Cluster Level Adoption of Better Management Practices in Shrimp (*Penaeus monodon*) Farming: An Experience from Andra Pradesh, India

P.A. PADIYAR[1], M.J PHILLIPS[1], B.V. BHAT[2], C.V. MOHAN[1], B.G. RAVI[2], A.B.CH. MOHAN[2] and P. SAI[2]

[1]*Network of Aquaculture Centres in Asia-Pacific (NACA), Suraswadi Building, Department of Fisheries, P.O. Box 1040, Kasetsart Post Office Bangkok 10903, Thailand*
[2] *Marine Products Export Development Authority (MPEDA) Ministry of Commerce and Industry, Govt. of India P.B. No. 4272, Panampilly Avenue, Cochin - 682 036, India.*

ABSTRACT

Disease is a major constraint to aquaculture production and profitability around the globe. Since the early 1990s, white spot disease caused by white spot syndrome virus has been causing unprecedented economic and social hardships to small-scale shrimp farmers in India. Since 2001, the MPEDA-NACA technical assistance programme on "shrimp disease and coastal management" with the additional support from Australian Centre for International Agriculture Research is working towards developing and disseminating better management practices (BMPs) and promoting farmer self help groups to collectively implement the BMPs at the cluster level. In 2005, the extension programme was conducted in modified extensive shrimp farms in 6 villages of West Godavari district. In total, 492 farmers participated with 642 ponds spread over 275 ha of water area. Farmers were organized under self-help groups called 'Aquaclubs' at village level and a set of BMPs were collectively implemented. The average crop outcomes in study ponds in terms of production, average body size, survival rate and crop duration were 1,366 kg/ha, 26.2 g, 72% and 116 days, respectively; while in non-study ponds were 764 kg/ha, 24.7 g, 46% and 98 days, respectively. Emergency harvests indicative of disease outbreaks was 2% in study ponds compared to 65% in surrounding non-study ponds and they were significantly different ($p=0.00$). In study ponds, the crop outcomes significantly ($p<0.05$) improved compared to those of the previous year (no extension support). And emergency

Padiyar, P.A., Phillips, M.J., Bhat, B.V., Mohan, C.V., Ravi, B.G., Mohan, A.B.Ch. and Sai, P. 2008. Cluster level adoption of better management practices in shrimp (*Penaeus monodon*) farming: an experience from Andra Pradesh, India, pp. 409-418. *In* Bondad-Reantaso, M.G., Mohan, C.V., Crumlish, M. and Subasinghe, R.P. (eds.). Diseases in Asian Aquaculture VI. Fish Health Section, Asian Fisheries Society, Manila, Philippines. 505 pp.

Corresponding author**:** arunpadiyar@gmail.com

harvest rate indicative of disease outbreaks significantly decreased (p=0.00) from 58% during 2004 to 2% during 2005. However in non-study ponds the emergency harvest rate marginally reduced from 68% during 2004 to 65% during 2005 (p =0.03). These results indicate that BMPs when implemented collectively by organizing the farmers in the form of Aquaclubs can significantly improve the crop outcomes and significantly reduce the impact of diseases.

INTRODUCTION

Shrimp farming is an important economic activity in India. Disease is a major threat to the aquaculture production and profitability (Subasinghe, 2005). White spot disease (WSD) caused by white spot syndrome virus (WSSV) is a major problem in shrimp (*P. monodon*) farming since early 1990s and small-scale farmers across the Asian region including India have severely suffered due to WSD epizootic (Karunasagar *et al.*, 1997; Mohan *et al.*, 1998; Shankar and Mohan, 1998). Recently some studies have identified the risk factors and developed risk management practices or so called better management practices (BMPs) to reduce the risk of disease outbreaks in shrimp farms (Leung and Tran, 1999; Corsin *et al.*, 2001; MPEDA/NACA, 2001; Turnbull *et. al.*, 2003).

In India, the Marine Products Export Development Authority (MPEDA), Ministry of Commerce and Industry, with technical assistance from the Network of Aquaculture Centres in Asia-Pacific (NACA), Bangkok, Thailand has started a project called 'Shrimp Disease and Coastal Management' during 2000 with the objectives of identifying risk factors for disease outbreaks and developing and disseminating practical measures for containing and preventing shrimp disease outbreaks on farms in the major shrimp farming state of Andhra Pradesh.

Risk factors for shrimp diseases were identified during 2001 by conducting a longitudinal epidemiology study in selected sites of Andhra Pradesh. Suitable BMPs were developed to reduce these risks at farm level. These BMPs were first pilot-tested in 5 private farms of Andhra Pradesh during 2002. Although disease occurrence could not be completely eliminated, the production obtained and the percentage of profit making ponds were encouraging (MPEDA/NACA, 2002; Padiyar *et al.*, 2003). In 2003, the cluster farm management concept was introduced and 58 farmers of Mogaltur village in West Godavari district participated with their 108 ponds by forming an Aquaclub (farmer self- help group consisting 20-30 neighboring shrimp farmers in given farm cluster). This resulted in 2.4 times better production in demonstration ponds than the surrounding non-demonstration ponds. But the prevalence of emergency harvests was not significantly different ($p>0.05$) between demonstration (82%) and non-demonstration ponds (89%) (MPEDA/NACA, 2003; Padiyar *et al.*, 2004). In 2004, extension programme was spread to extensive farming areas (in which average stocking density was about 2 shrimp/m^2 and farms with average shrimp production was about 250 kg/ha/crop) of seven villages of West Godavari district and resulted in improved crop outcomes (MPEDA/NACA, 2004).

During 2005, the extension programme was extended to modified extensive farming system (in which average stocking density was about 6 shrimp/m^2 and average shrimp production was about 750 kg/ha/crop) in six villages in this district. In this paper, we present the crop outcomes and experiences in implementing BMPs at cluster level in six villages of West Godavari district.

MATERIALS AND METHODS

Selection of study villages

Six villages, namely Badawa, Chinamamidipalli, Dharbharevu, Kotha Navarasapuram, Y.V. Lanka and Y.V. Lanka Society, were selected from Narasapuram sub-district of West Godavari district (Figures 1 and 2). All these villages were directly dependent on Godavari estuarine water source. Salinity of water in all six villages ranged between 20-35 ppt. These villages were situated near to the earlier demonstration villages of MPEDA/NACA project during 2002-2004. Motivated by the crop results and technical services of MPEDA/NACA study team in other villages, farmers of these six villages requested for extension support in their village during 2005 which was granted. In these villages, most of the shrimp farmers were small holders with farm size of less than 2 ha/farmer and practicing modified extensive farming system.

Farmer and pond selection

Willingness of farmers to join in the village cluster level Aquaclubs (farmer self-help group) and to co-operate with the study team primarily influenced the selection. Also willingness of farmers to implement the BMPs was considered during the selection. BMPs were given as choice to the farmers and it was not absolute necessary for farmers to implement all of them if they were to be considered in the study. However, BMP implementations were recorded from each and every study pond during the cropping cycle.

Recommended BMPs

Better management practices identified and field tested by MPEDA/NACA project in West Godavari district since 2001 were used (MPEDA/NACA, 2001). Also some relevant BMPs were used from existing information (Chanratchakool *et al.*, 1998). These are given below:

(a) sludge removal and disposal away from the pond site;
- ploughing on wet soil if the sludge has not been removed completely;
- water filtration using twin bag filters of 300 μ mesh size;
- water depth of at least 80cm at shallowest part of pond;
- water conditioning for 10-15 days before stocking;

(b) seed selection and stocking:
- uniform size and colored PL, actively swimming against the water current;
- nested PCR negative PL for WSSV (using batches of 59 PL pooled together. If test turns negative it means that the prevalence of WSSV infected PL is less than 5% in that population at 95% confidence);

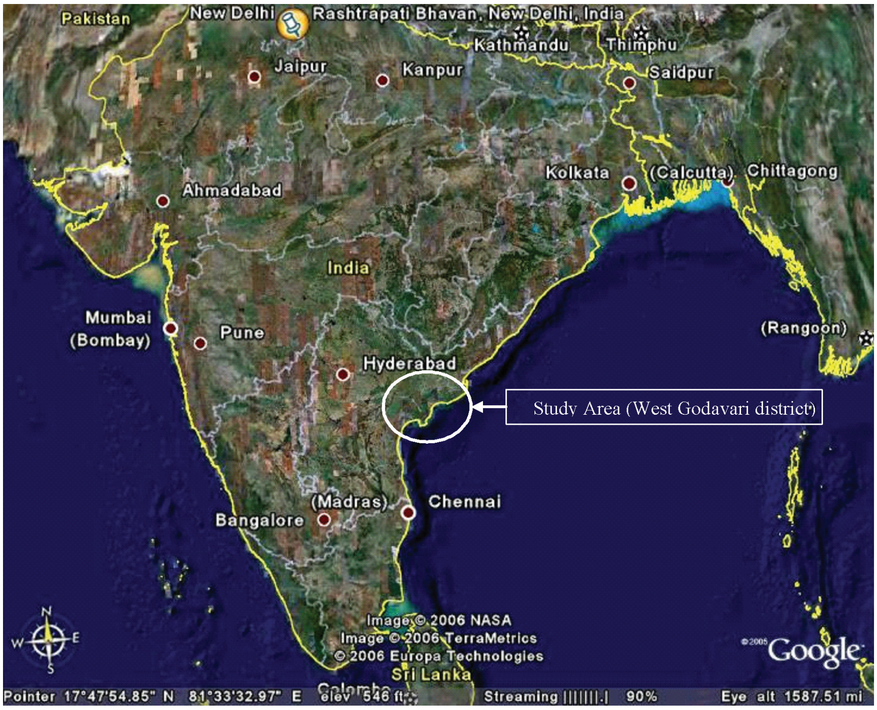

Figure 1. Map of India showing the study area.

Figure 2. Map showing the study villages (encircled) in West Godavari district.

- weak PL elimination before stocking using formalin (100 ppm) stress for 15-20 minutes in continuously aerated water;
- on-farm nursery rearing of PL for 15-20 days;
- stocking during 1st week of February to 2nd week of March;
- seed transportation time of less than 6 hrs from hatchery to pond site;
- stocking into green water and avoiding transparent water during stocking;

(c) post stocking management:

- use of water reservoirs, and 10-15 days aging before use on grow-out ponds;
- regular usage of agriculture lime, especially after water exchange and rain;
- no use of any banned chemicals;
- using of feed check trays to ensure feeding based on shrimp demand;
- feeding across the pond using boat/floating device to avoid local waste accumulation;
- regular removal of benthic algae;
- water exchanges only during critical periods;
- weekly checking of pond bottom mud for blackish organic waste accumulation and bad smell;
- regular shrimp health checks, and weekly health and growth monitoring using a cast net;
- removal and safe disposal of sick or dead shrimp;
- emergency harvesting after proper decision making;
- no draining or abandoning of disease affected stocks.

Extension method

The study team, consisting of one senior technical assistant and two junior technical assistants, stayed in one of the study villages starting two months prior to the start until end of the cropping season. The study team socialized with the villagers by keeping in touch with the farmers, villagers and village leaders on a daily basis. Through village level meetings, farmers were introduced to cluster farm management concept, formation of Aquaclubs and importance of adoption of BMPs. Key farmers from other villages involved in the MPEDA/NACA project (2002-2004) were invited to these new villages to share their experiences in the formation and management of Aquaclubs and implementation of BMPs. Depending on the willingness and availability of farmers, field visits were arranged for farmers from these six villages to other villages under the project for first-hand information exchange among the farmers. Aquaclubs prioritized the BMPs according to their local needs. Individual farmers were given freedom to implement the BMPs under the general guidance of Aquaclub leaders. Contract hatchery seed procurement system (Padiyar, 2005) was introduced in which meetings were arranged between farmers and hatchery operators for supply of good quality (BMPs) of shrimp seeds. The study team supported farmers in adopting the recommended BMPs and also to follow them through personal supervision of the farm activities on a daily basis.

Crop details in study ponds

Farm data from study ponds were collected using recording sheets and daily pond management books. The data included the following information: pond preparation (drying, sludge removal, ploughing, soil treatment, water intake), seed quality and source (activity of PL, body colour, body length in mm, deformities, diagnosis of WSSV by PCR test), stocking details (date, time, stocking density, acclimation), water management (water exchange practices, aeration, use of fertilizers, lime and other treatment chemicals, water quality parameters including water colour, salinity measured by refractometer, water pH measured by universal pH indicator, ammonia, hydrogen sulfide and total alkalinity measured by field test kits (Merck Inc.)), feed management (daily feed quantity, feed brand, feed size), health management (behaviour of shrimp, clinical signs, growth observation by weighing, use of treatment chemicals, number of dead and moribund shrimps on daily basis), harvest details (yield, average body weight, crop duration, estimated survival rate, market price) and crop expenditure details. However in this paper only the stocking densities and harvest details were considered.

Previous year crop details

The previous year crop (2004) details during same season (summer season of January - July) from the study ponds were gathered by interviewing the study farmers using a questionnaire. During 2004, there was no extension support for farmers in these six villages.

Crop details in non-study ponds

Information on farming practices and crop outcomes from non-study ponds in the above six villages and adjacent villages during demonstration period (2005) and previous year (2004) was collected using questionnaire. Each non-study ponds in the above six villages were targeted for information collection. In the adjacent villages, ponds and farmers were selected on convenience basis where in all the available farmers in those villages during the fixed 30 days of interview period were considered for interview. This kind of convenience sampling was preferred due to non-availability of the sampling frame (list of all farmers) from those of neighboring villages. Farmer interviews were conducted after completion of the cropping cycle and all the interviews were conducted in one month period.

Data analysis

The collected data were digitized and analyzed using a statistical software Epi InfoTM (downloaded from (www.cdc.gov/EpiInfo/). Mean values of two group of samples were compared using analysis of variance test (using EpiTable package in the above software). P-value lower than 0.05 is considered as significant.

RESULTS AND DISCUSSION

In the survey conducted to gather information on crop outcomes from non-study surrounding ponds, crop information from 294 ponds was gathered.

The average stocking density in study ponds was 67,850 shrimp seed/ha during 2004 and 69,900 shrimp seed/ha during 2005. In non-study ponds it was about 50,250 shrimp seed/ha during 2004 and 55,300 shrimp seed/ha during 2005. In both study and non-study ponds, stocking densities over the years did not significantly change (p=0.38 and 0.01, respectively). However, stocking density in study ponds was significantly higher (p =0.00) than that of non-study ponds during both years.

Table 1 shows the average values of crop outcomes in the study and non-study ponds in terms of production (kg/ha), average body size (g), survival rate (%), crop duration (days) and emergency harvest rate (%) indicative of disease outbreaks during 2005. They were 1,366 kg/ha, 26.2 g, 72%, 116 days and 2%, respectively in study ponds and 764 kg/ha,

Table 1. Average value of crop outcomes during demonstration period (2005) and previous year (2004) (no extension year)

Crop Outcome	**Study Ponds**		**Non-study ponds**	
	2004	**2005**	**2004**	**2005**
Production (kg/ha)	1078	1366	694	764
Mean Body weight (g)	24.4	26.2	28	24.7
DOC (d)	98	116	99	98
Survival rate (%)	67	72	41	46
Emergency harvest rate (%)	58.1	2	68	65
Stocking Density	6.79	6.99	5.025	5.53

24.7 g, 46%, 98 days and 65%, respectively in non-study ponds. These outcomes were significantly better study ponds than non-study ponds (p=0.00; 0.002; 0.00; 0.00; 0.00 respectively). Compared to non-study ponds, in the study ponds, average production was increased by 1.79 times, average body size was bigger by 1.5 g, survival rate was 26% higher, crop duration was 18 days longer and emergency harvest rate was lower by 5.2 times.

Table 2 shows the average values of crop outcomes in the study and non-study ponds in terms of production (kg/ha), average body size (g), survival rate (%), crop duration (days) and emergency harvest rate (%) indicative of disease outbreaks during 2004 (no extension period). They were 1,078 kg/ha, 24.4 g, 67%, 98 days and 58%, respectively in study ponds and 694 kg/ha, 28 g, 41%, 99 days and 68%, respectively in non-study ponds. All these average crop outcomes in the study ponds except crop duration and emergency harvest rate were significantly better in the study ponds than in the non-study ponds (p=0.00). Compared to the non-study ponds, the study ponds had 1.55 times more production, 3.6 g smaller-sized shrimps and 26% higher survival rate.

In the study ponds, although there was no significant change in stocking density over the years during 2004-2005 (p=0.387), all the outcomes showed significant improvement ($p < 0.05$). Average production was increased by 27%, average body size increased by 1.8 g, survival rate increased by 5.8%, crop duration increased by 18 days and emergency harvest rate reduced by 56.1%. In contrast, interestingly in the non-study ponds, there was no significant change ($p > 0.05$) in average crop outcomes except that the average body size and emergency harvest rate significantly (p=0.00002; 0.033) reduced by 3.3 g and by 3% during 2005 compared to 2004. However during 2005, emergency harvest rate was 65% in the non-study ponds, which was significantly higher by 63% compared to that of the study ponds in the same year (p=0.00). This shows that over the years, in the study ponds, emergency harvests were significantly and convincingly reduced and so as average crop outcomes. But in the non-study ponds, there was no significant but marginal improvement in crop outcomes which might indicate that indirect influence of study team and extension activities in the study villages on surrounding non-study ponds of same villages and neighbouring villages.

CONCLUSIONS

Extension activities to disseminate the information on BMPs and adoption of these BMPs by farmers showed significant improvement in the success of farmers by resulting in better crop outcomes and reduced emergency harvests, which is indicative of a disease outbreak. Cluster farm management approach by promotion of farmer 'Aquaclub' proved that unity and farming discipline among shrimp farmers can effectively contain the diseases at village cluster level. It is important that the study team socializes with the farmers to effectively disseminate the BMP information and motivate the farmers to quickly adopt them. Therefore it is essential to organize active extension programme to promote BMPs and cluster management approach for shrimp farming.

ACKNOWLEDGEMENTS

We thank the farmers of West Godavari district of Andhra Pradesh for their co-operation during the study period. We acknowledge the valuable services rendered by MPEDA/NACA technical assistants - Mr. Goda Ravi, Mr. Kanapala Ravi, Mr. Venkateswarulu and Mr. Sriranga Babu. We thank Mr. Mongkhon Primpon, Thailand and Mr. Umesh N.R. for their support. We would like to express our gratitude to the Chairman and the Director of the MPEDA, the Director-General of NACA, Bangkok, Thailand for their continuous support to carry out this study. We also acknowledge the support of the Australian Centre for International Agricultural Research (ACIAR) for this study through its project FIS/2000/061. This presentation was supported by the Fish Health Section of the Asian Fisheries Society (FHS-AFS), the Philippines, by awarding a travel grant to the first author. We are grateful to FHS-AFS.

REFERENCES

Chanratchakool, P., Turnbull, J., Funge-Smith, S.J., MacRae, I.H. and Limsuwan, C., 1998. Health Management in Shrimp Ponds. Aquatic Animal Health Research Institute, Bangkok.

Corsin, F., Turnbull, J.F., Hao, N.V., Mohan, C.V., Phi, T.T., Phuoc, L.H., Tinh, N.T.N. and Morgan K.L. 2001. Risk factors associated with white spot syndrome virus infection in a Vietnamese rice-shrimp farming system. *Dis. Aquat. Org*. 47:1-12.

Karunasagar, I., Otta, S.K. and Karunasagar, I. 1997. Histopathological and bacteriological study of white spot syndrome in *Penaeus monodon* along west coast of India. *Aquaculture* 153: 9-13.

Leung, P. and Tran, L.T. 2000. Predicting shrimp disease occurrence: artificial neural networks vs. logistic regression. *Aquaculture* 187: 35–49.

Mohan, C.V., Shankar, K.M., Kulkarni, S. and Sudha, P.M. 1998. Histopathology of cultured shrimp showing gross signs of yellow head syndrome and white spot syndrome during 1994 Indian epizootics. *Dis. Aquat. Org.* 34: 9-12.

MPEDA/NACA 2001. Report on Phase 2 of MPEDA-NACA technical assistance on shrimp disease and coastal management. MPEDA, Cochin, India. pp. 20-27.

MPEDA/NACA 2002. Report on Phase 3 of MPEDA-NACA technical assistance on shrimp disease and coastal management. MPEDA, Cochin, India.

MPEDA/NACA 2003. A report on village demonstration programme 2003 for sector-wide impact of MPEDA-NACA study on shrimp disease and coastal management. MPEDA, Cochin, India.

MPEDA/NACA 2004. A report on village demonstration programme 2004. MPEDA, Cochin, India.

Padiyar, P.A., Phillips, M.J., Primphon, M., Chanratchakool, P., Bhat, B.V., Rao, V.S. and Cameron, A. 2005. Application of epidemiology to support better health management in black tiger shrimp *Penaeus monodon* aquaculture: an experience from India. *In* Walker, P.J., Lester, R.G. and Bondad-Reantaso, M.G. (eds.). Diseases in Asian Aquaculture V. Asian Fisheries Society, Fish Health Section, Asian Fisheries Society, Manila.

Padiyar, P.A., Phillips, M.J., Primphon, M., Mohan, C.V., Bhat, B.V., Rao, V.S., Ravi, B., Mohan, A.B.Ch., Murthy, G.N. and Chanratchakool, P. 2004. Extension in Shrimp health management: experiences from an MPEDA/NACA programme in Andhra Pradesh, India. *Aquaculture Asia*, July-September 2003 (Vol. 8, No. 3), pages 7-13.

Padiyar, P.A. 2005. Contract hatchery systems: A practical approach to procure quality seeds for Aquaclubs of small-scale shrimp farmers in India. *Aquaculture Asia*, July-September 2005 (Vol. 10, No. 3), pages 30-31.

Shankar, K.M., and Mohan, C.V., 1998. Epidemiological aspects of viral diseases of shrimp in India. *J. Aqua. Trop.* 13:43-49.

Subasinghe, R.P 2005. Epidemiological approach to aquatic animal health management: opportunities and challenges for developing countries to increase aquatic production through aquaculture. *Preventive Veterinary Medicine* 67:117-124.

Turnbull, J.F., Corsin, F., Mohan, C.V., Thakur, P.C., Padiyar, P.A., Madhusudhan, M., Hao, N.V. and Morgan, K.L. 2003. An epidemiological study of White Spot Disease in shrimp farms of Karnataka, India, pp. 232-242. Proceedings of the SVEPM Annual Conference, 31 March to 2 April 2003, Warwick (UK).