*Indian J. Fish.*, 68(4): 135-141, 2021
DOI: 10.21077/ijf.2021.68.4.105451-15

# Prioritisation of training needs of extension personnel in brackishwater shrimp aquaculture of Maharashtra, India

SANDESH V. PATIL AND ARPITA SHARMA*
*College of Fisheries, Dr. B. S. Konkan Krishi Vidyapeeth,Ratnagiri - 415 629, Maharashtra, India*
**ICAR- Central Institute of Fisheries Education, Versova, Andheri (W), Mumbai - 400 061, Maharashtra, India*
*e-mail: arpitasharma@cife.edu.in*

## ABSTRACT

Shrimp farming is the fastest growing food producing sector in the world. India stands at second position in shrimp farming. Amongst all the states, Andhra Pradesh ranks first and Maharashtra occupies sixth position. Maharashtra has a huge potential for the development of shrimp farming as out of 10,400 ha suitable farming area, only 13% is presently used. Regulation of shrimp farms is done by Department of Fisheries (DoF) and Coastal Aquaculture Authority (CAA). The DoF has a mandate to provide extension services, conducting training and demonstration for farmers and fishers. Training need assessment and subsequent capacity development are important for the efficient and effective performance of extension personnel. In this context, a study was undertaken with the objectives of assessing and prioritising training needs of fisheries extension personnel working in brackishwater shrimp aquaculture in Maharashtra. Out of the 72 fisheries extension personnel, information was collected from 55 fisheries extension personnel from the DoF, Maharashtra who were involved in brackishwater aquaculture development. Borich Need Assessment Model which relies on the extension agent's judgments about their own performances was used to assess the perceived level of importance and perceived level of competency for each training area using five point scales. Mean Weighted Discrepancy Scores (MWDS) were used for prioritisation. The prioritised training areas with reference to technical skills were shrimp disease management (MWDS=10.28), followed by shrimp farming with biofloc technology (MWDS=9.85) and biosecurity management (MWDS=9.65). In extension skills, the top three training areas were 'organising and managing trainings' (MWDS: 5.40), conducting demonstrations (MWDS: 4.27) and regulatory guidelines and standard practices in farming (MWDS: 4.10). In order to have sustainable shrimp farming development, it is necessary to design scientific capacity development programmes for the extension personnel based on training need assessment performed in a scientific manner.

Keywords: Borich model, Fisheries extension personnel, Maharashtra, Shrimp aquaculture, Training needs assessment

## Introduction

Brackishwater shrimp aquaculture is currently the fastest growing food-producing sector in the world. In Brackishwater shrimp aquaculture, Pacific white shrimp *Penaeus vannamei* is an extensively cultured penaeid shrimp species globally, due to the availability of specific pathogen free (SPF) seed, agreeable to different salinities and high stocking densities. In 2008, India government permitted the use of specific pathogen free (SPF) stock of *P. vannamei* for culture. Changing the cultured species from *Penaeus monodon* to *P. vannamei* resulted in revival of shrimp culture along the coast of Maharashtra, Andhra Pradesh as well as other coastal states. The farming area of *P. vannamei* has increased from 283 ha in 2009-10 to 93496 ha (2017-18) and the production has also increased from 1731 t to 6,22,327 t in 2017-18 (MPEDA, 2020).

Among all the coastal states, Andhra Pradesh ranks first with a total production of 5,70,235 t followed by West Bengal with total production of 77,668 t. Maharashtra occupies sixth position in cultured shrimp production with production of 6,567 t in the year 2019-20 (MPEDA, 2020). However, Gujarat ranked first in productivity per ha with an average production of 7.28 t $ha^{-1}$ $year^{-1}$ due to their superior infrastructure, biosecurity and adoption of better management practices. The productivity in Andhra Pradesh was 7.15 t $ha^{-1}$ $year^{-1}$ and in Tamil Nadu it was 4.9 t $ha^{-1}$ $year^{-1}$. Maharashtra is fourth in average shrimp productivity with production of 4.7 t $ha^{-1}$ $year^{-1}$. The national average productivity is 4.45 t $ha^{-1}$ $year^{-1}$ (MPEDA, 2020).

Shrimp farming industry was at its peak around 1994-95 throughout India, but collapsed due to white spot syndrome virus (WSSV) after 1995 (Patil *et al*., 2019). Introduction of *P. vannamei* during 2009 has revived the shrimp farming industry along the Indian coast and many abandoned farms were reclaimed and new farmers entered into shrimp culture. However, *P. vannamei* farming too has several risks due to poor farm management (Kumaran *et al*., 2015).

A study by Kumaran *et al.* (2012) revealed that 90% of Indian aqua farmers depend on private extension sources for information and information-seeking by the extension personnel was less than 50%. They also reported that public-funded fisheries extension services have been blamed as poor and responsible for the slow pace of aquaculture development in India. Kashem *et al*. (2001) reported that success in extension services largely depends on skills of extension workers. DoF, the nodal agency to provide extension service has more focus on their role of regulation and welfare works. Continuous updating of scientific and extension skills is necessary and an opportunity for the same is absolutely essential. Therefore, identification of gaps in skills of extension personnel in the form of training needs and subsequent capacity building is the best option to bridge the gap. In Indian context, training needs of extension personnel in Pacific white shrimp farming in the state of Andhra Pradesh, Gujarat and Tamil Nadu have been studied (Kumaran *et al.,* 2015).

However, in the state of Maharashtra, studies related to training need assessment of extension personnel was not done. Only a few studies like efficacy and constraints in adoption of *P. vannamei* culture practices by shrimp farmers of North Konkan region, Maharashtra (Salunkhe, 2018), adoption of shrimp health management practices by shrimp farmers of North Konkan region, Maharashtra (Sathe, 2008) and an economic analysis of shrimp farming in coastal districts of Maharashtra (Sadafule *et al.,* 2013) are reported, but not on training need assessments. In this context, a study was undertaken with the objective of assessing and prioritising training needs of fisheries extension personnel working in brackishwater shrimp aquaculture in Maharashtra.

## Materials and methods

A total of 72 fisheries extension personnel (Assistant Fisheries Development Officer, Fisheries Development Officers and Assistant Commissioner of Fisheries) are working in the Department of Fisheries (DoF), Govt. of Maharashtra. (DoF GoM, 2020). Out of these, 55 fisheries extension personnel working in the coastal districts of Maharashtra were randomly selected.

Personal attributes of fisheries extension personnel like age, gender, educational status, experience, trainings attended in shrimp farming and extension, source of information for aquaculture related knowledge, frequency of meetings with farmers and preferred mode of contact with farmers were collected and percentage analysis was done.

The operational context of 'need assessment' was taken from Altschuld and Kumar (2010) and Popham (1993). Focusing on gaps between current conditions and desired conditions, Borich Need Assessment Model (BNAM) was adopted relying on the extension personnels' judgments about their own performances. BNAM uses perceived level of importance and perceived level of competency for each training areas (Borich, 1980) and then using importance and competency scores, Mean Weighted Discrepancy Scores (MWDS) were computed. Prioritisation ranking was done as per the ascending order of MWDS. Researchers like Alibaygi and Zarafshani (2008) have also used BNAM to assess the training needs of Iranian extension agents. Use of Westinghouse Model called GETNA (1997) has been adapted for use in conjunction with Borich's model (Borich, 1980) to determine training needs. In the studies conducted by Conklin *et al*. (2002), the competencies were grouped into process skills and subject matter areas. However, Chizari *et al*. (2006) used the factor analysis method to identify and prioritise the training needs of multifunctional extension workers in Iran. To adopt BNAM, the present study involved developing an expert group who listed the training areas/competencies and assigned importance to each training area. Thereafter, the extension personnel recorded their perceived level of importance and competency in order to prioritise the training areas.

Best Management Practices (BMPs) given by the Coastal Aquaculture Authority (CAA) guidelines (CAA, 2005) were used as a frame of reference for listing technical skills in shrimp farming. To enlist the extension skills in shrimp farming, National Occupational Standards (NOS) qualification packs given on the official website of Agriculture Skill Council of India (ASCI) was used as the framework (ASCI, 2020).

An expert group consisting 15 personnel comprising of academicians (5), extension workers (5) and Government officials was formed, who identified the training areas required for technical and extension skills in shrimp farming from the above list of skills. In addition, they also listed other important training areas which are not included in the BMPs or ASCI framework. Once the list of training areas was prepared, each member of the expert group indicated the degree of importance for each training area on a five-point continuum scale with points 'not important, less important, medium important, more important and very much important' with scoring 0, 1, 2, 3 and 4, respectively. The Importance Weightage (IW) was worked out for the training areas based on the score given by the experts. IW was computed as the ratio of actual total score obtained to the maximum possible score. The IW was calculated using the formula:

$$I.W = \frac{\text{Very important response x 4 + More important response x 3 + Medium important response x 2 + Less important x 1 + Not important x 0}}{\text{Maximum possible score}}$$

A total of 16 training areas with IW of 0.5 or more were selected. In order to check if experts were in agreement or not Kendall's coefficient of concordance (W) was used as follows (Kendall, 1938):

$$W = \frac{12S}{m^2 (N) (N^2-1)}$$

where, W = The degree of association among experts; S = Sum of squares statistic over the row sums of ranks; m = No. of judges or respondents ranking the objects or attributes; N = No. of objects or attributes that is evaluated by judges or respondents; Kendall's W was found to be 0.78 which showed agreement among experts.

Out of the 16 selected training areas, 10 training areas were from technical skills. These were: site selection and design of shrimp farm, pond preparation and pre-stocking management, selection of quality shrimp seeds, acclimatisation and stocking, water quality and pond bottom management, feed and feeding management, shrimp disease management, harvesting and post-harvest handling, shrimp farming with biofloc technology, organic shrimp farming and biosecurity management in shrimp farming.

Under extension skills; 6 training areas with a IW score of 0.5 or more were: planning for extension advisories in brackishwater aquaculture, organising and managing training programs, standards and practices in farming, preparation of projects and extension articles, conducting demonstrations and dissemination of location specific technology.

Thereafter, BNAM was adopted wherein, perceived importance and competency of extension personnel towards these training areas was recorded. For assessing the importance, the scale used was, 0: not important, 1: slightly important, 2: moderately important, 3: important and 4: very important and for competency the scale used was, 0: not competent, 1: slightly competent, 2: moderately competent, 3: competent and 4: highly competent. Average score for each training area was calculated separately for perceived importance and competency.

Reliability of the importance and competency scales was tested using test-retest method. Test-retest reliability coefficient for importance and competency scale was 0.81 and 0.80 respectively indicating good reliability. Hence, scale was considered to be reliable.

Mean weighted discrepancy score (MWDS) was calculated to rank and prioritise the training areas as follows:

Discrepancy score (DS) = I - C

Weight discrepancy score (WDS) = I (I - C)

Mean weight discrepancy score (MWDS) = $\sum$ I (I - C)/n

where, I = Importance level, C = Competence level and n = Number of extension personnel.

## Results and discussion

It was found that 58.18% of the extension personnel were male, with an average age of 41 years with a range between 26 to 56 years. Majority (83.64%) had a post-graduate degree in Fisheries Science or Zoology. The average experience was 17 years with a range of 5 to 30 years.

Internet was the main source of information for majority (74.55%) of extension personnel followed by fisheries institutions like College of Fisheries, Ratnagiri, Marine Product Export Development Authority (MPEDA), ICAR-Central Institute of Brackishwater Aquaculture and ICAR-Central Institute of Fisheries Education (16.36%). About half (49.09%) of extension personnel had occasional meeting with shrimp farmers, while 32.73% extension personnel had met shrimp farmers once in a month. Mobile phones were used as a mode for contacting farmers by 58.18% of them and 32.73% preferred group meeting for contacting farmers.

It was found that 58.18% had not attended any formal training in scientific shrimp farming and 72.73% had not undergone any training in extension management. The perceived level of importance for training areas is presented in Table 1.

It is clear from Table 1 that out of 16 training areas; 15 areas had an average score above 2.45/4, suggesting that extension personnel perceived almost all training areas as important. Among technical skills; 'training on shrimp diseases and its management' scored highest (3.60/4) followed by 'biofloc technology' (score: 3.56/4) and 'biosecurity in shrimp farming' (score: 3.38/4).

Among extension skills; 'training on organising and managing trainings' scored highest with an average score of 3.13/4 followed by 'regulatory guidelines and standard practices in farming' (score: 2.89/3) and 'planning for extension advisories in brackishwater aquaculture' in fisheries (score: 2.82/3). It is thus clear that almost all the technical and extension training areas were perceived to be important by the extension personnel. In addition to the importance; competency scores were also recorded and are presented in Table 2.

Table 2 gives an insight of the competencies of extension personnel in the selected training areas. Out of the 16 training areas, only 2 technical skills 'selection of quality seed, acclimatisation and stocking', 'pond preparation and pre-stocking management' and 1 extension skill 'dissemination of location specific technology' recorded average score above 2 suggesting that they perceived themselves to be moderately competent in these areas.

Table 1. Perceived level of importance for training areas

| S. No. | Training areas | Score (Mean±SD) |
|---|---|---|
| A. | *Technical skills in shrimp farming* | |
| 1 | Shrimp diseases and management | 3.60±0.66 |
| 2 | Shrimp farming with biofloc technology | 3.56±0.71 |
| 3 | Biosecurity in shrimp farming | 3.38±0.76 |
| 4 | Harvesting and post-harvest handling | 2.98±0.73 |
| 5 | Organic shrimp farming | 2.98±0.80 |
| 6 | Feed and feeding management | 2.96±1.43 |
| 7 | Water quality and pond bottom management | 2.89±1.40 |
| 8 | Site selection and design of farm | 2.82±1.11 |
| 9 | Pond preparation and pre-stocking management | 2.62±1.05 |
| 10 | Selection of quality seed, acclimatisation and stocking | 2.44±1.30 |
| B. | *Extension skills in shrimp farming* | |
| 11 | Organising and managing trainings | 3.13±0.84 |
| 12 | Regulatory guidelines and standard practices in farming | 2.89±0.83 |
| 13 | Planning for extension advisories in brackishwater aquaculture | 2.82±0.92 |
| 14 | Conducting demonstration | 2.53±1.17 |
| 15 | Preparation of projects and extension articles | 2.45±1.03 |
| 16 | Dissemination of location specific technology | 1.85±0.99 |

Table 2. Perceived level of competency for training areas

| S. No. | Training areas | Score (Mean±SD) |
|---|---|---|
| A. | *Technical skills in shrimp farming* | |
| 1 | Selection of quality seed, acclimatsation and stocking | 2.36±1.21 |
| 2 | Pond preparation and pre-stocking management | 2.13±1.16 |
| 3 | Harvesting and post-harvest handling | 1.60±1.21 |
| 4 | Site selection and design of farm | 1.53±1.05 |
| 5 | Water quality and pond bottom management | 1.42±1.18 |
| 6 | Feed and feeding management | 1.20±0.93 |
| 7 | Organic shrimp farming | 0.96±0.38 |
| 8 | Shrimp farming with biofloc technology | 0.80±0.89 |
| 9 | Shrimp diseases and management | 0.75±0.91 |
| 10 | Biosecurity in shrimp farming | 0.53±0.60 |
| B. | *Extension skills in shrimp farming* | |
| 11 | Dissemination of location specific technology | 2.05±1.06 |
| 12 | Preparation of projects and extension articles | 1.67±1.25 |
| 13 | Regulatory guidelines and standard practices in farming | 1.65±0.95 |
| 14 | Organising and managing trainings | 1.44±0.98 |
| 15 | Planning for extension advisories in brackishwater aquaculture | 1.33±0.86 |
| 16 | Conducting demonstration | 1.09±1.02 |

For other 13 training areas, the scores were below 2 and so it is clear that they did not consider themselves competent in these areas. However, as per Table 1, the importance of training in these areas is perceived from moderate to high.

Table 1 and 2 presents the training gaps through a systematic process, based on which prioritising of training needs of extension personnel was computed. Keeping the importance and competency score as the base, MWDS was computed as explained in the methodology. The MWDS was used to rank and prioritise training areas for technical skills and extension skills and the same is presented in Table 3.

From Table 3, it is clear that the top three prioritised training areas with reference to technical skills were 'shrimp disease and its management' (MWDS: 10.28), 'shrimp farming with biofloc technology' (MWDS: 9.85) and 'biosecurity in shrimp farming' (MWDS: 9.65).

In extension skills, the top three training areas were 'organising and managing trainings' (MWDS: 5.40), 'conducting demonstrations' (MWDS: 4.27) and 'regulatory guidelines and standard practices in farming' (MWDS: 4.10).

This study has revealed that most prioritised training need for extension personnel of Maharashtra was 'shrimp diseases and its management'. This is also corroborated by the study of Kumaran *et al.* (2015) who also found that first ranked training need of extension personnel of Tamil Nadu and Andhra Pradesh was 'disease diagnosis and management'. Kumaran *et al.* (2011) also reported that disease diagnosis and management was important felt need of extension personnel working in Gujarat, Tamil Nadu and Andhra Pradesh.

It is known that disease incidence is one of the major risks in shrimp farming (*P. vannamei*) and it needs to be prevented and managed efficiently for sustainable farming (Arthur *et al.*, 2009). Venkateswarlu and Venkatrayulu (2019) in their study in Andhra Pradesh reported around 40% shrimp farms were affected by diseases. As per IntraFish (2019), shrimp production in India was expected to drop in 2019-20 between 20-30%. In the present study, extension personnel reported that shrimp farmers inform about the problems of disease outbreaks in *P. vannamei* at various stages. Emerging diseases like gut disease were also reported with low survival and poor growth even when farmers used SPF shrimps for culture. Thus, this was the reason that extension personnel were interested in training on shrimp diseases and its management and ranked it as the first prioritised training area.

Table 3. Prioritised training needs of extension personnel

| S. No. | Training areas | MWDS | Rank |
|---|---|---|---|
| A | *Technical skills in shrimp farming* | | |
| 1 | Shrimp diseases and management | 10.28 | 1 |
| 2 | Shrimp farming with biofloc technology | 9.85 | 2 |
| 3 | Biosecurity in shrimp farming | 9.65 | 3 |
| 4 | Organic shrimp farming | 6.02 | 4 |
| 5 | Feed and feeding management | 5.44 | 5 |
| 6 | Water quality and pond bottom management | 4.26 | 6 |
| 7 | Harvesting and post-harvest handling | 4.01 | 7 |
| 8 | Site selection and design of farm | 3.64 | 8 |
| 9 | Pond preparation and pre-stocking management | 1.29 | 9 |
| 10 | Selection of quality seed, acclimatisation and stocking | 0.97 | 10 |
| B | *Extension skills in shrimp farming* | | |
| 1 | Organising and managing trainings | 5.40 | 1 |
| 2 | Conducting demonstration | 4.27 | 2 |
| 3 | Regulatory guidelines and standard practices in farming | 4.10 | 3 |
| 4 | Planning for extension advisories in brackishwater aquaculture | 4.05 | 4 |
| 5 | Preparation of projects and extension articles | 1.92 | 5 |
| 6 | Dissemination of location specific technology | 1.3 | 6 |

'Shrimp farming (*P. vannamei*) with biofloc technology' was the second prioritised training need expressed by the fisheries extension personnel. It is reported that biofloc is nutritionally rich and balanced with good amount of protein, minerals and other micronutrients. Use of bioflocs as a fresh feed (*in situ* feeding) within the system is considered to be a low cost sustainable feeding tactic and is receiving popularity in farming of white leg shrimp around the world. Bioflocs not only act as feed, but also manages water quality with no additional cost (CIBA, 2019). There are success stories with bioflocs but it needs investment. Investments towards biofloc based shrimp farming unit of 0.1 ha requires an approximate expenditure of ₹15 lakhs as given in Pradhan Mantri Matsya Sampada Yojna (PMMSY) guidelines. Kumaran *et al*. (2015) also suggested training on biofloc technology in shrimp farming. Studies are reported in other countries also like Bossier and Eksari (2017) have stressed that in Belgium, biofloc technology is an emerging avenue in aquatic animal health care and nutrition. Realising the importance of this, it is to be noted that in India, special scheme has been launched under PMMSY for brackishwater aquaculture using biofloc technology (DoF GoI, 2020).

'Use of biosecurity measures in shrimp farming' was prioritised as third training area. It is known that biosecurity is one of the most important tools to prevent the outbreak of many infectious diseases. Khairnar *et al*. (2009) and Kumaran *et al.* (2015) have also highlighted this. They have suggested that following the BMPs can prevent the risk factors identified at various stages of shrimp farming from pond preparation to harvest. They reported that major cause for potential economic losses in shrimp industry was disease outbreaks and this economic loss can be minimised through use of biosecurity measures. It is known that effective biosecurity management practices reduce the probability of pathogen introductions and their subsequent dissemination (GAA, 2017). Lightner (2005) also reported that application of biosecurity concepts to shrimp aquaculture will contribute significantly to making the industry much more sustainable and environmentally responsible well into the future. Extension personnel were aware of the importance of this and so were interested to understand the science behind the biosecurity so that they will be in a position to explain to the farmers.

Various researchers have highlighted the importance of extension skills. Hoque and Usami (2008) found positive effects of training on skill development of agricultural extension workers in Bangladesh. In the present study, under extension skills, the most prioritised training area was 'organising and managing trainings' and 'acquiring skills for conducting demonstrations at the farm level' was the second prioritised training area. Azizah (2011) has highlighted the significance of training needs assessment of Agricultural Extension Officers to enhance their performance and the success of the program carried out by them in Indonesia and has also highlighted the importance of extension skills. It can be seen from the personal attributes of extension personnel that maximum were post-graduates with Master's Degree in Fisheries Science or Zoology. It was reported by them that other than one or

two courses of extension, they have not been exposed to extension methodologies and so they require trainings on these areas.

The third prioritised training area was 'regulatory guidelines and standard practices in farming'. The CAA has framed strict regulatory guidelines for the seed production and farming of *P. vannamei*. It includes exclusive registration for *P. vannamei* farming, periodical reporting of culture details, farming protocols and infrastructure requirements, waste water treatment pond and standards for waste water. Presently, it is mandatory that shrimp farms be registered either with the CAA or with the State Departments. Salunke *et al*. (2020) also stressed on the need of an appropriate regulatory framework to assure the survival of the shrimp industry and to meet export standards.

It is clear based on the training need assessment, that extension personnel are keen to learn about the latest developments in shrimp farming with reference to technical and extension skills. At present the DoF focuses more on regulatory role and less on providing extension advisories to the shrimp farmers. Shrimp farmers mainly depend on private extension services such as aquaculture consultants followed by input dealers for technical assistance (Patil and Sharma, 2020).

Capacity development of extension personnel involved in shrimp aquaculture is very important because they can bring desirable changes in the adoption behaviour of farmers by providing them latest knowledge and skills. For this, the DoF personnel should have the necessary professional competencies in addition to being a regulatory authority. This is all the more important with new technologies coming at a rapid pace for which farmers require constant technical support. Otherwise, alternative technical support mechanisms from market and industry will dominate, as the current trend shows.

In order to have sustainable shrimp farming development, it is necessary to design scientific capacity development programmes for the extension personnel based on importance and competencies. In a review by Jasim *et al.* (2016) it has been stressed that training programmes have to be planned well by the training institutes and Governments. These days this can be planned with minimum costs by using online methods as virtual training was found to be as good as regular trainings, in a study by Bertram *et al.* (2015).

Many training areas were considered important by extension personnel but they lacked competency in those training areas. 'Shrimp disease and its management', 'shrimp farming with biofloc' and 'biosecurity in shrimp farming' were the top three prioritised technical training needs. In extension skills, 'organising and managing trainings', 'conducting demonstrations' and 'regulatory guidelines/practices in farming' were prioritised training needs. The training need assessment of extension personnel of Maharashtra has indicated that they require technical skills at field level and extension skills to transfer the subject matter to the shrimp farmers. Hence, it is suggested that DoF communicates these training needs to the education and research institutions like College of Fisheries, Ratnagiri, ICAR Fisheries Institutes and other agencies. Already a number of training programmes are being organised by different organisations. These training programmes can be redesigned as per this study by giving stress on the prioritised training areas and learning by doing mode as well as in virtual mode.

## References

Alibaygi, A. and Zarafshani, K. 2008. Training needs of Iranian extension agents about sustainability: The use of Borich's need assessment model. *Int. J. Agric. Res*., 3: 681-687.

Altschuld, J. W. and Kumar, D. D. 2010. *Needs assessment: An overview*. Sage Publications, Inc., USA, 171 pp.

Arthur, J. R., Bondad-Reantaso, M. G., Campbell, M. L., Hewitt, C. L., Phillips M. J. and Subasinghe, R. P. 2009. Understanding and applying risk analysis in aquaculture. A manual for decision-makers. *FAO Fisheries and Aquaculture Technical Paper, No. 519/1*, Food and Agriculture Organisation of the United Nations, Rome, Italy, 113 pp.

ASCI 2020. *Agriculture Skill Council of India*. https://asci-india.com/ (Accessed 02 February 2020).

Azizah, S. 2011. Training needs assessment of agricultural extension officers in animal husbandry department of Malang Regency, East Java, Indonesia. *J. Agric. Ext. Rural Dev*., 3: 147-152. https://doi.org/10.5897/JAERD.9000075.

Bertram, J., Moskaliuk, J. and Cress, U. 2015. Virtual training: Making reality work? *Comput. Hum. Behav*., 43: 284-292. DOI:10.1016/j.chb.2014.10.032.

Borich, G. D. 1980. A needs assessment model for conducting follow-up studies. *J. Teacher Educ.*, 31(3): 39-42. https://doi.org/10.1177/002248718003100310.

Bossier, P. and Ekasari, J. 2017. Biofloc technology application in aquaculture to support Sustainable Development Goals. *Microbial Biotechnol.,* 10(5): 1012-1016. https://doi.org/10.1111/1751-7915.12836.

Chizari, M., Baygi, A. H. A. and Breazeale, D. 2006. Analysis of the training needs of multi-functional extension agents associated with sustainability. *J. Int. Agric. Ext.. Educ*., 13: 51-58.

CIBA 2019. *Central Institute of Brackishwater Aquaculture*. http://www.ciba.res.in/ (Accessed 22 March 2020).

Conklin, N. L., Hook, L. L., Kelbaugh, B. J. and Nieto, R. D. 2002. Examining a professional development system: A comprehensive needs assessment approach. *J. Ext.*, 40: 1-9.

DoF GoI 2020. *Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India.* http://dof.gov.in/ (Accessed 22 March 2020).

DoF GoM 2020. *Department of Fisheries, Govt. of Maharashtra.* www.fisheries.maharashtra.gov.in (Accessed 22 March 2020).

GAA 2017. *Global Aquaculture Alliance*. https://www.aquaculturealliance.org/advocate/cost-effective-biosecurity-crucial-shrimp-farming/(Accessed 22 March 2020).

Hoque M. J. and Usami, K. 2008. Effects of training on skill development of agricultural extension workers in Bangladesh: A case study in four Upazilas (Sub-districts) under Kishoreganj District. *J. Soc. Sci.,* 4(1): 21-28. DOI: https://doi.org/10.3844/jssp.2008.21.28.

IntraFish 2019 https://www.intrafish.com/aquaculture/indian-farmers-completely-clueless-as-new-shrimp-disease-spreads/2-1-647079 (Accessed 22 March 2020).

Jasim, M. S., Norsida Man, J. M., Lafta, A. H., Saleh, M. H., Salim, H., Nolila, M. N. and Bassim H. K. 2016. A review: Training requirement of agriculture extension officers in Iraq. *Asian J. Appl. Sci.*, 9: 34-40. DOI: 10.3923/ajaps.2016.34.40.

Kashem, M. A., Hossain, M. A. and Islam, M. S. 2001. Factors responsible for determining communication behaviour of the block supervisors. *Bangladesh J. Ext. Educ.*, 13(1&2): 137-142.

Kendall, M. G. 1938. A new measure of rank correlation. *Biometrika*, 30(1/2), pp.81-93. https://doi.org/10.1093/biomet/30.1-2.81.

Khairnar, S. O., Mali, K., Kapse, P., Deshmukh, A. and Solanki, B. 2009. *Biosecurity: Its application in shrimp farming*. http://aquafind.com/articles/Shrimp-Biosecurity.php.

Kumaran, M., Vimala, D. D., Chandrasekaran, V. S., Alagappan, M. and Raja, S. 2012. Extension approach for an effective fisheries and aquaculture extension service in India, *J.Agric. Educ. Ext.*. 18(3): 247-267. https://doi.org/10.1080/1389224X.2012.670442.

Kumaran, M., Krishnan, M. and Ravichandran, P. 2007. Extension services in coastal aquaculture: Need for a public and private partnership. *Indian J. Fish.*, 54(1): 75-83.

Kumaran, M., Kumar, J. A., Anand, P. and Paul, J. 2015. Training needs of extension personnel in Pacific white shrimp (*Litopenaeus vannamei*) farming. *Fishery Tech.*, 52(2015): 265-270.

Kumaran, M., Vimala, D. D. and Nagarajan, S. 2011. Perceived skill gaps of fisheries extension officers *vis-à-vis* shrimp aquaculture. *Indian J. Fish.*, 58(4): 147-153.

Lightner, D. V. 2005. Biosecurity in shrimp farming: Pathogen exclusion through use of SPF stock and routine surveillance. *J. World Aquac. Soc.*, 36(3): p. 229-248. https://doi.org/10.1111/j.1749-7345.2005.tb00328.x.

MPEDA 2020. *Marine Products Export Development Authority*. https://mpeda.gov.in/MPEDA/# (Accessed 31 March 2020).

Patil, S. V. and Sharma, A. 2019. Shrimp industry gender gap in India: Case of Maharashtra state. *J. Entomol. Zool. Stud.*, 7(6): 380-383.

Patil, S. and Sharma, A. 2020. Empirical analysis of constraint faced by shrimp farmers of Maharashtra. *J. Exp.. Zool. India*, 23(2):1867-1875.

Popham, W. J. 1993. *Educational evaluation,* 3rd edn. Allyn and Bacon, Needham Heights, Boston, USA.

Sadafule, N. A., Shyam, S. S. and Pandey, S. K. 2013. Economic analysis of shrimp farming in the coastal districts of Maharashtra. *J. Fish. Econ. Dev.*, 14(1): 42-54.

Salunkhe, A. B. 2018. *Efficacy and constraints in adoption of Littopenaeus vannamei (Boone, 1931) culture practices by the farmers of North Konkan region of Maharashtra*. M. F. Sc. Thesis*,* Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India, 89 pp.

Salunke, M., Kalyankar, A., Khedkar, C. D., Shingare, M. and Khedkar, G. D. 2020. A review on shrimp aquaculture in India: Historical perspective, constraints, status and future implications for impacts on aquatic ecosystem and biodiversity. *Rev. Fish. Sci. Aquac.,* 28(3): 1-20. https://doi.org/10.1080/ 23308249.2020.1723058.

Sathe, A. R. 2008. *Adoption of shrimp health management practices in the North Konkan region of Maharashtra.* M. F. Sc. Thesis, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India, 96 pp.

Venkateswarlu, V. and Venkatrayulu, C. 2019. Prevalence of disease problems affecting shrimp *Litopenaeus vannamei* farming in Andhra Pradesh, India. *Int. J.Fish. Aquat. Stud.*, 7(5): 275-279.

Date of Receipt : 30.09.2020
Date of Acceptance : 01.10.2021