FARMING OF INDIAN WHITE SHRIMP, *Penaeus indicus*

(Under Tribal Sub-Plan)

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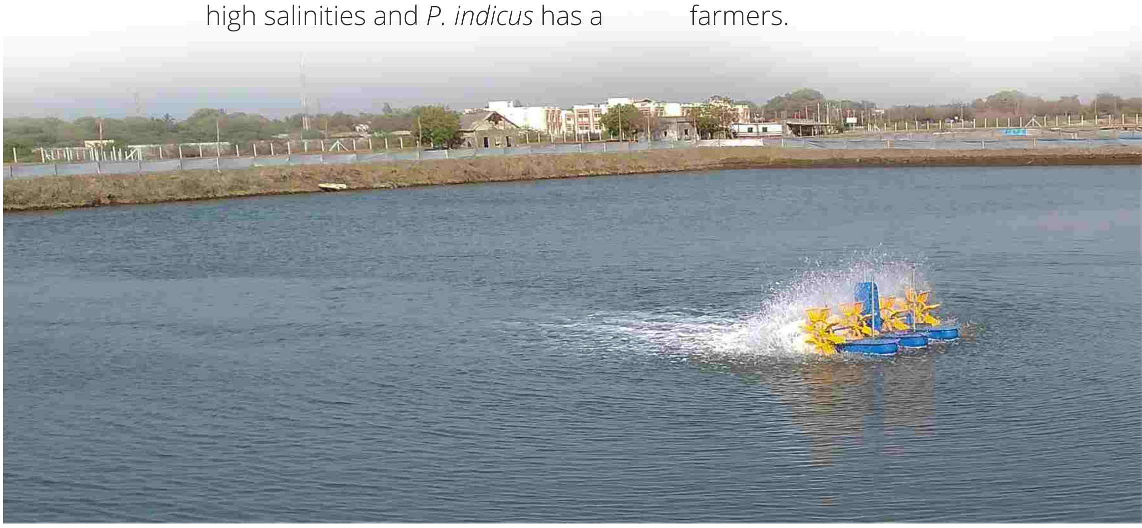
Brackishwater aquaculture for
food employment and prosperity

NGRC FARM, MATWAD,
NAVSARI, GUJARAT

Brackishwater aquaculture in India is synonymous with shrimp farming and a single species i.e. Whiteleg shrimp, *Penaeus vannamei* dominate the Indian shrimp industry. *P. vannamei* is a non-native species, with natural populations inhabiting the pacific coast of North America. *P. vannamei* 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 an effect of over dependence on a single species. Indian white shrimp, *Penaeus indicus* is an indigenous candidate species of shrimp that can bring about diversification in the sector and act as 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 such hyper saline conditions, thus making it a suitable species for Gujarat. Low density farming of *P. indicus* in monoculture or along with brackishwater finfish can also be used as an alternate livelihood option 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 soon replaced by other penaeid shrimp. Farming practices and husbandry of *P. indicus* especially at high densities up to 30 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 for standardizing farming of 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.



SPECIES

Shrimp aquaculture in India began with the Indian white shrimp in the 80s and 90s and gradually gave way to the faster growing tiger shrimp, *P. monodon* and subsequently replaced by *P. vannamei* post 2009. *P. indicus* is a fast growing shrimp and PL produced from captive wild caught brooders exhibit similar growth to domesticated SPF *P. vannamei* up till 10-12 g average body weight after which growth slows down at high densities. *P. indicus* is a euryhaline shrimp and can grow optimally at salinities ranging from 5 ppt to 55 ppt and several studies reveal that the species demonstrates a preference to hyper saline environments. The species attains an average body weight 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 keep stocking densities at 30 PL/m^2. However, at higher stocking densities there are reports of productions to the tune of 16-18 tonnes/ha/crop for *P. indicus*. *P. indicus* being an indigenous species the production of disease free stocks would be easier and cheaper and it is not the natural host for an array of diseases that affect *P. vannamei*.

SITE SELECTION

Standard procedures followed for the identification of suitable sites for shrimp farming holds good with the farming of *P. indicus* as well. The optimal water and soil quality parameters required for the culture *P. indicus* is shown in Table 1. Site selection for shrimp aquaculture shall also follow the regulations by Coastal Aquaculture Authority and it is mandatory that all shrimp farms are registered under CAA.

Table 1: Optimum water and soil quality parameters for *P. indicus* culture

Water quality variables			Soil Quality parameters		
Sl.No.	Parameter	Optimum range	Sl.No.	Parameter	Optimum range
1	Salinity	10-25 ppt (Range 5-55 ppt)	1	Soil type	Sandy clay, Clay loam or sandy clay loam
2	pH	7.5 -8.5	2	Soil pH	6.5 to 7.5
3	DO	>4 ppm	3	Organic carbon	1.5-2.0%
4	Temperature	23-32^{o}C	4	Calcium carbonate	>5%
5	Alkalinity	150 to 200 ppm	5	Electrical conductivity	>4 dS m^{-1}
6	NH3-N*	<0.01			
7	NO2-N*	<0.01			

**P. indicus can tolerate and exhibit normal growth/survival in media with NH_3-N levels of up to 1.0 ppm, and maximum tolerable levels of NO_2-N in the media is concentration of chlorides in the medium expressed in ppt divided by two expressed as ppm. For example, in a medium of salinity 35 ppt, that contains 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 seen up to 4.8 ppm. (to be used as thumb rule)*

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. Maintaining higher water depth of over 5 feet is recommended for *P. indicus* reared in earthen ponds with clayey soil as the species would churn up mud and lose clay from the pond bottom due to their aggressive feeding behaviour resulting in high clay turbidity over 100 JTU. Higher water depth would limit build-up of excessive clay turbidity. 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 tipping 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 this *P. indicus* culture and the recommended pond size is 0.4 ha or 4000m^2. Lined ponds may also be employed for rearing of *P. indicus*. A reservoir pond of greater depth and size based on the area and number of the growout ponds may also be constructed to ensure biosecurity.

Sluice gate structure

Rectangular earthen pond

POND PREPARATION

Pond bottom soil should be allowed to dry and crack after harvest of the last 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 excess soil at the bottom or dyke sides which has settled down shall be lifted and placed back in to the dykes for strengthening. Depending on the pH of the pond bottom soil and based on quantity of organic matter present, liming shall be done and soil may be tilled again for proper mixing. Following this, pond bottom may be compacted using a tractor or other heavy machinery depending on the stocking density and proposed number of aerators to be used. Following this filling of water shall be initiated.

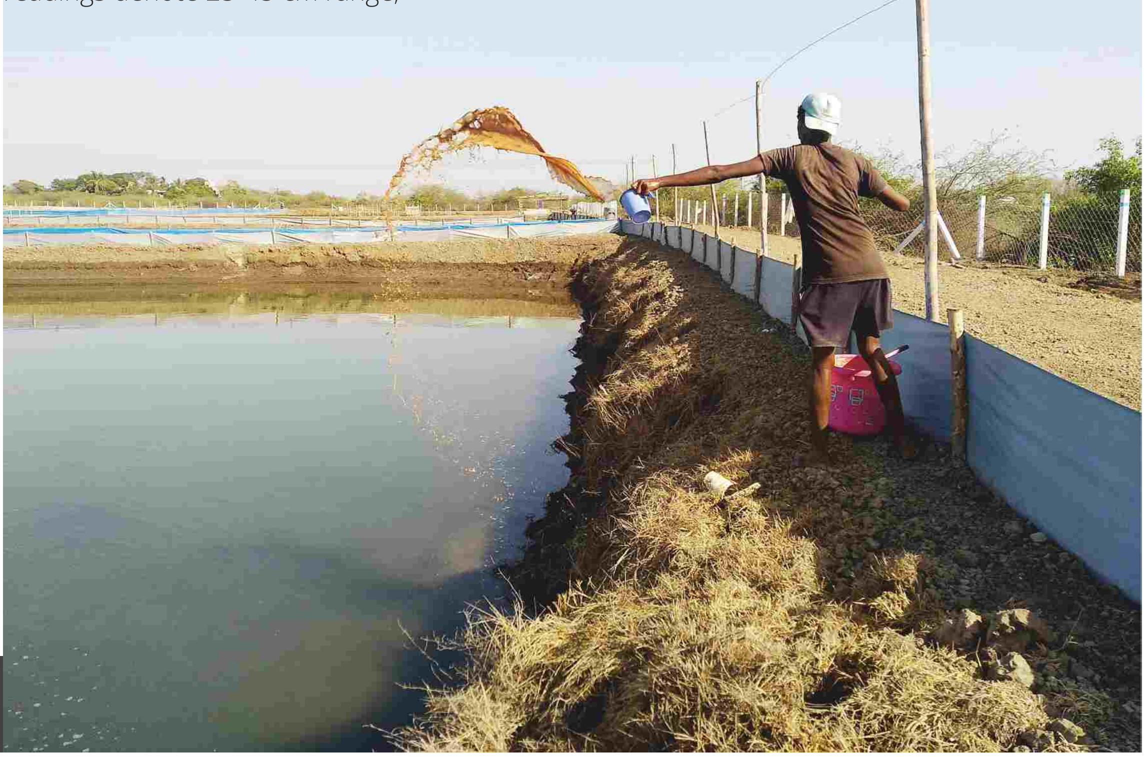
BIOSECURITY

Biosecurity is vital for any form of shrimp aquaculture. A reservoir pond of required size and depth based on the number and area of grow out ponds are mandatory. Water pumped in to the reservoir pond may be allowed to settle for 2-3 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 @10-20 ppm depending on intensity of the problem. Disinfection of water filled in the ponds may be carried out using bleaching powder (preferably triple packed, containing 33% free chlorine) or other chlorine derivatives and other 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 exist in the pond water after 48-72 hours. 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 and hence a chain dragging procedure during the early morning hours may result in the required bloom. Additionally, fertilization, application of probiotics and mineral mixtures may also be carried out in the reservoir pond to minimise issues in growout pond. The dyke of the growout and reservoir ponds shall be secured with crab fencing made using shade netting/PVC netting/PE netting of small mesh/120-150 gsm plastic sheets to prevent entry of crabs in to the shrimp pond. 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 dips and vehicle dips may also be provided at the farm for disinfection of farm tools, and labourers etc.

Installation of crab and bird fencing around the pond for biosecurity

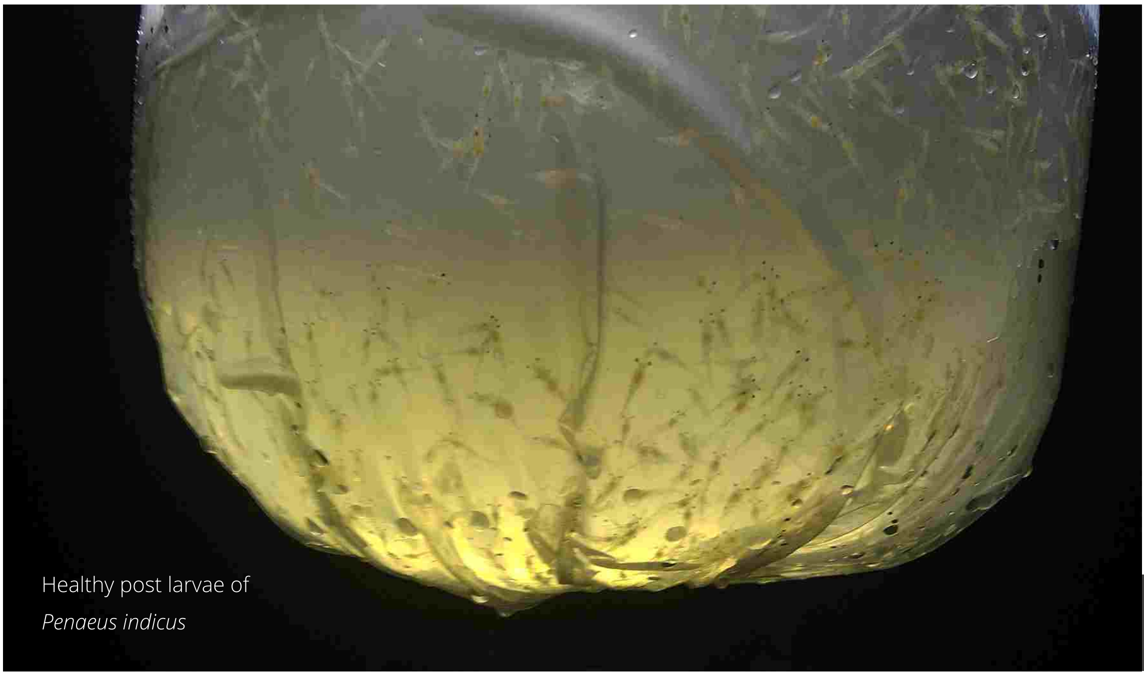
FERTILISATION

The disinfected water may be fertilised using inorganic fertilisers, organic slurry or commercial plankton booster formulations. ICAR-CIBA has developed a plankton booster formulation CIBA Plankton^{Plus} made from fish slaughter waste which has been giving excellent phytoplankton and zooplankton bloom resulting in high survival, lower FCR and faster growth, may also be applied if necessary. Fertilisation may be repeated in case bloom fails to develop. Once sufficient bloom has been noted or the transparency readings denote 25-45 cm range, stocking shall be carried out. Water quality analysis shall be carried out prior to stocking. If blooms fail to emerge even after frequent fertilisations, liming and chain dragging may be carried out. Liming can also be done in 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.



STOCKING

Hatchery reared *P. indicus* PL 10 to PL15 are ideally suited for stocking to growout ponds. The seed shall be screened for WSSV, EHP and IMNV prior to stocking using standard PCR techniques. The seed shall be acclimated to the required salinity from the hatchery and transported in media of salinity similar to that of the salinity of 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. Salinity shall be increased at the rate of 4 ppt/hour and the seed can be released in to the pond by siphoning. Similar procedure may also be followed in case hatcheries that are unable to provide seed at lower salinities. However, in case of salinity drop below 10 ppt the rate of salinity reduction shall be kept at 3 ppt/hour. It is recommended to have a stocking density not exceeding 30 PL/m^2.



Healthy post larvae of
Penaeus indicus

FEEDING AND WATER QUALITY MANAGEMENT

Commercial Indian white shrimp formulated feeds are not available in the markets and hence *P. vannamei* feeds may be used. ICAR-CIBA has developed specially formulated feed for *P. indicus* which has a higher protein level than commercial white shrimp feed based on nutritional requirements of the species. Crumbled feed may be broadcasted until the average body weight 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 4000m^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 quality data. Additionally, organic juice application may be carried out on weekly or fortnightly basis to maintain optimum water quality and C:N ratio in the water. Addition of mineral supplements in feed or water and other feed supplements like Vitamin C or immuno-stimulants may be given depending on the pathological 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 stock, 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* which would consume larger quantity of feed due its genetic growth traits.

Commercial farming trials on *P. indicus* has indicated that the species has a peak feed consumption only for a period of 4-5 days after each moulting (4-5 days after moulting) 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 first rains.

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 parameters. Initiating sampling from 30 DOC is recommended so that animals can be observed closely to identify their physiological status. Sampling can be carried out using small meshed cast nets during the initial period of culture and may be replaced by a larger meshed one towards the 2nd half of the culture period. Sampling shall be ideally carried out during the early morning hours before intense sunshine. Individual weighing of the animals or combined weighing may be followed during sampling in order to calculate the weekly and daily weight gains.

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 like moulting, disease occurrence etc. when feed drop or mortality are observed in trays or the sides of the dykes.

Check trays are the most important tools 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 and check trays are tools for this management, sturdy cat walks or other structures may be constructed for check tray observations, so that farm workers can freely move and take observations from the tray. Check tray frames shall be constructed of light weight galvanized iron or aluminium so that farm workers can lift the trays easily

Sampling of shrimp from growout pond

Check tray observations

during all feeding sessions. Check trays shall be installed in the pond from 15 DOC and some feed may be put in to the trays to train the shrimp to feeding in check trays. However, after 30 DOC, weighed amounts of feed may be added to the trays and observations may be made after stipulated time periods to judge feeding status of the shrimp. The quantity of feed added and the checking period in the trays is a function of the DOC, feed number and animal size. Check trays with feed shall be lowered from the cat walks only after completion of the feeding. Pond bottom shall also be monitored on a weekly basis as in the case of pond bottom soils with higher sludge accumulation and H_2S, the shrimp have a tendency to finish feed in the check trays prior to that broadcasted in the bottom. This shall result in faulty check tray observations that shall result in greater water quality deterioration. The feeding strategy to be followed in a *P. indicus* growout pond based on check tray observations are listed in Table 2.

Table 2: Feeding strategy based on check tray observations for *P. indicus* growout pond of size 4000m^2 equipped with four trays

Check tray observations				Feed adjustments
Tray 1	Tray 2	Tray 3	Tray 4	
C	C	C	C	Raise 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= Empty tray U=20% or more of lowered feed remains unconsumed

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. 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.

HARVEST AND ECONOMICS

P. indicus attains an average body weight of 20 g in 100-120 DOC and can be harvested at the desired size. Subsequent rearing also may be done to produce larger sized shrimp that shall fetch a premium price. *P. indicus* fetches similar or higher price to 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 (Rs.)
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 acessories	10,500
Total capital investment	4,18,700
Fixed cost	**Amount (Rs.)**
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 (Rs.)**
pond preparation	10,000
Cost of PL	52,000
Feed cost	2,34,300
Fertlizer	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	
Total yield	2053 Kg
Rate/Kg	Rs. 310/Kg
Gross return	Rs.6,36,430.00

Economic parameters	Amount (Rs)
Total gross return	636430
Total fixed cost	84038.75
Total variable cost	5,03,220
Total cost	5,87,258.75
Production cost	245.1144666
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 (Rs/ha/crop)	1,22,928.125
Total revenue (Rs/ha/year)	2,45,856.25

Notes

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