than 5% in that population at 95% confidence.
3. Weak PL elimination before stocking using formalin (100 ppm) stress for 15-20 min in continuously aerated water*.

Box 3: BMPs for post-stocking / grow-out

1. Use of water reservoirs, and 10-15 days aging before use on grow out ponds*
2. Regular usage of agricultural lime, especially after water exchange and rain
3. No use of any harmful/banned chemicals
4. Using of feed check trays to ensure feeding based on shrimp demand*
5. Feeding across the pond using boat/floating device to avoid local waste accumulation*.
6. Regular removal of benthic algae.

Demonstration method

Study team and farmers worked together to identify specific BMPs for implementation in each pond. The study team supported farmers in adopting the recommended BMPs and also to follow them by personal supervision of the farm activities on a daily basis.

Previous year crop details

The previous year crop details during same season from the demonstration ponds were gathered by interviewing the farmers.

Crop outcomes in other village ponds

Information on pond outcomes from other ponds in both villages during demonstration period was collected using questionnaire. From each village, 100 ponds were randomly selected. The information collected included details on pond sizes, stocking, disease and harvest.

RESULTS

The average stocking density was about 5 shrimp/m^2. Farmers stocked hatchery-sourced post-larvae (PL) except in ponds A1 and A2, in which on-farm nursery reared (for 16 days) juveniles were stocked.

All the ponds except pond D2 experienced outbreaks of disease clinically consistent with white spot. The main gross sign of moribund shrimps was white spots on the carapace. The pond-wise crop outcomes in terms of days of culture (DOC), production (kg/ha) and mean body weight (MBW) in g are shown in Table 1. The average values of these outcomes were 93 d, 417 kg/ha and 17.3 g, respectively. Farmers of Mogalthur village which is a low saline area, obtained better crop outcomes than those in Losari village, a high saline area. The average values of crop outcomes from ponds of these two villages are shown in Table 3.

Table 1. Pond-wise crop results during demonstration.

Crop Outcome	Mogalthur				Losari			
	A		B		C		D	
	A1	A2	B1	B2	C1	C2	D1	D2
DOC (d)	102	102	112	112	90	100	72	57
Production (kg/ha)	658	920	350	439	157	396	264	155
Mean Body weight (g)	23.1	23.2	22.1	23.8	7.8	13.9	17	7.4

Table 2 shows the crop outcomes in the same ponds during the previous year, in same season crop. Average stocking density was about 3 shrimp/m^2. During this crop also, all the ponds were affected by disease outbreaks with white spots on carapace being the typical gross sign on moribund shrimps of all ponds. Three ponds (B1, C1 and C2) were drained out without any harvests. The average values of DOC, production and MBW were 47 d, 92 kg/ha and 8.6 g, respectively, are much lower than those during the demonstration crop trial.

Table 2. Pond-wise crop results during previous year.

Crop Outcome	Mogalthur				Losari			
	A		B		C		D	
	A1	A2	B1	B2	C1	C2	D1	D2
DOC (d)	77	77	47	44	28	28	36	37
Production (kg/ha)	291	312	0	35	0	0	50	50
Mean Body weight (g)	23.2	25.6	-	8.3	-	-	6	6

- Drained out the stocks following early disease outbreaks and so shrimp sizes not available.

Table 3. Average values of crop outcomes in demonstration ponds and other village ponds.

Crop Outcome	Mogalthur		Losari	
	Demo Ponds	Village ponds	Demo Ponds	Village ponds
DOC (d)	107	96	80	61
Production (kg/ha)	591	265	243	66
Mean Body weight (g)	23.1	21	11.5	12.2

Table 4. Profit and loss amounts for each pond (US$ / ha).

Crop	Loss-Profit status	Mogalthur				Losari			
		A		B		C		D	
		A1	A2	B1	B2	C1	C2	D1	D2
Demonstration crop	Profit	768	1420	609	503	-	-	411	49
	Loss	-	-	-	-	968	365	-	-
Previous year crop	Profit	459	642	-	-	-	-	-	-
	Loss	-	-	290	327	753	770	758	683

1 US$ = 45 Rs.

The pond-wise crop outcomes in terms of DOC and production were higher in all the ponds with marginal increase in stocking densities during the demonstration crop compared to the previous year crop. But in case of MBW, except in ponds A1 and A2, farmers achieved better results during the demonstration trial. This almost similar MBW could be attributed to doubled production in those ponds.

Not all farmers complied in the survey conducted to gather information on crop outcomes from other ponds in the villages. Information from 60 ponds and 49 ponds was gathered from Mogalthur and Losari villages, respectively. Of these, 51 and 48 ponds were reported with disease outbreaks in Mogalthur and Losari villages, respectively. The average stocking density was 2.5 shrimp/m2. Table 3 shows the average outcomes from demonstration ponds and other ponds in their respective villages. Demonstration ponds achieved better DOC and production than did other ponds in their respective villages. However, the average MBW was almost the same in both the cases. This may be attributed to the local village farming conditions and the nearly double stocking density in demonstration ponds relative to others. Information on previous crops in other ponds in the village could not be collected to evaluate if the previous crop had poorer production in the whole village. However, these results show a clear trend towards better DOC and production.

Crop economics in terms of profit and loss are shown in Table 4. The cost of production included running costs of that crop like costs for seed, feed, lime, fertilizers, fuel, electricity, labour and miscellaneous expenditures. But the land cost was not considered, as the ponds were owned by the study farmers. Except for Farmer C all the three farmers achieved reasonably good profit. Farmer C was a laggard who used to implement the BMP suggestions with long delays compared to other three farmers who were early adopters of BMPs. The average profit was US$ 627/ha. By contrast, during the previous year's crop, only one farmer obtained a profit.

CONCLUSION

Although farmers were given BMP recommendations and on-farm continuous support to implement these recommendations by the study team, the crop outcome invariably depended on farmer attention towards active implementation of the recommended practices in given time, which in turn depended on his understanding and willingness to adopt the recommended practices and also on willingness to invest financially. The comparatively better crop outcomes suggest further scope for utilization of epidemiological findings to support the BMPs at local level with more effort towards extension programs. The occurrence of disease outbreaks in the face of improved management practices suggests the need for further understanding of diseases through more specific epidemiological studies.

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