Studying the prospects, suitability and best management practices in cultivation of Vannamei Shrimp in north India with special reference to Western UP, Haryana and Rajasthan

Vinod Kumar Bist

DGM & Faculty Member

National Bank Staff College (NBSC)

Sector-H, LDA Colony, Kanpur Road

Lucknow 226 012 (UP)

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Executive Summary

- Brackish water prawn or shrimp farming started in a big way during 1991-94 especially in the coastal districts of Andhra Pradesh and Tamil Nadu and also proved to be a highly remunerative venture for the entrepreneurs. Incidentally, in many of the inland states, the subsoil water has become saline or semi saline due to some or the other reasons with the salinity generally ranging between 5 ppt and 15 ppt. These pockets are available in northern states like Rajasthan, Western Uttar Pradesh, parts of Punjab, Haryana and elsewhere. These lands, which are otherwise unsuited for any other agricultural activity can be utilised by culturing brackish water prawns viz. the popular white leg Pacific shrimp or the vannamei shrimp.

- In order to gain better insight in the matter, need was felt to study the suitability of the vannamei shrimp species with respect to these areas as also to study its tolerance to temperature and conditions prevailing in north India. The study also focussed on suggesting a financially viable and technically feasible model for vannamei shrimp farming besides also finding out various constraints being faced by the shrimp farmers. Accordingly, Shri V. K. Bist, DGM & Faculty member conducted a five days study during 11-15 February 2019 in districts Rohtak (Haryana), Churu (Rajasthan) and Mathura & Hathras (Uttar Pradesh) with the following objectives.

    - To study the suitability and potential of the shrimp species in salt infested land in northern India and also assess its present status in various states
    - Understanding the best management practices in cultivation of the Vannamei shrimp which could be adopted by the small farmers in the northern India.
    - Suggesting an economically viable replicable model for the farmers for cultivation of the Vannamei shrimp in northern India.
    - Identifying constraints in availability of SPF seeds, quality feed, credit availability, awareness issues, marketing etc., the major factors impeding the propagation of the vannamei shrimp farming activity in north India and their likely solutions.
    - Availability of technical / extension services for farmers through department / other agencies for promoting Vannamei shrimp farming.

- Fourteen farmers who had either adopted or were in advance stages of adopting shrimp farming i.e. with their ponds excavated and other inputs also being arranged, were visited and interviewed. Information was sought regarding the suitability of the shrimp species, its management practices, availability of inputs, various constraints being faced, role of departments/extension agencies, income and credit related aspects.
- Being relatively expensive and to some extent risky and skilful venture, as at present, SF/MF were not coming forward to adopt the activity in a big way. Most

of the entrepreneurs were large farmers, who had relatively more risk bearing capacity. Discussions with the nodal departments revealed that they were popularising the shrimp farming amongst small farmers too. Farmers taking up shrimp farming were also being covered under the GoI's Blue Revolution Scheme wherein they were eligible for substantial amount of subsidy.

- Considering high level of subsidy under brackish water shrimp farming, many a farmers usually did not feel the need for credit. During the course of the field visit only few farmers had expressed the need for credit, but were however denied by the bank perceiving risk in the activity. Even the Annual Credit Plans with respect to the four visited districts did not depict the existing potential under the sector. Further, despite nominal targets being fixed under the fisheries sector, there is hardly any support from the banks. Considering shrimp farming and fisheries as emerging and innovative activity, there is a need for the banks to encourage and support the activity in a bigger way.

- Shrimp farming was practiced by the farmers in pond usually measuring one acre. They were mostly found to be scientifically constructed facilitating easy drainage and drying after each harvest. Generally, the farms were found to be maintained well with regard to treatment of organic and inorganic fertilizers, maintenance of water parameters, adequate seed stocking, formulated feeds and proper aeration.

- The average production of shrimps was observed to be 3,500 kgs/acre/season, with most of the respondents preferring only one crop a year. The average farm gate price being fetched by the farmers when sold to the exporters/processors ranged between Rs.350/- and Rs.400/-. This was much higher than the average price fetched at the Ghazipur Mandi at Delhi (ranged between Rs.250 and Rs.350 per kg).

- Despite the farmers doing well, some of the constraints coming in way of the success of the activity were timely availability of quality inputs like the seed, formulated feed and probiotics etc. Besides these, other important aspect was the fluctuating market for the shrimps. Availability of credit and insurance support, besides, proactive role of the nodal departments in providing guidance and training to the entrepreneurs will also go a long way in the success of the shrimp farming in north India.

- The success of the shrimp farming in north India can be a game changer not only for the farmers but also for the country as whole as prawn is not only a high value commodity but also has a high export value. Besides other benefits, shrimp farming in saline wastelands of north India has an immense potential for generating employment on a long term basis.

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Chapter-I

I. Introduction

India is endowed with a long coastline and hence offers scope for large exploitation of marine wealth. Till a few years back, fishermen in India were involving themselves in traditional marine fishing. In the seventies fishermen started concentrating on catching prawns more commonly known as ‘shrimps' due to high profitable return on the same on account of their export value. Brackish water prawn farming started in a big way during 1991-94 especially in the coastal districts of Andhra Pradesh and Tamil Nadu.

Brackish water is most commonly found in estuaries, places where a freshwater river meets the sea. The resulting combination of freshwater and salty seawater is brackish water**.** With less salt than sea water and more salt than freshwater, brackish water is the result of the mixing of these two types of water. Brackish water can have wide range of salt concentration and generally ranging between 5.0 gms/litre (or 5 ppt also called as parts per thousand) to 25 gms/litre (25 ppt.).

However, this does not mean that such water is not found elsewhere. In many of the inland states of our country, the subsoil water has become saline due to some or the other reasons. Such waters can also be termed as semi saline or saline or one can call it brackish, where the salinity generally ranges between 2 ppt and 25 ppt. Such waters can support only particular type of flora and fauna which can thrive well only in these waters often making these waters very productive for brackish water aquaculture.

Photograph No 1 : Salt deposits seen in vast tracts of land in Mathura district rendering the land unsuited for other agricultural use

Incidentally, many areas are available in northern states like Rajasthan, Western Uttar Pradesh, parts of Punjab, Haryana and elsewhere, where there are saline soils and saline ground water. Saline or semi saline waters can no longer be used for irrigation or drinking. It is toxic to plants, and high sodium levels in them makes the soil hard, compact and reduces the ability of the soils to absorb water. Irrigation water becomes toxic to most plants at concentrations above 1.5 ppt. Salinity is not dangerous to humans, but water becomes non-potable for human consumption at about 0.50 ppt.

Such areas in the inland regions of the country are unsuited for agriculture activities and can be utilised alternately and economically for activities related to aquaculture wherein both fish and prawns/shrimps can be cultured. On the basis of experience gained over the years and pilots conducted, these regions were being used for culturing prawns i.e. the

tiger prawn (*Penaeus monodon)*. However, in view of being disease prone and non-availability of quality tiger prawn seeds, some of the farmers have started cultivating the white legged shrimp or the Vannamei shrimp since the past few years.

Considering the national scenario, the aquaculture activity and production has grown enormously in recent years and Penaeid shrimps are one of the most important cultured varieties of prawns worldwide, especially in Asia, due to their high economic value and export. *Litopenaeus vannamei* (white leg shrimp) species, introduced to many coastal states of India 5-6 years earlier, now accounts for 90 percent of the country's total shrimp culture. The species exhibits a fast growth rate and its culture period is significantly shorter than that of *Penaeus monodon* (tiger prawn), making it an attractive alternative to tiger prawn production in several countries. Although marine in habitat, due to its wide tolerance to salinity and also because of its hardy nature, the shrimp has got limited success in northern India which includes parts of western Uttar Pradesh, Haryana, Punjab and Rajasthan.

Thus, a need was felt to study the suitability of the Vannamei shrimp species with respect to these areas as also to study its tolerance to temperature and conditions prevailing in north India. The study was also focussed to arrive at a financially viable model for vannamei shrimp farming in northern India besides giving an insight into various constraints being faced by the shrimp farmers. The findings of the study will help in planning proper strategy for shrimp cultivation in the northern region of the country. In the field of aquaculture, the success of the prawn species especially in the northern India can be a game changer not only for the farmers but also for the country as whole as prawn is not only a high value commodity but also has a very high export value.

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Chapter II

Study Objectives and Methodology

The five days study was taken up during 11-15 February 2019 in Rohtak district of Haryana, Churu district of Rajasthan and Mathura & Hathras districts of Uttar Pradesh with the following objectives.

- To study the suitability and potential of the shrimp species in salt infested land in northern India and also assess its present status in various states.
- Understanding the best management practices in cultivation of the Vannamei shrimp which could be adopted by the small farmers in the northern India.
- Suggesting an economically viable replicable model for the farmers for cultivation of the Vannamei shrimp in northern India.
- Identifying constraints in availability of SPF seeds, quality feed, credit availability, awareness issues, marketing etc., the major factors impeding the propagation of the vannamei shrimp farming activity in north India and their likely solutions.
- Availability of technical / extension services for farmers through department / other agencies for promoting Vannamei shrimp farming.

Methodology Adopted

The study was carried out by covering some of the potential pockets and villages in the aforementioned 04 districts of the three states. A total of 14 farmers who had either adopted or who were in advanced stages of adopting shrimp farming i.e. with their ponds excavated and other inputs also being arranged, were visited and interviewed. Information was sought regarding suitability of the shrimp species, its management practices, availability of inputs, various constraints being faced, role of departments/extension agencies, income and credit related aspects. The observations emanating from the interview with farmers are given in Annexure I and II.

The officials from the Department of Fisheries, Rohtak, Mathura and Hathras as also the Scientists and Technical officers from the Regional centre of the Central Institute of Fisheries Education (CIFE, ICAR), Rohtak were also a part of the study. Inputs were gathered from respective DDMs, NABARD on the overall credit flow in the district *vis a vis* the fisheries sector and shrimp farming in particular.

The village wise summary of the farms visited is depicted in the table as given in the next page.

Table No 1 : Details of districts and villages visited

Name of the State	District	No of farmers covered / interviewed	Villages covered	Tehsil
Rajasthan	Churu	2	Shyopura	Rajgarh
	Sub total	***2***		
Haryana	Rohtak	1	Lahli	Rohtak
		2	Chidi	Rohtak
		1	Chandi	Meham
		1	Gharoti	Rohtak
	Sub total	**5**		
Uttar Pradesh	Hathras	1	Midhawali	Sadabad
	Mathura	1	Dadisara	Mat
		2	Kharot	Chhata
		1	Raheda	Goverdhan
		1	Kishanpur	Goverdhan
		1	Kishanpur Hatia	Goverdhan
	Sub total	**7**		
	Total	**14**		

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Chapter III

Role of extension agencies and financial institutions in promoting shrimp farming

The Fisheries departments of different states in the northern part of the country are mainly focussing on the development and promotion of fresh water fisheries by utilising the existing ponds and tanks and also the newly excavated ponds, abandoned kilns, low lying areas etc. In order to give a fillip to the aquaculture sector across the country, all the states had established the Fish Farmers' Development Agencies (FFDAs) and the Brackish water Fish Farmers' Development Agencies (BFDAs) with GoI assistance. However, after reduction in the central assistance, the FFDAs and the BFDAs were gradually done away with and instead the Fisheries Departments of the respective states are now promoting aquaculture including shrimp farming under the newly launched Centrally Sponsored Scheme on Blue Revolution : Integrated Development and Management of Fisheries.

Centrally Sponsored Scheme on Blue Revolution is an umbrella programme for integrated development and management of fisheries by merging all the existing schemes, with an outlay of Rs.3,000 crore during a period of five years (2015-16 to 2019-20). The Mission covers inland fisheries, aquaculture, marine fisheries including deep sea fishing, mari-culture and all activities undertaken by the National Fisheries Development Board (NFDB) towards realizing "blue revolution".

Being relatively expensive and to some extent risky and skilful venture, as at present, SF/MF are not coming forward to adopt the activity in a big way. Most of the entrepreneurs are large farmers, who have relatively more risk bearing capacity. Discussions with the nodal departments revealed that they are popularising the shrimp farming amongst small farmers too. Two farmers visited during the field visit practicing shrimp farming in less than one hectare, were also motivated by the respective state nodal departments.

Farmers taking up shrimp farming (including vannamei farming) are being covered under the scheme whereby, they are eligible for substantial amount of subsidy. The total assessed cost as also the prescribed subsidy under brackish water shrimp farming is as under.

Table No 2 : Subsidy for shrimp cultivation under the Blue revolution scheme

Sr. No.	Component (per hectare)	Total cost (Rs.)	Subsidy amount (Rs.)	
			General (40%)	SC / ST / Women (60%)
1	New pond excavation in saline / alkaline waters	7,00,000	2,80,000	4,20,000
2	Input cost for Vannamei farming	3,00,000	1,20,000	1,80,000
	Total	**10,00,000**	**4,00,000**	**6,00,000**

As gathered from the farmers, the respective nodal department is promoting the shrimp farming and desired extension services to the farmers, except in case of Rajasthan (district Churu), where, there was no office of the nodal department and the farmers obtained extension and training support from the Regional Centre of the Central Institute of Fisheries Education (CIFE, ICAR) situated at Rohtak, Haryana. In fact, the CIFE centre, Rohtak was instrumental in providing regular extension services to many farmers in all the four states apart from the respective State Fisheries Departments.

Photograph No 2 : CIFE – ICAR centre at Lahli, Rohtak

The CIFE is a focus point for all the four states as far as shrimp farming is concerned. Besides extension support, it provides five days training programme to farmers for Vannamei farming, during which both theoretical and practical inputs are provided to the trainees. The training certificate provided by the Institute is also recognised by various State Fisheries Departments for making the farmers eligible for availing subsidy under the Blue Revolution Scheme. The Institute trains about 200 farmers on yearly basis. It was informed that the farmers are trained on aspects like pond construction, selection of seed, administration of various inputs like the fertilizers, feed, probiotics ; concept of feed check trays, maintenance of various chemical parameters, use of aerators, harvesting and marketing of shrimps. The Institute aids the farmers in testing important soil and water parameters like pH, total alkalinity, total hardness, calcium, magnesium, salinity, and potash. These parameters are very critical and need to be maintained at desired levels for the survival and growth of prawns. Incidentally, there is no chemical analysis laboratory in any of the four states i.e. Punjab, Haryana, UP and Rajasthan.

Discussions with the Department of Fisheries, Haryana revealed that for promoting the shrimp farming activity, earlier the farmers were being provided subsidy @ Rs.12.0 lakh /hectare under the GoI's Rashtriya Krishi Vikas Yojana (RKVY). Since 2018-19, the support under the scheme has been withdrawn and the farmers are now being supported only under the Blue Revolution Scheme @ Rs.4.0 lakh/ha (Rs.6.0 lakh/ha for SC/ST/Women). Number of farmers supported under the GoI's programme depends upon the allocation of fund to respective states. The state of Haryana also has a training centre viz. Aquaculture Research & Training Institute at Hissar, where, the

farmers are also trained in different fisheries activities including shrimp farming for a period of 10 days. As per the state government policy, the department doesn't provide subsidy support to those practicing shrimp farming in less than one hectare area. This acted as disincentive for smaller farmers who wanted to take up shrimp farming as a livelihood activity.

The Department of Fisheries, Uttar Pradesh after realising the fact that immense potential exists in many of the western districts of the state have started encouraging farmers for taking up the shrimp cultivation. Districts like Mathura, Hathras, Agra, Etah etc. promise good potential for taking up the activity. It was also informed that the Fisheries Department at Mathura had conducted initial training of about 60 farmers in the Central Institute of Fisheries Education (CIFE, ICAR) at Rohtak. The training was able to motivate about 40 farmers who have excavated the ponds and will be culturing the shrimps in the current season i.e. from April 2019 onwards. The farmers will also be covered under the Blue Revolution Scheme. The Fisheries Department provides subsidy support for shrimp farming even in less than one hectare area (0.50 or even 0.25 hectares). As a result of which, as informed by the Department, many SFs are also keen in taking up the shrimp farming activity.

One of the entrepreneurs Mr Kamal Kumar Keshwani, from village Medhawali, district Hathras, promoted by the Fisheries Department and practicing the activity in 3.20 hectares, also proposes to further expand it. His farm has become a resource farm for most of the nearby fish farmers who are in the process of taking up the shrimp farming as Mr Keshwani would be providing seed, feed, consultancy and most importantly, marketing facilities too. Such arrangement is going to definitely boost the prospect of prawn farming in western Uttar Pradesh. The Department of Fisheries, Uttar Pradesh is thus playing an important role in promoting new farmers as also forge their linkage with M/s Keshwani Farms.

Role of banks in promoting shrimp farming activity

Considering high level of subsidy under the fisheries activities and specially the brackish water shrimp farming, many farmers usually did not feel the need for credit. During the course of the field visit only two farmers had expressed the need for credit, but were however denied by the bank perceiving risk in the activity. In most of the cases the farmers reported that they were able to meet the total cost on their own and also by way of the subsidy being provided by the State (under the Blue Revolution Scheme). However, this in no way, means that the farmers may not be needing bank credit in future.

Discussions with the respective DDMs of the districts revealed that Annual Credit Plans do not depict the existing potential under the fisheries sector as a whole and shrimp farming in particular. Except for district Rohtak, in all other districts, hardly any targets are being projected under the fisheries sector under the Annual Credit Plan. Further, despite nominal targets being fixed under the fisheries sector, there is hardly any support from the banks. Considering shrimp farming and fisheries as emerging and

innovative activity, there is a need for the banks to encourage and support the activity in a bigger way.

Data on the projections and achievement under the fisheries sector *vis a vis* the overall ACP is as given below.

Table No 3 : Credit Potential and Projections under Fisheries Sector

ACP projections/Ache. (Amt in crore Rs)	Districts							
	Mathura		Churu		Rohtak		Hathras	
	17-18	18-19	17-18	18-19	17-18	18-19	17-18	18-19
ACP Target	3943.34	4340.42	4396.41	4461.52	4127.66	4260.96	2997.10	3570.06
Agri T/L Target	3005.68	3143.64	635.57	836.46	754.52	755.78	350.52	582.42
ACP Target - Fisheries	4.22	6.02	Nil	Nil	16.75	16.75	5.07	5.72
ACP Ache - Fisheries	0.09	0.10	Nil	Nil	Nil	Nil	NA	NA

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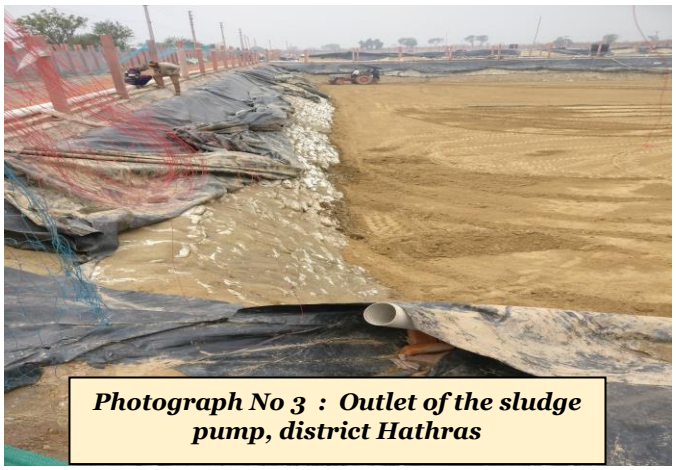
Chapter-IV

Management Practices Being Adopted for Vannamei Shrimp Farming

The various management practices adopted by the shrimp farmers in three states is summarised as under.

a) Pond size, structure and Design

The average size of the ponds being utilized under shrimp cultivation was one acre (0.40 hectare). The ponds on an average had a water depth of five feet and were constructed with slope towards center. The slope inside the pond bottom was ensured to facilitate the natural flow of the sludge / detritus towards the central and deep portion of the pond. The sludge from the center of the pond was being removed either using a sludge pump or by underground laid pipe line (called as central line) mechanically by way of gravity usually once in a fortnight. There were no separate inlet and outlet in the ponds as the water was usually pumped into the ponds from bore wells. Most of the ponds were owned by the farmers, however, some of them were also taken on long term lease from fellow farmers with an agreed lease amount varying between Rs.20,000 and Rs.40,000 per acre per year. The phenomenon of taking land on lease was predominantly observed mainly in Rohtak.



Photograph No 3 : Outlet of the sludge pump, district Hathras

b) Farm Management

b.1) Pond preparation -- The site mostly being used for shrimp farming was either degraded having saline soil rendering it non usable for normal agricultural practices, or an area where there is water logging, which also could not be used for agriculture. The ponds were constructed using tractor and JCB machines. On an average, construction of one acre of pond with a depth of about 07 feet (inclusive of a free board of about 2 feet) including compaction of the embankments required about five to six days. Ideally, the selected site should have an impervious soil so as to retain water for a long but in most cases, soil being more of sandy nature, had poor water retention. Many of the farmers hence, had laid a polythene lining (HDPE) of about 500 micron size

Photograph No 4 : Cleaning of the pond bottom – preparation for the next crop – Churu, Rajasthan

thickness so as to make the pond bottom impervious. This however had increased the construction cost by nearly Rs.2.40 lakh per acre. The average cost of construction (Rs.0.80 lakh) including the HDPE lining (Rs.2.40 lakh/acre) was observed to be about Rs.3.20 lakh for one acre shrimp pond. Some of the farmers, however, were practicing the farming in an area which was low-lying without any seepage, thus saving on the cost of the HDPE lining.

The pond bottom was being treated with inorganic fertilizers viz. DAP and urea, and lime depending upon the requirement before filling water in the pond. In fact, most of the fertilizers were added to the pond in an interval of every month depending upon their deficiency and requirements.

b.2 Water availability and application of home-made slurry treatment -- The source of water in the pond was either ground water or through canal. During the course of the field visit it was observed that except for three cases in Mathura, UP, where, the source was canal, in all other cases, the source of water was bore well usually sunk at a depth of 150 to 200 feet. Whenever the water is taken from canal it was necessary for the farmer to ensure that the water was strained properly so as to avoid entry of unwanted animals in the shrimp ponds.

The shrimp seeds are stocked in the pond after the pond is subjected to a "slurry treatment". For one acre of the shrimp pond slurry preparation was carried out using 20 kg of rice polish/bran, 20 kg of molasses (shira) and 300 gm of yeast. The ingredients were mixed in 150 litres of water, kept for fermentation for about 2-3 days and later sprinkled in the pond water. This treatment fertilized the pond and enhanced the growth of plankton production within a week's period. Thus, the slurry treatment ensured sufficient quantity of natural feed for the small sized shrimp larvae. The seeds were stocked after about 14 days of slurry treatment in the pond.

The pond water was also treated with minerals and probiotic yeasts before seed stocking.

b.3 Concept of reservoir ponds -- As gathered from the CIFE as also some of the progressive farmers, water from any source should not be directly added to the shrimp ponds. Rather, there should be reservoir pond measuring nearly one third of the total culture area where, the water has to be first stored. Since, the water may be deficient in various minerals (potash, calcium, magnesium, pH etc.), it is better to maintain the water quality in the reservoir pond itself. All the ponds are later on supplied the water through the reservoir pond itself. Since, the shrimps are very delicate in nature, maintaining the water quality in ponds at a later stage may cause undue stress to the shrimps. However, due to paucity of space, many farmers were not maintaining the reservoir ponds. Of the 14 farms visited, only one farmer had constructed the reservoir pond.

b.4 Biosecurity norms -- It is desirable to have certain biosecurity measures like using a bird netting over the ponds, rodent traps/nets on the embankments etc. The bird net were observed only in 02 out of 14 farms. In none of the cases rodent traps/nets were observed. The farmers did not feel the necessity of using bird nets and rodent traps.

However, it is desirable to have at least bird nets over the entire pond surface in order to avoid the birds predating upon the shrimp stock, thus causing loss to the farmers.

b.5 Seed Stocking -- *Litopeaneus vannamei* post-larvae PL-10 to PL-14 (seeds) were procured from registered shrimp hatcheries after quality and PCR tests. The post-larvae are transported from hatcheries to culture ponds by road and air, and stocked after proper acclimatization process. Since located in the north, the seeds are to be essentially brought from hatcheries and suppliers from the south. Most of the respondents informed that they had an arrangement with suppliers from Visakhapatnam, Pondicherry, Chennai, Nellore etc. and the seeds were air lifted till Delhi and later brought to the farm site by road. The farmers informed that they had a tie up with the hatchery owners or their agents and the orders for shrimp seeds in advance is being given as per the salinity prevailing in their ponds. The hatchery owner is expected to acclimatize the shrimp seeds as per the salinity existing at the farm site so as to ensure their better survival. The seeds are transported in polythene bags containing two third oxygen which is then placed inside thermocol boxes. The PL-10 to PL-14 stages of the shrimp seed procured from the hatcheries cost about 35 to 40 paise at source but its ultimate cost to the farmer works out to be about 60-70 paise per seed. Experience shows that it is better to stock seeds which are relatively larger in size say, grown for at least one month after the PL-14 stage (also referred to as 30 DOC ; DOC referring to day of culture) would ensure more survival in culture ponds. It was observed that only one farmer at Hathras, UP, viz. M/s Keshwani Farms was doing the seed rearing for one month (by way of re-circulatory aquaculture system or RAS) and growing them up to a size of 2.50 to 3.0 gms before introducing them in the culture ponds. As a result of which the seed had more survival and also weight gain. Almost all the farmers interviewed in the Mathura district informed that they would be procuring prawn seeds weighing about 2.5 to 3.0 gms seeds from M/s Keshwani Farm. The seed would be costing to them about Re.1.0/seed.

Photograph No 5 : Thermocol boxes used for transportation of seed and marketing of harvest

The stocking density of shrimp post-larvae (seed) observed was usually in the range of 25 nos to 50 nos per square meter. This was quite low in comparison to much higher density of more than 100 nos/sq. m being practiced in the southern India. Higher stocking density is possible if the farmer utilizes better management practices especially with regard to sludge removal and more aeration. One of the farms viz. M/s Keshwani Farms has plans to stock seeds @ 80-90 nos/sq.m. in the coming season as they would be using air diffusers inside the pond apart from the paddle wheel aerators, thus aiming at much higher production.

b.6 Feeding --- All farms were observed using formulated commercial pellets for routine feeding purposes. Most use a combination of broadcasting and check tray methods as feeding strategies, adjusting the levels regularly according to observations. On the whole the shrimps are fed four times a day, according to the recommendations of individual feed companies. The feed was procured from dealers and distributors from different places in south India with an average cost of Rs.70/kg having an average protein content of about 35%. Feed containing higher protein level is fed initially which gradually is reduced with the growth of the animal.

b.7 Water exchange --- The water level is being maintained at a depth of about 5 feet throughout culture period by pumping water into the pond from mainly bore wells (canals in the farms visited in UP). Water exchange as such is not done, but, most of the ponds have installed a three HP sludge pump which is being operated on a fortnightly basis. This helps in removing the sludge and waste materials which gets accumulated at the pond bottom. Two of the farms situated at Rajgarh, Rajasthan had laid an underground central pipe line from the pond centre with its outlet outside the farm which was being operated through a valve. This helped easy removal of the bottom sludge and accumulated waste by way of gravitation.

b.8 Aeration --- All the farms were using about four, 2 HP paddle wheel aerators in an acre of shrimp pond. Usually, higher the stocking density, more are the number of aerators employed. The aerators typically operate for 8-12 hours per day during the entire culture period and create water current for the accumulation of wastes towards the centre of the pond and to increase the dissolved oxygen in the water column. Aerators are placed 3 m away from the dykes and almost 40 m apart. Farmers were procuring the aerators from dealers from south.

Photograph No 6 : Paddle wheel Aerator

b.9 Water & soil treatments and maintenance of various parameters -- Probiotics, minerals, zeolites, ammonia reducer compounds, dissolved oxygen (DO) enhancer compounds and disinfectants were widely used in the pond at regular intervals after stocking. The pond bottom sediment turns blacker with the increase of culture days and rate of feeding dose. The sludge formation was controlled by applying sludge digesting probiotic products from various commercial companies. The various feed supplements were applied along with pellet feed for the promotion of growth, avoiding loose or soft shell, preventing diseases etc. Ideally, the major water parameters need to be measured and recorded daily or weekly with the help of field testing instruments and test kits. The major water quality parameters viz. salinity, dissolved oxygen, pH, temperature and total ammonia nitrogen are monitored at regular intervals. Hence, it is advisable that

Photograph No 7 : Formulated feeds, probiotics and water quality enhancers

the farms may have an integrated digital meter costing about Rs.25,000, which can measure most of these critical parameters. In the field, only two farmers were having this arrangement. They were dependent on the CIFE station at Rohtak for the chemical analysis of water. Most of the farmers were assessing the parameters only on monthly basis.

c. Growth and production --- Weekly sampling is very important to assess shrimp health, growth and survival. Ideally, sampling is undertaken fortnightly at dawn, with cast net, after 60 DOC (days of culture) in most of ponds. Four to five hauls at different places in the pond are made in each pond to assess survival, moulting stage, average body weight and general health. Most of the farmers however, were actually assessing the same on a monthly basis.

The average growth rates ascertained by interacting with the farmers was about 25-30 gms in about 100 days of culture with a survival of about 75 percent. The final shrimp production rate ranged from 6.3 tons to 12.0 tons per hectare per crop depending stocking density, growth rate and mortality levels. All except two farmers were taking one crop per year. Unlike the coastal brackish water areas where the temperatures are more or less uniform throughout the year and more conducive for the shrimp growth, it is more extreme in north India. In fact, the white leg shrimp hardly grows after October and cannot survive the cold temperatures from December onwards till February. Hence, most of the farmers were resorting to one culture operations i.e. from April/May till July/ August. However, three farmers had adequate arrangements for seed rearing (RAS /extra rearing ponds) and were bringing the seeds in the month of March and also in June, rearing them for one month before stocking them in the ponds in April and July. This helped them to enhance their income from the same pond. One of the farmers at Rohtak had plans to culture fish like sea bass and milk fish after the shrimp crop was harvested.

d. Harvesting and marketing --- Shrimps were harvested by drag nets, weighed and thereafter packed with ice in trays after proper washing in fresh water. Many of the farms visited had arrangements with the fish catching parties (called as Jal party) to whom they would pay about Rs.7,000 to 8,000 for carrying out the harvest. Farmers resorted to complete harvest so that they could sell the entire catch at one go. Many of the farmers had tried marketing the prawns at the Ghazipur Mandi, Delhi, which they found to be

quite fluctuating. It was felt that the Delhi Mandi has a maximum capacity to sustain nearly 2 tons of produce per day. The average price being fetched by the farmers usually ranges between Rs.250 to Rs.350/kg (may be higher if the supply is less). In case, there is more supply in the Mandi, the price can fall as low as Rs.200/kg (for 30-35 counts/kg of shrimp). The price also depends upon the size of the shrimp at the time of harvest or counts/kg. Most of the farmers had hence, forged a tie up with the processors and exporters situated at Mumbai, Kolkata, Visakhapatnam, Chennai and Gujarat. The agents of the processors would collect the shrimp harvest after it is weighed by the shrimp farmer. The average price being fetched by the farmers when they sold to the exporters/processors ranged between Rs.350/- to Rs.400/- which was higher than the average price fetched at the Ghazipur Mandi at Delhi. The farmers reported timely repayment being made by both the exporters as well Arhtiyas of the Ghazipur Mandi at Delhi. One of the entrepreneurs being a partner in one of the shrimp processing industries at Kolkata (M/s Keshwani Farms from Hathras, UP) was not only marketing his produce directly to Kolkata but was also willing to purchase the harvest from all the shrimp farmers interested to sell him from Mathura and nearby areas at price better than being offered at Delhi market or by the exporters.

e. Risk factors

None of the ponds visited reported any sort of environmental or disease risk as the stocking density of the shrimps was less than 50 nos/sq. m. No farmer was practicing hi-density stocking, hence, for the present did not face any disease threat. The farmers were aware of the fact that the animal can be reared only till October, hence had planned their culture period accordingly. However, some of the other perceived risks might be as under.

i) Quality supply of shrimp seeds – Risk could be in the form of poor quality shrimp post-larvae (seed) supplied by hatcheries, mortality in early DOC (days of culture), stunted growth due to poor quality etc.

ii) Market : Low price, market fluctuations etc.

iii) Fluctuation in water parameters – Since, most of the farms were adopting a semi intensive farming approach with an average production of 3,500 kgs / hectare / crop, periodic testing of the water quality for important parameters like dissolved oxygen, ammonia, sulphide, nitrates, bacterial load, pH, alkalinity, hardness etc. is a must.

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Chapter - V

Constraints impeding the success of Vannamei farming

Interaction with various stakeholders viz. the farmers, nodal departments, CIFE (ICAR), District Development Managers and the Lead District Managers of a few districts revealed the following constraints coming in the way of the success of the shrimp farming in northern India.

1. Availability and quality of Seeds

In view of the high seed stocking density generally being maintained in the shrimp farms, the timely availability, quality as also its high cost may be identified as one of the major constraints for shrimp farming. Unlike the coastal areas, where the seeds are readily available, the shrimp seeds have to be transported by air from Kolkata, Visakhapatnam, Chennai, Pondicherry and other coastal places. In view of the high chances of disease and also to ensure good growth of the animal, the seeds need to be essentially purchased from SPF certified and registered hatcheries. As at present, many of the farmers were dependent on agents or hatchery owners and relied upon them for its quality. The seeds were reaching the farm site at a higher cost and also with high mortality. There is thus a need for establishing a mother or resource farm in major districts like Rohtak, Churu, Agra /Mathura and potential districts in Punjab where the seed may be reared and be always available for the farmers. An initiative in this direction has been taken by M/s Keshwani Farms at Hathras, which has established an RAS for rearing the shrimp seeds. This facility ensures availability of advanced seeds to the nearby farmers throughout the season. Although, there are no reports so far on disease outbreaks, but spurious and diseased seeds from the coastal areas may be a major threat to shrimp farming.

2. Feed Constraint

Vannamei feed was observed to be an important constraint for shrimp growers in the visited districts. High cost of feed and dependence on coastal feed manufacturers was reported as a constraint by many farmers. In view of this, the feed has to be ordered in bulk, hence, proper stowing arrangement is necessary for increasing its shelf life. Apart from this, there has been a rise in the cost of probiotics and mineral mixture which also increases the cost of shrimp production. There is also a potential for private dealers and agents to establish outlets in the potential districts to ensure regular, timely and quality supply of feed as also other inputs to the farmers.

3 Management Constraints

Many of the smaller and distantly located units were not aware of the aspects pertaining to hygienic/bio-secure/ quarantine standards as also various services extended by the nodal departments like training and availability of subsidy under the

project. Lack of proper chemical analysis laboratory is a critical constraint considering the fact that shrimp is a sensitive and delicate animal and even smaller fluctuations in the water parameters can be fatal. For undertaking the chemical and to some extent the microbial analysis, most of the farmers are currently dependent on the CIFE (ICAR) centre at Rohtak. There is hence a need for the respective state departments to establish laboratory of similar standard in all the potential districts.

4. Marketing Constraints

The study revealed that there was immense fluctuation in the farm gate prices of shrimp even though market is available for various shrimp counts at national and global level. The present study also revealed that majority of the respondents reported lack of ice factories & storage facilities as also lack of information on actual market price prevailing in Mandi and also at the processors / exporter level. It is suggested that processing factory with ice plant and cold storage may be established in potential districts. But at the same time, it may also be integrated with other raw materials such as poultry, fish and meat products as shrimp production will be limited to only a few months. Almost all the farmers reported fluctuations of prices. The farm gate price the farmers realised ranged between Rs.250 to Rs.525 per kg. It was gathered from the respondents that the Ghazipur Mandi in Delhi has a capacity of absorbing about two to two and half tones of shrimp per day. In case of excess supply coming from the adjoining states, the price of shrimp becomes uneconomical, hence, most of the farmers are in touch with the agents of the export houses located at Visakhapatnam, Mumbai, Kolkata, Chennai and other places. Providing adequate information to shrimp growers at regular intervals by the Govt., or some industrial source is the need of the hour so as to minimize the marketing losses.

5. Availability of Credit and insurance

Considering the activity as highly capital intensive, some of the respondents felt that for pursuing shrimp farming on a commercial scale, there is a need for credit support on easy terms. However, it was reported that banks were not keen on financing the activity, may be, considering it a risky venture. The nodal departments also endorsed the view. There is need for popularising the activity amongst the bankers in the potential districts by effectively utilising the DCC, DLRC and BLBC platforms. The respective DDMs of NABARD and the nodal departments need to play a proactive role in the matter. Two of the various respondents visited, reported their need for credit support and also non- inclination of the banks in providing the required assistance.
Apart from the bank credit, providing adequate insurance cover under the activity is also the need of the hour. Lack of insurance policy may also be a reason for the banks not supporting such a venture. Hence, the Govt. / Insurance companies may make appropriate crop insurance policies for Vannamei/shrimp culture on similar lines as existing in agriculture and allied sectors.

6. Role of Nodal departments in promoting the activity

The respective nodal departments in the states are providing guidance and other technical support to the prawn farmers, but, being a new activity in the northern part of the country, it was felt that there was a need for upgrading the skills and improving the awareness and technical knowhow of the departmental officials about the activity and its commercial aspects. Further, it was observed that no subsidy was being provided at Rajgarh, district Churu, Rajasthan to the shrimp farmers. Even farmers at Rajasthan were not aware of incentive in the form of GoI subsidy for undertaking the shrimp cultivation. Interactions with the department revealed that the Government of Rajasthan has so far not approached GoI for taking up the subsidy programme on shrimp and related activities in their state. They would be doing so from the year 2019-20. Considering the importance of the activity, the nodal departments need to be more active in all the states.

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Chapter - VI

Economically viable model on vannamei farming -- Replicable in North Indian conditions

After visiting and interacting with various farmers and nodal departments in different districts of three important and potential north Indian states, where, the Vannamei farming has already begun, the following replicable model is being suggested. The model is proposed along with the economics and financial viability has been assumed for farmers who can adopt the shrimp farming in one acre of brackish lands or areas where the ground water has a salinity in the range of 5 ppt. to 15 ppt.

Table No 4 : Break-up of model unit cost

A	Capital Cost	Unit	Quantity	Rate (Rs)	Amount (in Rs)	Remarks
1	Earthwork for construction of pond by tractors and dozers / machinery - 1.50 meters depth and 1.0 meters free board	Acre	50	1,600	80,000	50 hrs / acre @ Rs.1600/- per hr. Time required is about 05 days
2	Cemented pond for seed rearing 8.5m X 8.5m X 1.4m	cubic meter	108.375	900	97,538	Material plus labour cost @ Rs.900/cum
3	Bore well and pump sets	Nos	1	80,000	80,000	180 feet deep, 01 no including 12 HP submersible pump set
4	HDPE poly lining	Area	1	2,40,000	2,40,000	500 micron width, 4000 sq.ft. size inclusive of laying cost
5	Office, laboratory and stores	Sq.ft	225	250	56,250	--
6	Watchman shed cum room	Sq.ft	120	250	30,000	100 sqft watchmen shed
7	Sludge Pump	3 HP	1	20,000	20,000	Pipe plus foot valve
8	Aerators	2 HP	4	35,000	1,40,000	Cost includes cable, starters etc.
9	Small generator or Engine for operation of the aerators	15 HP	1	40,000	40,000	Including shafts and other fittings

10	Bird scare/ Bird net	Sq. mt.	4,000	6	24,000	4,000 sq mt @ Rs.6 per sq. mt
11	Lab and farm equipment	LS	LS	33,000	33,000	Digital meter for pH, DO, salinity, conductivity etc. chemicals /other reagents
12	Miscellaneous equipment	LS	LS	10,000	10,000	--
	Subtotal (A)				**8,50,788**	
B	**Operational cost for first crop (1acre)**					
1	Cost of shrimp seed - 30 days reared after PL 14 stage (30 DOC stage)	Re	1,60,000	1	1,60,000	Stocking density @40 nos/sq. m.
2	Feed	kg	4,704	70	3,29,280	FCR @ 1 : 1.4
3	Chemicals and manures for pond preparation (Lime, potash, magnesium and calcium)	kg/acre	--	--	1,00,800	Depends upon the salinity as also existing quantity of minerals in the water. - Cost assumed @ Rs.30 / kg of harvested shrimp
4	Cost of probiotics, mineral mixture and growth promoters	kg/acre	--	--	50,400	Cost assumed @Rs.15 per kg of harvested shrimp
4	Electricity/Power /Diesel charges	LS	LS	20,000	20,000	Lumpsum
5	Repairs and maintenance	LS	LS	15,000	15,000	Lumpsum
6	Harvesting charges	per kg	3,360	3	10,080	Rs. 3 per kg
7	Watchman cum labour	1	4	8,000	32,000	For one crop
8	Misc. expenses	LS	LS	10,000	10,000	Lumpsum
	Subtotal (B)				**7,27,560**	
	Grand Total (A+B)				**15,78,348**	

Table No 5 : Means of Finance (Rs.)

Total Financial outlay	15,78,348
Margin 15%	2,36,752
Financial Assistance	13,41,595
Rate of Interest (%)	12

Table No 6 : Production and Income (in Rs.)

1	Production from 1 crop (kg) in 1 acre	3,360
2	Price per kg (for 30 gms size)	330
3	Price per kg (for 20 gms size)	260
4	Operational cost for one crop in a year	7,27,560
5	Total income from 1 crop in Ist year	11,08,800
6	Operational cost for two crops in a year	14,55,120
7	Total income from 2 crops from IInd year onwards	17,32,800

Table No 7 : Some Assumptions

1	Farm size (water spread area) in acres	1
2	Culture period : Ist crop (April - June) in months	4
3	Culture period : IInd crop (August - October) in months	3
4	Stocking rate 40 Nos / sq.m	1,60,000
5	Survival rate (%)	75
6	No of pieces at harvest (Nos)	1,20,000
7	Harvest size (average) Ist crop in Ist year (gms)	28
8	Harvest size (average) IInd crop in the 2nd and subsequent years (gms)	20
9	Production Ist crop (kgs)	3360
10	Production IInd crop (kgs)	2400
11	Water exchange	No, only sludge removal every fortnight
12	Feed Type	Formulated feed
13	No of crops per year	Two, one crop in the first year
14	FCR	1 : 1.40

Table No 8 : Financial Analysis - *Litopeaneus vannamei* culture - 1 Acre Model

Year	1	2	3	4	5	6	7	8
Capital Cost	850788	0	0	0	0	0	0	0
Recurring Cost	727560	1455120	1455120	1455120	1455120	1455120	1455120	1455120

Total Cost	**157834 8**	**145512 0**	**145512 0**	**145512 0**	**145512 0**	**145512 0**	**145512 0**	**145512 0**	
Income	1108800	1732800	1732800	1732800	1732800	1732800	1732800	1732800	
Net Benefit	**-469548**	**277680**	**277680**	**277680**	**277680**	**277680**	**277680**	**277680**	
Disc. Factor @15%	0.870	0.756	0.658	0.572	0.497	0.432	0.376	0.327	
PWC @ 15%	1372476	1100280	956765	831970	723452	629089	547034	475681	**6636746**
PWB @ 15%	964174	1310246	1139344	990734	861508	749137	651424	566455	**7233022**
Net Present Worth (PW Benefit - PW Cost)				596276					
Benefit Cost Ratio (PW of Benefit / PW of Costs) at 15%			**1.09**	**: 1.00**					
Internal Rate of Return			**57%**						

Table No 9 : Repayment schedule of L. vannamei - 1 Acre Model

Means of Finance	Amount in Rs.
Total financial Outlay	15,78,348
Margin @ 15%	2,36,752
Financial Assistance	13,41,595

(Amount in Rs.)

Year	O/S loan at the beginning of the yr.	Net Income	Interest	Principal	Total outgo	Bank loan O/S at the year end	Net Surplus	DSCR
1	1341595	1108800	1502587	0	1502587	1341595	-393787	0.00
2	1341595	1732800	1502587	191656	1694243	1149939	230213	1.02
3	1149939	1732800	1287932	191656	1479588	958282	444868	1.17
4	958282	1732800	1073276	164277	1237553	794005	659524	1.40
5	794005	1732800	889286	136897	1026184	657108	843514	1.69
6	657108	1732800	735961	113429	849390	543679	996839	2.04
7	543679	1732800	608920	93873	702793	449806	1123880	2.47
8	449806	1732800	503783	77668	581451	372138	1229017	2.98
Repayment period : 8 years with one year moratorium						**Average DSCR**		**1.82**

The model may be replicable in all the northern states of the country especially in western Uttar Pradesh, plains of Uttarakhand, Rajasthan, Punjab, Haryana and rural

areas of the NCR. Some of the costs which are at the discretion of the farmer or the financer are as under.

a) HDPE poly-lining of the pond may be included in case, the soil is pervious. This will be on case to case basis.
b) The source of water could be bore well or from the canal. For the sake of economics, bore well component has been assumed.
c) It is desirable that all the farmers provide for a nursery pond in the project so that they could stock their ponds with advance sized seeds (30 DOC stage). This will facilitate better survival and more so, the farmer will be in a position to take two crops in a year. A cemented pond of 108.375 cubic meter has been assumed as the nursery area.

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Chapter-VII

Summary and Conclusion

A. Summary

Based on a five days study taken up on Vannamei shrimp cultivation in Rohtak district of Haryana, Churu district of Rajasthan and Mathura & Hathras districts of Uttar Pradesh, a summary of the analysis related to the prospects, suitability and best management practices in cultivation of the shrimp in north India with special reference to Western UP, Haryana and Rajasthan is presented as under.

1. Considering the importance and profitability of shrimp farming, the respective Fisheries Departments in different states are playing a positive and proactive role by providing the farmers the necessary information and guidance. They are also providing the farmers incentive in the form of subsidy under the Neel Kranti Mission (Blue Revolution Scheme), except in the state of Rajasthan.

2. Being relatively expensive and to some extent risky and skilful venture, as at present, SF/MF are not coming forward to adopt the activity in a big way. Most of the entrepreneurs are large farmers, who have relatively more risk bearing capacity.

3. The Regional Centre of the Central Institute of Fisheries Education (CIFE, ICAR) situated at Rohtak, Haryana is instrumental in providing regular extension services, water testing facility and offering training programmes for farmers in all the four states.

4. The average size of the shrimp ponds observed was of one acre, where, semi intensive shrimp farming was being practiced by the farmers with an average production of about 3,500 kg per crop. The farmers had constructed ponds not only on own land but had also taken saline wasteland from fellow farmers on area under long term lease. Except for the farms in Uttar Pradesh (Mathura and Hathras districts), where the source of water for the ponds was by canals, in most of the farms in Rajasthan and Haryana, the source of water was bore wells. In case of seepage, the farmers resorted to HDPE poly-lining of the pond bottom, which increased the cost of farming by about Rs.2.30 lakh/acre.

5. Many of the farmers were adopting the home made slurry treatment for enhancing the pond productivity, besides other inorganic fertilizers. Prawn seed and the formulated feed (with high protein) including other inputs like the probiotics, mineral mixture etc. were brought from different places in South India. Procurement of quality feed and other inputs from far off places increased the cost of shrimp farming.

6. The average stocking size of shrimp seed ranged between PL-10 and PL-14 with an average stocking density of 25 to 50 nos per square meter. The seed costing nearly 70 paise per seed at the farm site was brought from various registered hatcheries located at Visakhapatnam, Pondicherry, Chennai, Nellore by air till New Delhi followed by road transportation till the farm site.

7. The shrimp farms located at various places had salinity ranging between 2 and 14 ppt. Interaction with the CIFE, Rohtak centre and other experts revealed that a salinity ranging between 5 and 15 ppt was quite satisfactory for the shrimp growth.

8. All the farmers had the awareness that the pond has to be kept clean and as a result were using sludge pumps or other means to clean the bottom sludge. On an average, four 2 HP aerators were being used in an acre of pond to enhance the dissolved oxygen content.

9. Maintaining essential water parameters like dissolved oxygen (DO2), pH, ammonia, nitrates, alkalinity, hardness and elements like potash, calcium, magnesium etc. is a crucial aspect of shrimp farm management. These parameters decide the growth and survival of the shrimps and hence directly linked to the profitability aspect. Close monitoring of these parameters by the farmers was not being done due to lack of water testing kits and suitable laboratories in most of the potential districts.

10. The average growth rates ascertained by interacting with the farmers was about 25-30 gms in about 100 days of culture with a survival of about 75 percent. The final shrimp production rate ranged between 6.3 tons and 12.0 tons per hectare per crop depending on stocking density, growth rate and mortality levels.

11. Considering lower temperatures during November to February, most of the farmers were taking a single crop of shrimp i.e. from April/May till July/ August. However with seed rearing arrangements, taking two crops in a year was possible as demonstrated by a few farmers.

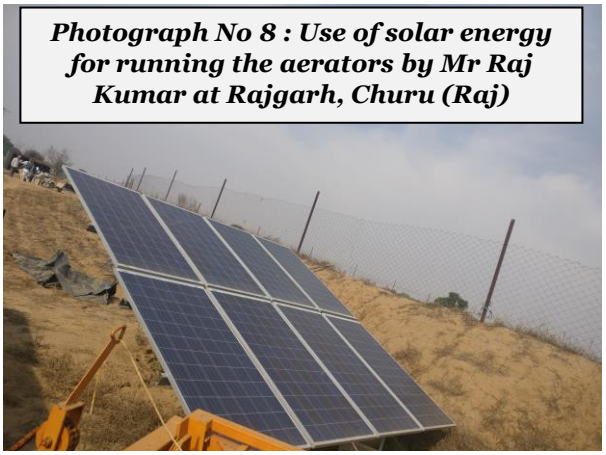
Box No 1

Successful endeavours of Shri Raj kumar from Village Shyopura, Tehsil Rajgarh, District Churu

He holds more than 10.0 hectares of waste saline land in a remote village of district Churu. The land used to be bane for the farmer until he came to know about the Vannamei shrimp farming from some relatives. The highly pervious barren land area was got excavated and a shrimp pond was created in 01 hectare in May 2017. Three bore wells ninety feet deep were sunk so as to get water with salinity of near 15 ppt. Being extremely pervious, the pond was lined with 500 micron HDPE film.

The first year yielded him 6,000 kgs of shrimp harvest followed by 8,000 kgs harvest in the next year. Today, the farmer has about 3.20 hectares of area under shrimp farming and 3.0 hectares of new area is under construction. The total shrimp production reported by him in 3.20 hectares is about 24,000 kgs. The farmer is able to fetch a farm gate price of Rs.380/kg of shrimp with an income of Rs.1.04 crores per year. The farmer is using solar energy for operating aerators as also electricity for the farm.

A silent revolution is in the making and the activity has become a game changer for the farmer. Nearly 20 more farmers have adopted the activity in the nearby villages after seeing his success.



Photograph No 8 : Use of solar energy for running the aerators by Mr Raj Kumar at Rajgarh, Churu (Raj)

12. Most of the Farmers resorted to completely harvesting their ponds so that they could sell the entire catch at one go. The harvest was sold at Delhi market as also to agents of processors and exporters situated at Mumbai, Kolkata, Chennai Visakhapatnam, and in Gujarat. Delhi market being highly fluctuating, most of the farmers preferred selling their produce to the exporters. The average price realised when the harvest was sold to the exporters/processors ranged between Rs.350 and Rs.400 in comparison to Rs.250 to Rs.350 realised at the Ghazipur Mandi in Delhi.

13. None of the ponds visited reported any sort of environmental or disease risk as the stocking density of the shrimps was less than 50 nos/sq. m. However, some of the other risks from the point of view of the farmers could be poor quality shrimp post-larvae supplied by hatcheries resulting in poor growth, price fluctuations of the shrimp in the market and the most important being fluctuations in the water parameters.

14. Considering the activity as highly capital intensive, the respondents reported that there was a need for credit on easy terms for pursuing the activity. It was reported that Banks were not very keen to finance the activity considering it to be a risky venture. There is need for popularising the activity amongst the bankers in the potential districts by using the DCC, DLRC and BLBC fora. The respective DDMs of NABARD and the nodal departments need to play a proactive role in the matter.

15. The overall activity can be considered to be economically quite viable since, it is being carried out at areas which otherwise cannot be used for any other farm purposes. After interacting with various stake holders, a replicable one acre model for Vannamei shrimp farming in north India has been suggested with a total outlay of Rs.15.78 lakh per acre. The total income from one acre of shrimp farming is expected to be about Rs.11.09 lakh in the first year followed by Rs.17.33 lakh in the second and subsequent years. The model is replicable in all the northern states of the country especially in western Uttar Pradesh, plains of Uttarakhand, Rajasthan, Punjab, Haryana and rural areas of the NCR

B. Conclusion

In many of the inland states of our country, the subsoil water has become saline due to some or the other reasons. The saline / semi saline water also referred to brackish water is available in many of the northern states like Rajasthan, Western Uttar Pradesh, parts of Punjab and Haryana. In view of no other livelihood options available in such areas, the farmers have been looking for some productive alternatives. One of the easily adaptable marine prawn species viz. *Litopeaneus vannamei* popularly called as the

Pacific white shrimp, due to its wide tolerance to salinity and also because of its hardy nature, has been cultivated by the farmers with success in northern Indian states.

There is a need for conducting specialized intensive training on prawn farming for the existing as well as prospective farmers. More soil/water testing laboratory also need to be established in potential districts as the entire shrimp farming depends upon the stability of the water parameters like DO2, pH, ammonia, nitrates, alkalinity, hardness and elements like potash, calcium, magnesium etc. Further, establishment of processing/storage facilities for prawn faming along with other meat products in potential districts will go a long way popularising the activity as also benefitting the farmers.

The activity which is immensely popular in the coastal belt of the country has also been proved to be an economically viable activity in the saline lands of north India. Many shrimp farms on a large scale are coming up in areas which are not only arid and semi-arid, but, where the ground water cannot be used for any other purpose due to high salinity. As gathered from the Department of Fisheries, Rohtak and the CIFE, Rohtak, number of farmers/entrepreneurs practicing the shrimp culture under their guidance are increasing progressively. The following table gives an indication that increasing number of farmers are getting themselves trained and practicing the shrimp farming in the northern states.

Table No 10

Year	No of farmers taking up shrimp farming in district Rohtak	No of farmers seeking guidance or trained by the CIFE, Rohtak till December 2018	
2014-15	6	Haryana	212
2015-16	22	Punjab	250
2016-17	24	Uttar Pradesh	80
2017-18	105	Rajasthan	20
2018-19	140	Delhi	2

In fact, the success of the prawn species in north India can be a game changer not only for the farmers but also for the country as whole as prawn is not only a high value commodity but also has a high export value. Besides other benefits, shrimp farming in saline wastelands of north India has also immense potential for generating employment on a long term basis.

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