ICAR-CIBA Extension Series No. 88

Farming of Indian white shrimp, *Penaeus indicus* and winter farming of whiteleg shrimp, *Penaeus vannamei* in South Gujarat



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NAVSARI-GUJARAT RESEARCH CENTRE
ICAR- CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Indian Council of Agricultural Research)
1st Floor, Animal Husbandry Polytechnic,
Navsari Agricultural University Campus,
Eru Char Rasta, Navsari, Gujarat - 396 450.

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Dr. K.P. Jithendran
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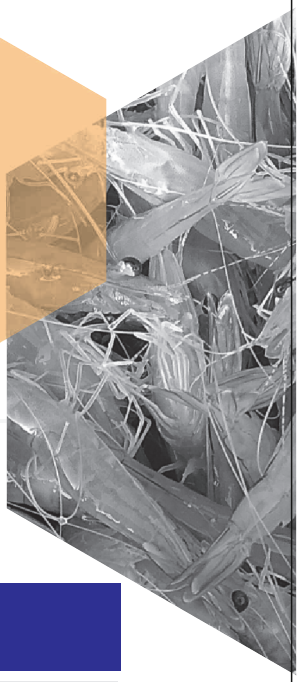
Prepared by

Jose Antony
Tanveer Hussain
Pankaj A. Patil
P. Mahalakshmi
Biju Francis
P.S. Shyne Anand
A. Panigrahi
C.P. Balasubramanian
K.P. Jithendran

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1.Farming of Indian White Shrimp, *Penaeus indicus*

Brackishwater aquaculture in India is synonymous with shrimp farming and a single species i.e., whiteleg shrimp, *Penaeus vannamei* dominates the Indian shrimp industry. *Penaeus vannamei* is a non-native species, with natural populations inhabiting the pacific coast of North America. This species is also the largest farmed species of shrimp around the world in terms of production and area under culture. However, off late the culture of *P. vannamei* in India has been seriously affected by an array of issues like emerging diseases, poor growth, lower success rates, higher incidence of viral diseases and rising productions costs resulting in poor production and profitability. Several of these issues are due to over dependence on a single species. Indian white shrimp, *Penaeus indicus* is an indigenous candidate shrimp species that can be economically grown in brackishwater regions of the country. Farming of *P. indicus* ensures diversification in the sector, apart from acting as a supplementary species to the exotic *P. vannamei* to sustain the Indian farmed shrimp production. Most shrimp farming regions in the Gujarat coast experience high salinities and *P. indicus* has a preference for higher salinities, thus making it a suitable species for the Gujarat coast. Semi-intensive farming of *P. indicus* singly (monoculture) or in combination with other brackishwater finfish (polyculture) is also an alternate livelihood opportunity for coastal tribal communities. Though shrimp farming in India started with *P. indicus* as the species of choice in late 80s and early 90s, it was gradually replaced by other penaeid shrimp. Farming practices and husbandry of *P. indicus* especially at medium stocking densities of up to 30-35 PL/m^2 requires to be standardised and compared with production parameters of *P. vannamei* for large scale farming. ICAR-CIBA, through its pilot project initiatives has demonstrated the farming of *P. indicus* in coastal regions of all maritime states in the country over the years and has carried out research to standardize farming practices for the species in varied agro-climatic conditions. This extension series is based on our experiences from the farming of the species and would provide technical knowhow to prospective Indian white shrimp farmers.

1.1. Species

Shrimp aquaculture in India began with the Indian white shrimp in the 80s and 90s and gradually gave way to the fast-growing tiger shrimp, *Penaeus monodon*, and subsequently to *P. vannamei* post 2009. *Penaeus indicus* is a fast-growing shrimp and post larvae (PL) produced from captive wild caught brooders exhibit similar growth characteristics as compared to domesticated SPF whiteleg shrimp up to 10-12 g average body weight (ABW) after which growth slows down at higher densities. *P. indicus* is a euryhaline shrimp that can grow optimally at salinities ranging from 5 ppt to 55 ppt. Several studies reveal that the species demonstrates a preference for hyper saline environments. The species attains an ABW of 16 to 18 g in 140 to 150 days of culture (DOC) at densities of 30-35 PL/m^2. Indian white shrimp is also amenable to high stocking densities, although commercial operations restrict stocking densities to 30 PL/m^2. However, there are reports of production to the tune of 16-18 tonnes/ha/crop for this species at high stocking densities. Being a native species, producing disease-free stocks would be comparatively cheaper for *P. indicus*. There is also an added advantage that the Indian white shrimp is not the natural host for a range of diseases that affect the whiteleg shrimp.



Indian White Shrimp, *Penaeus indicus*

1.2. Site selection

Standard procedures followed for identifying suitable sites for shrimp farming holds good with the farming of Indian white shrimp as well. The optimal water and soil quality parameters required for the culture of *P. indicus* is shown in table 1. Site selection for shrimp aquaculture shall also follow the regulations laid out by the Coastal Aquaculture Authority (CAA) and all shrimp farms must be registered with the CAA.

Table 1: Optimum water and soil quality parameters for Indian white shrimp farming

	Water quality variables		Soil Quality parameters	
Sl.No.	**Parameter**	**Optimum range**	**Parameter**	**Optimum range**
1	Salinity	10 to 25 ppt (Range 5 to 55 ppt)	Soil type	Sandy clay, clay loam or sandy clay loam
2	pH	7.5 to 8.5	Soil pH	6.5 to 7.5
3	DO	>4 ppm	Organic carbon	1.5 to 2.0%
4	Temperature	23 to 32°C	Calcium carbonate	>5%
5	Alkalinity	150 to 200 ppm	Electrical conductivity	>4 dS m^{-1}
6	Ammonia (NH_3-N)*	<0.25 ppm		
7	Nitrite (NO_2-N)*	Depends on salinity		

**P. indicus can tolerate and exhibit normal growth/survival in media with NH_3-N (TAN) levels of up to 0.5-0.75 ppm, although maintaining the TAN levels at less than 0.25 ppm is recommended. Maximum tolerable levels of NO_2-N at any given salinity is the concentration of chlorides in the medium expressed in ppt divided by two and expressed as ppm. For example, in a medium of salinity 35 ppt, containing 19500 ppm (19.5 ppt) of chloride, shrimp can tolerate NO_2-N levels of up to 19.5/2=9.75 ppm and normal growth/survival can be observed up to 4.8 ppm. (To be used as thumb rule)*

1.3. Pond design considerations

Ponds shall be provided with a water outlet structure (monk or sluice gate) for ease of harvesting and water exchange. Ponds shall have a design water depth of 2.2 to 2.5 m in order to hold 1.5 to 1.8 m of water. Indian white shrimp churns up the mud and lose clay from the pond bottom due to their aggressive feeding behaviour resulting in high clay turbidity of over 100 NTU. Therefore, maintaining a greater water depth of over 5 feet is recommended for the farming of the species in earthen ponds with clayey soil. Clay or mud loosened from the bottom remains in suspension due to aeration and would be difficult to control once levels go beyond certain limits. Ponds built in clayey soils may therefore be subjected to sufficient compaction using heavy compaction machinery to control turbidity. A free board of 30-50 cm may be provided in the dyke to prevent over topping during heavy rains or winds. Pond bottom slope of 1% may be provided towards the water outlet structure. Rectangular or square shaped ponds may be used for *P. indicus* culture and the recommended pond size is 0.4 ha or 4,000m^2. Lined ponds may also be employed for rearing of *P. indicus*. Reservoir pond(s) of appropriate size based on the area and number of the growout ponds may also be constructed to ensure biosecurity.





1.4. Pond preparation

Pond bottom soil should be allowed to dry and crack after harvest of the previous crop and fallow period (inter crop duration) of 30-40 days may be provided. Sludge on the pond bottom may be removed and placed away from the dykes. The pond bottom soil may be tilled using a cultivator and excessive soil at the bottom or dyke sides that has settled down as a result of rainfall, aeration and gravity, shall be lifted and placed back on to the dykes for strengthening using a levelling tractor or dozer. Depending up on the pH of the pond bottom soil and the quantity of organic matter present, liming shall be performed and the soil may be tilled again for proper mixing. Following this, pond bottom may be compacted using a tractor or other heavy machinery depending up on the stocking density and proposed number of aerators to be installed (targeted biomass).Following this water filling shall be initiated.

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1.5. Biosecurity and water treatment

Biosecurity is vital for any form of shrimp aquaculture. Reservoir pond(s) of required size and depth based on the number and area of grow out ponds is mandatory. Water pumped in to the reservoir pond may be allowed to settle for 1-2 days prior to disinfection. In case of excessive clay turbidity in source water creek, Poly aluminium chloride (PAC) may be applied to the pond water @3-5 ppm. Excessive organic matter in the source water can be treated using application of potassium permanganate ($KMnO_4$) @1-2 ppm. Disinfection of water filled in the ponds may be carried out using bleaching powder (preferably triple packed, containing 33% free/available chlorine) or other chlorine derivatives and disinfecting agents. Bleaching powder may be applied at a dosage resulting in 15 ppm free chlorine levels in the pond water. During periods of intense sunshine, no free chlorine radicals would exist in the pond water after 48-72 hours and in the case of cloudy weather the water may be agitated using a paddle wheel aerator for fast dissociation of free chlorine derivatives. Presence of free chlorine in

the medium may be additionally tested using a simple colorimetric test involving o-toluidene reagent available with most chemical reagent manufacturers. Once all free chlorine residuals in the water are lost, fertilisation and application of soil /water probiotics may be carried out according to the existing water quality parameters. In sandy and loamy soils, nutrients can get trapped in the sediments, preventing development of the bloom despite fertilisation. In such cases, chain dragging of the pond sediment using a heavy chain can be performed for improving sediment quality and initiation of phytoplankton bloom. The dike of the growout and reservoir ponds shall be secured with crab fencing to prevent the entry of crabs into the shrimp pond. Materials like shade net, PVC netting, PE netting of small mesh, 120-150 gsm plastic sheet, etc. can be used to erect the crab fencing. Bird fencing using large meshed nylon netting or nylon twines may be erected on the upper side of the pond to prevent entry of birds in to the ponds. Biosecurity measures are carried out to prevent the entry of external pathogens in to the shrimp pond. Foot dips, hand wash, and tyre baths may also be provided at the farm for disinfection of farm tools, and labourers etc.



1.6. Fertilisation

The disinfected water may be fertilised using inorganic fertilisers, organic juice (fermented rice bran) or commercial plankton booster formulations. ICAR-CIBA has developed a plankton booster formulation viz., CIBA-Plankton^{Plus} made from fish slaughter waste, that has been giving excellent phytoplankton and zooplankton bloom to the shrimp pond, resulting in high survival, lower FCR and faster growth of the stocked PL. Fertilisation may be repeated in case the bloom fails to develop. Stocking shall be carried out once sufficient bloom has been observed or the water transparency reaches 25-40 cm. Water quality analysis shall be carried out prior to stocking. If the bloom fails to develop, even after repeated fertilisation, liming and chain dragging may be carried out. Liming can also be done in the case of water pH being less than 8.0. Liming of the rearing medium for raising pH may be done using calcium carbonate or hydrated lime. Aerators may be switched on during fertilisation to ensure uniform distribution of the contents around the pond.



1.7. Stocking

Hatchery reared *P. indicus* PL8 to PL12 (08 to 12 days after becoming PL) are ideal for stocking to growout ponds. The PL shall be screened for WSSV, EHP and IMNV prior to stocking using standard PCR techniques. The seed shall be acclimated to the required salinity in the hatchery and transported to the growout pond. In case the pond water salinity is more than 35 ppt, seed may be transported at 30-35 ppt and the PL can be acclimated to the higher salinity at the pond site. In such cases keep an FRP tank, aquarium blower and oxygen cylinder handy for acclimation process. During acclimation, salinity shall be increased at a rate of not more than 4 ppt/hour and the seed can be released in to the pond by siphoning.Similar procedure, may also be followed in case of hatcheries that are unable to provide seed at lower salinities. However, in case of salinity reduction below 10 ppt, the rate shall not exceed 3 ppt/hour. It is recommended to have a stocking density not exceeding 30 PL/m^2 for *P. indicus* farming.



Healthy post larvae of *Penaeus indicus*

1.8. Feeding and water quality management

Commercial Indian white shrimp formulated feeds are not available in the market and hence *P. vannamei* feed may be used. ICAR-CIBA has developed a formulated feed for *P. indicus*, based on the nutritional requirements of the species that has a higher crude protein level than commercial white shrimp feed. Crumbled feed may be broadcasted until the ABW reaches 3.5 g following which pelleted feed shall be broadcasted. Feed shall be broadcasted 4-5 times a day in equal or varying ration sizes. Blind feeding shall be carried out until 30 DOC and subsequently feed volume shall be adjusted based on the average body weight, estimated survival rates, and check tray observations. For a unit of 4,000m^2, four check trays may be installed for optimal recording of feed data. Water and soil probiotics may be applied once every fortnight based on water and soil parameters. Additionally, application of organic juice may be carried out weekly or fortnightly to maintain optimum water quality and C:N ratio in the water. The addition of mineral supplements in feed or water and other feed supplements like Vitamin C or immuno-stimulants may be given depending on the health status of the animal and shall not be broadcasted unnecessarily to minimise production costs.





Aerators shall be operated continuously from 30 DOC onwards during the late evening and early morning hours.
Subsequently, operation of aerators shall be regulated depending on ABW, DOC, estimated biomass, weather conditions etc. As a thumb rule 1HP aeration is required for 300 kg of biomass. Feeding behaviour of *P. indicus* is different from that of *P. vannamei* as the later would consume larger quantity of feed, owing to its genetic growth traits. Commercial farming trials of Indian white shrimp has indicated that the species has a peak feed consumption only for 4-5 days aftermoulting (early intermoult period) and subsequently consumes less feed (30-35% drop) for another 10-12 days until next moulting. Feed consumption is affected by external and abiotic factors like water temperature, rainfall and lunar rhythms. During intense rainfall, feed consumption is reduced by 35-40% and prolonged drop in feed uptake is noticed during rainy season. Daily and weekly growth rate would come down severely during such rainy spells and hence prospective farmers are suggested to plan crops such that harvest is scheduled prior to or during the first rains.

1.9. Sampling and check tray observations

Sampling of shrimps shall be carried out on a weekly basis starting from 30 to 45 days of culture for assessment of growth and health status. Sampling can be carried out using smaller-meshed cast net during the initial period of culture and may be replaced by a larger-meshed one towards the 2nd half of the culture. Sampling shall be ideally carried out during the early morning hours before intense sunshine to minimise stress on the shrimp. Individual weighing of shrimp or combined weighing may be followed during sampling to calculate the weekly and daily growth rate. Cast nets may be broadcasted in any suitable region of the pond and sampling points may be changed regularly. Sampling may also be conducted to check the physiological status of the shrimp i.e., moulting, disease occurrence etc., especially during a reduction in feed intake or occurrence of mortality in the pond. Check trays (0.8 to 1.0 m^2 area, circular/square shaped, depth 8-10 cm, 40-mesh screen) is the most important tool used in a shrimp farm for feed management. A 4000 m^2 pond may be ideally provided with 4 such trays. Since, the overall success of shrimp farming depends on feed and water quality management, check tray estimation is an essential tool for successful operation.



Sturdy cat walks or other structures may be constructed for installing the check trays, so that farm workers can freely move and take observations from the tray. Check tray frames shall be constructed using light weight galvanized iron, stainless steel or aluminium so that farm workers can lift the trays easily during all feeding sessions. Check trays shall be placed in the pond from 15 DOC and some feed may be put in to the trays to train the shrimp to feed from the check trays. However, after 30 DOC, weighed quantities of feed may be placed in the trays and observations are to be made after stipulated time periods to ascertain feeding status of the shrimp. The quantity of feed added to the trays and the checking period is a function of the DOC, feed code and animal size. Most feed manufacturers provide this information in their feeding charts. Check trays with feed shall be lowered from the cat walks only after completion of the feeding. Pond bottom quality shall also be monitored on a weekly basis as in the case of pond bottom soils with higher sludge accumulation and H_2S loading, the shrimp may have a tendency to consume the feed in the check trays prior to those broadcasted in the bottom. This causes faulty check tray observations resulting in feed wastage and water quality deterioration. The feeding strategy to be followed in a *P. indicus* growout pond, based on check tray observations is shown in table 2.



Sampling of shrimp from growout pond



Check tray observation

Table 2: Feeding strategy based on check tray observations for *P. indicus* growout pond of size 4,000m^2 equipped with four trays.

CHECK TRAY OBSERVATIONS				Feed adjustment
Tray 1	Tray 2	Tray 3	Tray 4	
C	C	C	C	Increase feed by 10%
C	C	C	U	Continue same feeding
C	C	U	U	Reduce feed by 20%
C	U	U	U	Reduce feed by 40 %
U	U	U	U	Reduce feed by 50-60%

* C: Fully consumed trays; U: Trays with leftover feed

1.10. Disease management

Maintaining optimal water quality parameters in the pond is pivotal for disease management. There are an array of viral diseases that can cause large scale mortality in shrimp ponds for which no treatment exist. Outbreak of viral diseases can be controlled only through rigorous biosecurity, selection of disease-free PCR screened seed, usage of certified products and proper management. Bacterial infections especially Vibriosis causes significant losses during the culture and arise mostly due to poor water quality, stressed shrimp and over feeding. Most diseases can be prevented through maintenance of optimal water quality and proper feed management. In case of severe bacterial infections, application of permissible antibiotics (CAA guidelines) may be carried out at requisite levels. The withdrawal period of these antibiotics shall also be kept in mind before harvest to avoid antibiotic residue in shrimp muscle. Continuous and repeated application of antibiotics may be avoided.



1.11. Harvest and economics

Penaeus indicus attains an average body weight of 16-20 g in 120-150 DOC and can be harvested based on market conditions. Indian white shrimp fetches a similar or higher price than the exotic *P. vannamei*. From a 4000 m^2 pond stocked with 1.2 lakh PL (30 no./m^2), a total production of 2 to 2.5 tonnes shall be obtained when shrimp of 55 to 65 count are harvested. Depending on the farm gate price an average profit of ₹1.0 to 1.5 lakhs/ha/crop can be realised through the farming of *P. indicus*. Economics of *P. indicus* farming operation during a commercial farming trial in a 1-acre pond in Navsari, Gujarat during the year 2019 (June-Oct, 2019) is listed below for reference (Table 3).



Table 3: Economics of *P. indicus* farming in a 1-acre pond stocked with 1.2 lakh PL. Data based on a commercial farming trial carried out at NGRC farm, Matwad, Navsari, Gujarat in 2019.

Capital Investment	Amount (₹)
Pond construction	45,000
Pumps, engine, pipelines and motors	55,200
Generator (25 KV)	1,80,000
Aerator	1,08,000
Electrical lines and circuit	20,000
Farm tools and accessories	10,500
Total capital investment	**4,18,700**
Fixed cost	**Amount (₹)**
Lease value/rental	1,000
Depreciation on capital investment	41,870
Interest on capital investment	26,168.75
Repair and maintenance	15,000
Total fixed cost	**84,038.75**
Variable cost	**Amount (₹)**
Pond preparation	10,000
Cost of PL	52,000
Feed cost	2,34,300
Fertilizer	3,950
Chemicals	25,800
Probiotics	56,260
Fuel and electricity charges	72,900
Labour	35,000
Harvesting charges	5,120
Transportation	4,200
Miscellaneous cost	3,690
Total variable cost	**5,03,220**

Gross returns	Amount (₹)
Total yield	2,053 kg
Rate/kg	310
Gross return	**6,36,430.00**
Economic parameters	**Amount (₹)**
Total gross return	6,36,430
Total fixed cost	84,038.75
Total variable cost	5,03,220
Total cost	**5,87,258.75**
Production cost	286
Net return on TC	49,171.25
Net return on TVC	1,33,210
BCR on TC	1.08
BCR on TVC	1.26
Rate of return on capital investment TC basis	8.37%
Rate of return on capital investment TVC basis	26.47%
Total revenue (₹/ha/crop)	**1,22,928**
Total revenue (₹/ha/year)	**2,45,856**



2. Winter farming demonstration of whiteleg shrimp, Penaeus vannamei in South Gujarat

South Gujarat region in the Gujarat state enjoys a fair winter wherein night temperatures drop to as low as 10-12°C. Winter season in Gujarat extends from November to February. South Gujarat forms the most intensive shrimp farming region in Gujarat where maximum number of farms are located adjacent to each other. Shrimp farming in Gujarat comprises of two farming seasons i.e., 1st crop from March to June, and a 2nd crop that is practiced by few farmers, from July-August to November-December. Winter season is traditionally a closed season for shrimp farming in Gujarat after harvesting shrimp from the 2nd crop during October to early December. Winter season in Gujarat coincides with the drying of ponds, pond preparation and other preparatory work for the next crop. Ponds remain idle during the period and due to no farming activity, all input suppliers also shut down. Low water temperatures and an assumption of poor growth of shrimp are the major factors that force farmers to discontinue farming during the winter. However, such presumptions or hypothesis needs to be validated before drawing valid conclusions. To evaluate the feasibility of farming whiteleg shrimp, *P. vannamei* during the winter season, NGRC of CIBA carried out a commercial farming trial for the species at its research farm in Matwad Village, Navsari Dist., Gujarat.

A 4,000 m^2 (1-acre) earthen pond was selected for the farming trial. After pond preparation and pre-stocking management, *P. vannamei* post larvae (PL), 7 days old (PL7, average body weight≈ 1 mg) was stocked in to the pond during evening hours of 23rd October, 2020. Night and early morning



temperatures start dropping in Gujarat from mid-October whereas actual winter starts from November and extends until mid-February. The experimental trial was planned such that the entire rearing period falls within the winter season (23rd Oct, 2020 to 19th Feb, 2021). A total of 1.3 lakh PL was stocked in to the pond at a stocking density of 33 individuals/m^2. The seed was sourced from a CAA approved shrimp hatchery (SPF brood shrimp: Shrimp Improvement Systems, Hawaii) and was tested negative for WSSV and EHP through PCR screening. The PL were initially stocked in to four large hapas (5 m x 5 m x 1 m) installed in the same growout pond for nursery rearing, wherein PL was stocked at a density of 1850 individuals/m^3. After a week of nursery rearing, advanced PL were stocked in to the pond.

The shrimp were fed using ICAR-CIBA's formulated white shrimp feed, CIBA-Vanami^{plus} (crude protein:35%) during the entire rearing period. Salinity during the trial ranged from 9 ppt at the time of stocking to 24 ppt at the time of harvest (after 120 DOC on 19/02/2021). Large diurnal variations in the atmospheric temperature were evident during the rearing period where the average day and night temperatures were 30.96 ± 0.26°C and 19.62 ± 0.24°C respectively. The highest and lowest atmospheric temperature experienced during the period was 36°C and 13°C respectively. The mean water temperature at early morning (05:00 to 07:00 hours) late afternoon (15:00 to 17:00 hours) and night (21:00 to 23:00 hours) during the trial was 21.92 ± 0.23°C, 25.37 ± 0.42°C, and 23.50 ± 0.21°C, respectively. The lowest water temperatures recorded during the day and early morning was 22.5°C and 17.9°C, respectively. The highest water temperatures recorded during the day and early morning hours were 27.2°C and 24.1°C, respectively.

The shrimp were fed four times in a day (0730, 1130, 1530, and 1930 hours). The morning feed was delayed until day break for water temperatures to rise. Starting from 45 DOC, the shrimp feed was supplemented using Vitamin C and a mixture of mannan oligo saccharide, ß 1-3 glucan, and ß 1-6 glucan (Saffmannan®, Phileo, Lesaffre, France) at 5g/kg feed for two feeding sessions i.e., Vitamin C at 1130 hours and Saffmannan® at 1530 hours. The supplementation of feed was performed to enhance the immunity of the shrimp and increase its resistance to stressful conditions which in this case was extremely low water temperatures. The supplementation of feed using sugars and vitamins were done during the 2nd and 3rd feeding sessions of the day, to coincide with increasing water temperatures that would trigger a greater feed intake. Water quality parameters were adequately maintained throughout the culture period and TAN

values never exceeded 0.15 mg/L. Fermented rice bran produced using anaerobic probiotic bacteria was applied at 1 mg/L twice weekly apart from the direct application of soil and water probiotics on a biweekly basis.

2.1. Harvest and economics

The shrimp attained a mean body weight of 8.54 g by 64 DOC and 16.76 g by 90 DOC. At the end of 120 days of rearing, shrimp attained a mean body weight of 20.88 g equivalent to 48 count (Fig.1). The winter farming trial resulted in total production of 2,633 kg of shrimp. The survival rate and FCR observed during the trial were 97.00 % and 1.069 respectively. During the trial, the average weekly and daily growth rate stood at 1.2 g/week and 0.1738 g/day, respectively. Interestingly, even during peak winter from the last quarter of December to the 3rd quarter of January (64 to 90 DOC), wherein water temperatures remained the lowest, the average weekly growth rate observed was 2.01 g/week.

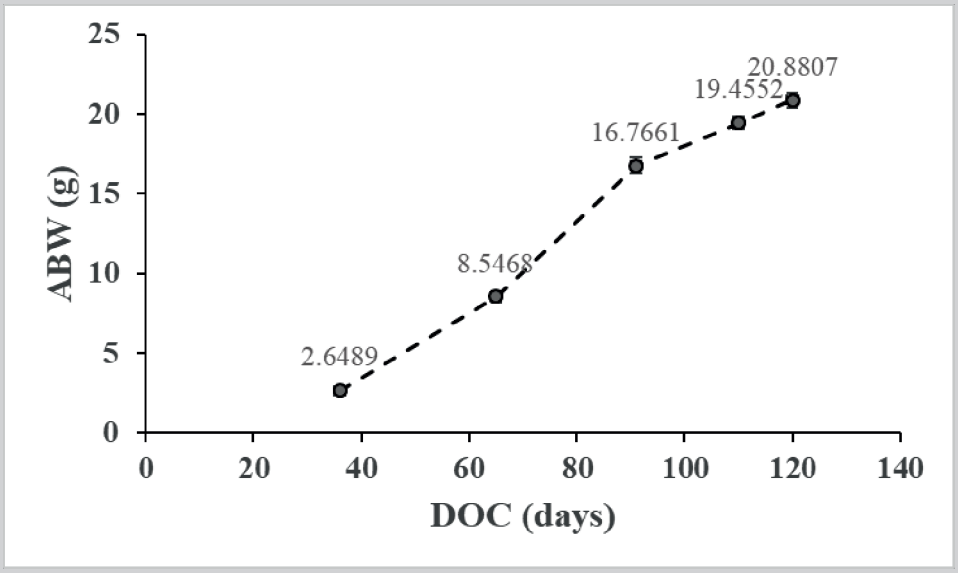


Fig. 1: Growth characteristics of *Penaeus vannamei* during the winter farming trial

These results suggest that farming of *P. vannamei* can also be carried out during the winter season in south Gujarat. Shrimp produced as part of the trial realized a revenue of ₹9.58 lakhs. An economic evaluation of the experiment indicated that the trial resulted in a net return of ₹3.19 lakhs with a production cost of ₹242/kg and a profit margin of ₹122 for each kilogram of shrimp produced (Table 4). Overall productivity and total revenue were estimated to be 6.58 tonnes/ha and ₹7.99 lakhs/ha/crop.



Penaeus vannamei attained an ABW of 20 g in 120 DOC during the winter farming trial

Table 4: Economics of P. vannamei farming trial during the winter season in South Gujarat region, in a 1-acre pond stocked with 1.3 lakh PL. Data based on a commercial farming trial carried out at NGRC farm, Matwad, Navsari, Gujarat in 2020-21.

Capital Investment	Amount (₹)
Pond construction	60,000
Pumps, engine, pipelines and motors	85,000
Generator (25 KV)	1,80,000
Aerator	1,08,000
Electrical lines and circuit	30,000
Farm tools and accessories	10,500
Total capital investment	**4,73,500**
Fixed cost	**Amount (₹)**
Lease value/rental	1,000
Depreciation on capital investment	47,350
Interest on capital investment	35,512.50
Repair and maintenance	15,000
Total fixed cost	**98,862.50**
Variable cost	**Amount (₹)**
Cost of PL (80,000 nos)	48,000
Cost of Feed (2816.1 kg)	1,88,143
Rice bran, jaggery, and other miscellaneous	19,624
Chemicals	55,392
Minerals	10,109
Probiotics	37,958
Diesel	21,500
Labour	63,000
Harvesting charges	3,000
Biosecurity	22,000
Transportation	6,000
Electricity charges	65,000
Total variable cost	**5,39,726**

Mean production and gross returns	Amount (₹)
Total yield	2,633 kg
Rate/kg	364
Gross return	**9,58,412.00**
Economic parameters	
Total gross return	9,58,412
Total fixed cost	98,862.50
Total variable cost	5,39,726
Total cost	6,38,589
Production cost	**242.50**
Net return on TC	3,19,82
Net return on TVC	34,18,68
BCR on TC	1.50
BCR on TVC	1.77
Rate of return on capital investment TC basis	50.08
Rate of return on capital investment TVC basis	77.57
Total revenue (₹/ha/crop)	7,99,558
Total revenue (₹/ha/year)	15,99,116

Growth rate and the total shrimp production during the trial were economically viable and profitable. Considering the scenario of shrimp farming in South Gujarat over the last few years wherein the industry was plagued by issues of emerging diseases, low survival and poor growth rate, production parameters obtained during the winter season as part of this trial opens up a prospective opportunity to farmers in the region. Although growth rate of the shrimp was lower when compared to shrimp raised during summer, growth parameters observed during the winter were adequate for raising shrimp economically. It should also be noted that, growth and production achieved during winter as part of this trial, was superior to production performances reported by most farmers during the summer crop in South Gujarat over the last few years. However, prospective farmers shouldchoose the best quality PL for stocking and take special care on improving the immune status and stress resistance of the animals. In a country like India where coastal resources have several conflicting uses, vertical

expansion of shrimp farming is the only way to increase farmed shrimp production and improve the country's export earnings. By 2024-25, India targets to raise its revenue from export of fishery products to a whopping ₹1 lakh crore, which necessitates a quantum jump in fish production. Over the years farmed shrimp has spear headed India's export earnings, accounting for more than 70% of the value realized. Therefore, producing more shrimp would be the best way to boost the country's export earnings. Shrimp farming regions that experience mild winter conditions, i.e., south Gujarat and parts of West Bengal, wherein majority of the farms traditionally remain idle during the winter season, can be effectively used to raise farmed shrimp. This in turn, increases the volume of shrimp that can be produced from a unit area, contributing to increased production of shrimp in the country.



Notes

Notes



Brackishwater aquaculture for food, employment and prosperity

For more information, contact

Director

ICAR - Central Institute of Brackishwater Aquaculture
(Indian Council of Agricultural Research)
#75, Santhome High Road, M.R.C. Nagar, R. A. Puram,
Chennai, Tamil Nadu - 600 028.
E-mail: director.ciba@icar.gov.in
Phone: +9144 24617523 (Office)
Fax : +9144 24610311
Web : www.ciba.res.in

Office In-Charge

Navsari-Gujarat Research Centre of CIBA
1st Floor, Animal Husbandry Polytechnic,
Navsari Agricultural University Campus,
Eru Char Rasta, Navsari, Gujarat - 396 450.
Phone: +912637 283509

/ icarciba