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Economic evaluation of white shrimp *Litopenaeus vannamei* farming in Punjab, India

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Abstract
White shrimp *Litopenaeus vannamei* farming has become a profitable venture for inland saline water areas in India and has noted remarkable growth during the last decade especially in Panjab. Region specific and viable aquaculture technologies are desirable to overcome the dual problems of salinity and waterlogging in Punjab. *Litopenaeus vannamei* farming which has become a profitable venture for inland saline water areas. In order to fulfil the contribution towards the uplift of their socio-economic status of the farmers, quantification of economic indicator venture could earn them more profit which can further be increased to manifolds by increasing cropping intensity in a year. An innovative attempt has been made to assess the economic viability of *L. Vannamei* farming in inland salt water affected areas of Punjab.

Keywords: Punjab, Viable. Saine water, economic indicator, profit

Introduction
White shrimp *Litopenaeus vannamei* is a decapod crustacean which occurs in the Gulf of Panama and its range in the eastern Pacific is from Sonora, Mexico, south to Tumbes, Peru (Perez-Farfante and Kensley, 1997) [4]. It has been introduced widely around the world since the 1970s. *L. vannamei*, first introduced in 1980 in the Philippines, followed by Taiwan in 1981 and mainland China in 1988. In 1996, mainland China and Taiwan started commercial production of *L. vannamei* and from there, aquaculture production spread rapidly to other nations in Asia, including Thailand, Indonesia, Vietnam, the Philippines, Malaysia and India (Rosenberry, (2004) [9]. Asia (particularly China, Thailand and Indonesia) now produces 75% of the worlds *L. vannamei*, with only 25% being produced in its original Western hemisphere.

Out of total 6.74 million ha salt affected (including coastal saline soil) areas in India, around12lakh ha is located in the non-coastal Indo- Gangetic plains of Northern India, including seven states *viz*, Punjab (1.51 lakh ha), Haryana (2.32 lakh ha), Rajasthan (3.75 lakh ha), Bihar (1.53 lakh ha), Uttar Pradesh (1.37 lakh ha), Madhya Pradesh (1.39 lakh ha) and Jammu and Kashmir (0.17 lakh ha) Development of viable, sustainable and suitable technologies for utilization of inland saline areas has been marked as a national priority by the Government of India. The states of Haryana, Punjab, Rajasthan and Uttar Pradesh are the worst affected with underground water salinity. Non-utilization of saline waters in these areas is leading to the problem of water logging and secondary salinization. South western districts of Punjab like Bhatinda, Faridkot, Firozepur, Mansa and Muktsar are also affected with ground water salinity, Dhawan *et al.*, (2010) [1] and reported salinity between 23- 165 ppt in some villages like Bhudda, Gujjar and Channu in Muktasar district of Punjab, Dhawan *et al*., (2009) [1].

Scientists have reported on the growth and survival of *L. vannamei* in different salinities and densities (Wyban *et al*., 1988; Samocha *et al*, 1993; Samocha., *et al*, (1999). Emberson and Samocha, (1999) [16, 12, 11, 3] recommended a salinity range of 10 – 35 ppt was ideal for shrimp farming. Samocha *et al*, 2004; Sowers and Tomasso, 2006 reported that growth is higher in low saline (2 ppt) water than in sea water. Punjab state has suitable land for aquaculture for taking up shrimp farming. Department of fisheries, Punjab is regularly highlighting the need for continuous development of innovative techniques and modernization in *L.vannamei* farming.

Implementation of such measures can not only enhance the shrimp farming but also improve the livelihood of shrimp farmers and help to contribute towards commercial shrimp farming.

Punjab Scenario

In recent years, white shrimp *Litopenaeus vannamei* farming has played a dynamic role by providing alternative source of income for farmers along the saline groundwater areas in Punjab and is considered as a socio-economic development. Shrimp farming practices have attracted considerable attention for its food supply and became a profitable employment. Since development of *Penaeus monodon* shrimp farming has been stagnant since 1995, due to White Spot Syndrome Virus (WSSV), *L vannamei* farming is introduced. Punjab contributes shrimp production doubled in inland saline ground water area. State has suitable land for aquaculture for taking up shrimp farming. Department of fisheries, Punjab is regularly highlighting the need for continuous development of innovative techniques and modernization in *L.vannamei* farming. Implementation of such measures can not only enhance the shrimp farming but also improve the livelihood of shrimp farmers and help to contribute towards commercial shrimp farming.

Litopenaeus vannamei white shrimp farming has been recently introduced on commercial scale by Fisheries Department, Punjab which is new way of farming in saline affected districts namely Mansa, Bathinda, Sri Muktsar Sahib, Fazilka, Ferozepur and Faridkot. Many parts of this land area are useless for any agricultural or horticultural activities due to the high saline nature of soil and ground water. Being the least rainfall region of the country, the I am very happy to learn that more and more farmers are adopting *L. vannamei* farming in Punjab with the guidance and under supervision of Fisheries Department. Farmers are coming forward and using their zero earning land of saline affected areas for *L vannami* shrimp farming in order to earn very good income within 120 days.

With continuous technical support from Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) from 2007 to 2018 and the promotional activities of the state government from 2016 to 2018 implemented by the Fisheries Department of the State, about 250 ha of salt-affected, waterlogged lands in the southwest district have been converted into aquafarms during the last five years, including freshwater carp culture in low-saline (≤ 5ppt) areas and *L. vannamei* culture in medium- to high-saline areas (10 to 25 ppt). In 2017, shrimp farming was carried out in 15 ha of salt-affected areas of Punjab, which increased to 92 ha in four districts (Fazilka, Sri Muktsar Sahib, Mansa and Bathinda) during 2018, and is expected to increase further to over 200 ha in 2019 (Meera *et al.*, 2019).

Success of first pilot project on aquaculture in inland saline area by the university, under pioneering funding by the Punjab State Farmers Commission (2007-2010), was recognized and financially supported by the Indian Council of Agricultural Research (ICAR). First fish harvest from the waste lands attracted the attention of the farmers and subsequent adoption in the village increased the area under aquaculture from 1 ha in 2010 to about 30 ha in 2015; with an average annual earnings of Rs. 1,50,000/ha. Encouraged by successful culture of freshwater carps in low saline area, university further took the challenge of utilizing medium to high saline area for aquaculture and conducted the preliminary *L vannamei* shrimp culture trial in village Shajrana (2013), followed by first commercial farming trial in village

Painchanwali (District Fazilka) in 2014, which also reaped rich harvests beyond expectations of the villagers. Impressed by the outcomes of the said aquaculture trials (fish and shrimp), Government of Punjab sponsored *L vannamei* culture demonstration project in village Rattakhera (District Sri Muktsar Sahib) in 2016; through State Fisheries Department under technical guidance of GADVASU and Regional Centre of ICAR- Central Institute of Fisheries Education (CIFE), Rohtak, Haryana. After overwhelming success of the said demonstration project, the State Government initiated start-up promotional scheme (financial assistance/subsidy) for aquaculture in inland saline areas which motivated the farmers to adopt shrimp farming in state; with consequent increase in culture area from 37.5 acres (in 2017) to 230 acres (in 2018) and approximately 350 acres in 2019. As we know, shrimp is the major aquaculture commodity contributing more than 60% to the India's total export earnings (over Rs. 46,000 crores) from fisheries; hence, shrimp farming in inland saline areas is expected make significant contributions to state and national economies.

Village Korvala, Mansa district of Punjab was harvested a crop of 8.36 tonnes from market value 23.5 lakh, against an operating cost of Rs 15.5 lakhs /ha for/140days, thus resulting in a net profit of Rs 8.00 lakhs/ha (Singh *et al.*, 2019). Punjab are estimated to have provided employment to approximately 2800 people (including forward/backward supply chain). With further expansion of the sector and subsequent establishment of processing hub in the region, employment potential is expected to grow @ 30 for every hectare of shrimp farming development. Only 1% (1500 ha) conversion of available saline resources is expected to produce 10,000 tonnes of shrimp from one crop (worth 300 crores) and generate employment opportunities for 45,000 people, Singh *et al.*, 2022) [13].

Expansion in Shrimp farming in Punjab

The five years continuous increase after initial trial, in number of farmers, area of shrimp farming, shrimp production indicates that farmers have readily accepted this diversified form of allied agriculture activity. These are given in following table. This has to be seen as a sign of new entrepreneurship developing from the very zero earning land resources which hitherto remained devoid of any fruitful activities. For mobilising their share of investments, most of them have borrowed money from the relatives and market. This way, society is helping the poor farmers to initiate shrimp farming to come out from the vagaries of purity and indebtedness.

From one farmer involved in shrimp farming trial in 2016, the shrimp farming increased to 14 farmers in 2017; to 97 farmers in 2018-19 and now gone up to 133 farmers in 2019-20. From one acre in trial during 2016, increased to 37.5 acre in 2017; 252 acres in 2018-19 has gone up to 410 acre in 2019-20. About 750 tons of shrimp was produced in 2019-20 compared to 520 tons in 2018-19 and 121.85 tons of shrimp in 2017-18. In 2018-19 shrimp rate was bit lower and 520 tons at a average farm gate price Rs 280-300, the total value of shrimp was Rs 14 to 15 crore. In 2019-20, about 750 tonnes shrimp at the average rate of Rs. 300-320, has been valued at 22 crore to 24 crore. With scientific and careful handling of shrimp farming, Rs. 3-5 lakh per acre profit can easily be achieve.

Table 1: Year wise expansion of farming area, and production and number of farmers in Punjab.

S. No	Year	Area under shrimp farming (in acre)	Shrimp production in tonnes	No. of farmers
1	2016-17	0,4 Trail (Sri Muktsar Sahib District)	4.00	1
2	2017-18	14.8	121.00	14
3	2018-19	100.8	520.00	67
4	2019-20	164	750.00	133
5	2020-21	156.74	787.88	133
6	2020-22	334	1500.00	259

Since presently, the culture duration for producing shrimp is only 4- summer months, but the farmers of northern India can easily take two crops per year between March and November. This way the profit in the same year can be multiplied by the farmers.

A Demonstration Farm cum Training centre has been established by the Department of Fisheries, Government of Punjab at Ena khera district Sri Muktsar Saheb which is suitable for shrimp farming from technical point of view.

Materials and Methods

With this background, an attempt has been made to assess an economic viability of *L.vannamei* faming done between the study periods 2019 to 2021. Among the six Mansa, Bathinda, Sri Muktsar Sahib, Fazilka, Ferozepur and Faridkot districts, district exist in the extreme part of south west Punjab. To assess the socioeconomic status of *L.vannamei* shrimp farmers there, and primary data was collected through interviewing 30 shrimp farmers by using pretested structural questionnaire. Secondary data was also collected from Department of Fisheries Ministry of Fisheries, Animal Husbandry and Dairying, New Delhi. Collected data was then analysed by using statistical software SPSS version 20.0. To estimate the various cost and income and to obtain profitability measures Dhondyal., (1998) [2], Lekhi and Singh,, (1999) [5] such as gross profit, net profit, pure profit, return to capital, output input ratio, rate of return and benefit cost ratio Raju and Rao,, (1993) [8], farm business analysis is used.

Table: 2: Farming of White shrimp *Litopenaeus vannamei* in 1. ha (2.5acres) of inland saline area technical inputs and financial requirements and gains

Sl. No	Parameters	Average Cost in (RS/ha/yr)
A	**Non -recurring**	
1	Cleaning, cutting & de-rooting bushes	50,000
2	Pond construction	4,00,000
3	Poly Lining 150 M2 (150 x Rs.10,000)	15,00,000
4	Tube wells pump sets (1)	3,00,000
5	Aerators, 2 H.P (10 Nos x Rs.45000)	4,50,000
6	Diesel Pump set 5 H.P (2Nos)	50,000
7	Generator set 125 KV	3,00,000
8	Miscellaneous	50,000
	A Sub- total	31,00,000
B	**Recurring**	
1	Land Lease (per year)	25,000
2	Seed (5 Lakh)	3,75,000
3	Feed (1:1.25) (15 tonnes x Rs.75,000)	10,50,000
4	Manures and Fertilizers	50,000
5	Muriate of Potash	50,000
6	Soil and water probiotics	50,000
7	Manpower (2 persons for 4 months)	56,000
8	Diesel and electricity	1,25,000
9	Miscellaneous	50,000
	B Sub-total	18,31,000
	Grand total A + B = C	49,31,000
	Total production: (12000kg/ha/crop of 120 days)	
	Grass income (Sale of 12 tonnes x 3,00,000/tonne)	36,00,000
	Recurring Cost	18,31,000
	1/7 of Capital	4,43,000
	Interest	5,92,000
	Total Expenditure	26,66,000

Source: Department of Fisheries, Government of Punjab

Economic indicators

From the Firozpur shrimp farmers of *L.vannamei* farming in Panjab has to bear total variable cost depends on 16 variables in all which comes as Rs. 18,31,000/ha/yr. Details of these cost for each variable is given in the above Table 2.

From the table it is clear that farmer has to bear the major cost of feed and seed used for the farming. Nearly, 90% *L.vannamei* farmers purchased seed from Coastal Aquaculture Authority (CAA) approved Specific Pathogen Free (SPF) hatchery from Andhra Pradesh and Tamil Naidu,

while rest of them purchase from other state hatcheries. Average seed cost comes out as Rs.3,50,000 /ha/crop of total variable cost. All the farmers follow feeding rates in different sizes and grade suggested by the feed supply company. The average cost of feed come out as Rs. 10,50,000 /ha/crop 18,31,000 of total variable cost. Now to explore that to what extent *L.vannamei* farming is profitable venture for them, quantification of economic indicators has been done and is listed below in the table 3. It takes nearly Rs 14 lakh to dig a pond in one hectare (2.5 acres), and purchase seed, feed and equipment.

Table 3: Economic indicators and their quantification per hectare in one crop

S. No	Economic Indicators	Quantification Indicators	Statistics/Calculation
1	Total Fixed Cost Non -recurring)	31,00,000	A cost that doesn't change with an increase or decrease in the level of production is known as total fixed cost and has to be borne by shrimp farmer in long run. (Initial cost)
2	Total Variable Cost (Recurring)	18,31,000	Variable cost is the part of the total cost and changes with a change in output level. (Operational cost)
3	Total Cost	49,31,000	Total Fixed Cost+Total Variable Cost
4	Yield or Production	12,000	It is defined as the production of shrimp per hectare per year and expressed in kg/ha/yr.
a	Feed Conversion Ratio	1.25	Feed Intake/Weight Gain
b	Feed Conversion Efficiency	125%	Feed Intake / Weight Gain*100
5	Gross Income	36,00,000	Quantity of Produce *Selling price
	Total Expenditure	26,66,000	Recurring cost+1/7 of Capital+ Interest
6	Net Income	9,34,000	Gross Income -Total Expenditure
7	Gross Profit	17,69,000	Total Return –Total Operational Cost
8	Net Profit	9,34,000	Total Return –Total Cost
9	Pure Profit	8,78,000	Net Profit–Opportunity Cost of Family Labour
10	Return to Capital	32.9	Net Profit–Unpaid family labour/ Total Cost*100
11	Output-Input ratio	1.35	Total Returns/Total Cost
12	Benefit Cost Ratio	1.35	Gross Income/Total Cost
13	Net Benefit Cost Ratio	0.35	Benefit Cost Ratio -1
14	Pay-Back- Period	120	Number of years required to recover the investment
15	Rate of Return on Investment	30.1%	Gross Farm Income/Total Investment * 100
16	Rate of Return on Variable Cost	51.0%	Gross Farm Income/Variable cost* 100

Conclusion

L. vannamei farming brought a greater up-lift to their socio-economic status under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), the Central and state and governments give 40 to 60 per cent subsidy as per the eligibility to encourage initial start for shrimp farming. GADVASU (Guru Angad Dev Veterinary and Animal Sciences University) is an Indian veterinary university located in Ludhiana, Punjab was founded on August 9, 2005, as part of Punjab Agricultural University, to assist society by boosting livestock productivity, health, and disease prevention via integrated teaching and extension initiatives. Department of Fisheries, Punjab, Central Institute of Fisheries Education (CIFE), GODVASU and are regularly organizing short term training programmes and had helped them to increase their level of awareness. Operational feedbacks are also provided time to time by input supplier of seed, feed and equipment companies. About 20% of these farmers have constructed their farms in their own land and other 80% have constructed either in leased land or in their relative's land.

The socio-economic status of *L vannamei* farmers in Punjab will be improved better then present with the quantification of economic indicator venture and earns double the profit which can further be increased to manifolds by increasing cropping intensity in a year.

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