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**Development
of
Aquaculture in India
Challenges and Opportunities**



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Development of Aquaculture in India: Challenges and Opportunities

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Shrimp Farming Practices in Andhra Pradesh: A Case Study in West Godavari District

K. Swarupa Rani

Abstract

*The paper is an attempt to study the shrimp farming practices in West Godavari District of Andhra Pradesh. It gives an outline of shrimp culture operations in general and proceeds with an assessment of the farming practices of the sample shrimp farmers in the study area collected through a questionnaire. It discusses the problems and prospects of shrimp culture in the area. The findings of the study reveal that 95 per cent farmers adopt intensive culture system using *L. Vannamei* species. Above 60 per cent purchase seed from registered hatcheries, whereas 38.54 take it from local unregistered hatcheries. Almost 90 per cent of the farmers depend on private firms for knowledge source, and 73.34 per cent prefer three crops per annum. Though the farmers are aware of the prospects of the sector, they are facing a number of problems.*

Introduction

‘Shrimp culture’ is harvesting of shrimp or prawn in fresh or brackish water for human consumption. Traditional shrimp farming was started during 1960’s in the Asian region. In conventional paddy fields, shrimp was grown and harvested as a secondary crop. At the end of the last century, the shrimp farmers recognized the potential of shrimp culture in terms of gaining higher incomes than from agriculture. This attracted many farmers who began converting their rice fields, fish ponds, and salt beds into shrimp farms. Among the marine fisheries such as fish, shrimp, crab, and lobster, shrimp occupied an important position, obviously due to its higher demand and greater returns. However, the supply of captured shrimp declined in the 1970s, giving rise to cultured shrimp industry especially in the East Asian countries.

There are many species of shrimp available like *P. Monodon*, *P. Indicus*, *M. Ensis*, *M. Monoceros*, *M. Brevicornis*, *P. Semisulcatus*, *P. Merguiensis* and *P. Vannamei*, but only a few are chosen for farming due to their larger size and higher demand. The potential candidates for commercial farming are *P. Monodon*, *P. Indicus*, and *P. Vannamei*. Today, *P. Vannamei* (*L. Vannamei*) is extensively (95.59 %) cultured in West Godavari District, the area of the study.

Methodology

West Godavari District occupies the first place in inland shrimp culture in Andhra Pradesh with its production quantity of 100568.00 MT for 2015-16 year. Therefore, this district is purposively selected for the study. There are five revenue divisions in the district: Eluru, Narasapuram, Jangareddygudem, Kovvur and Kukunoor of which, only Eluru and Narasapuram are actively engaged in aquaculture. But the highest intensity of shrimp culture is found in Narasapuram division. Hence, this division is taken for the study.

Among the twelve mandals in Narasapuram division, Bhimavaram and Akiveedu mandals are purposively selected because they have the largest area under shrimp culture. Further, Vempa and Tundurru villages from Bhimavaram Mandal and Chinakapavaram and Kollaparru from Akividu Mandal are purposively chosen for the study as they have the highest number of shrimp farms. From these four villages, there are 454 farms registered at Regional Office, MPEDA, Bhimavaram. The percentage of unregistered farms is very minor as registration is made mandatory today. The selected farms consist of small, medium and large farmers too. The entire 454 farmers are taken as sample for the present study. The details of the farmers by village and farm size are provided in Table 1.

Table 1: Division of Sample Farmers by Village and Farm Size

Name of the Village	Scale of Farming (in acres)			Total
	Small (< 2)	Medium (2 to 5)	Large (>5)	
Vempa	82	20	28	130
Tundurru	38	46	20	104
Kollaparru	60	32	30	122
Chinakapavaram	11	25	62	98
Total	191	123	140	454

Source: Primary Data

A structured, pre-tested schedule-cum-questionnaire was prepared for collecting data on core farm operations, type of farming, scale of farming, pond size, species cultured, management practices, sale of produce, and knowledge extension. The entire primary data was collected during the period from June 2017 to May 2018. The data was classified and analysed both qualitatively and

quantitatively with the help of tabulation, calculation of means, percentages, bar charts, column charts, and pie charts. The perceptions of the farmers on the problems being faced in the field, positive and negative impacts of shrimp culture, farmers' expectations from the Government, and their willingness to continue in the sector were also collected through field visits and discussed.

Objectives

- To find out the farming practices of shrimp farmers in the study area;
- To analyse the best management practices being implemented in the study area; and
- To find out the farmers' perceptions, problems and prospects in shrimp culture.

Demographic and Socio-Economic Profile of the Sample Villages

The sample villages chosen for the current research are Vempa and Tunduru from Bhimavaram Mandal and Kollaparru and Chinakapavaram from Akividu Mandal in West Godavari District of Andhra Pradesh. Based on the secondary data about the concentration of shrimp culture, the two mandals from the district and the four villages from the two mandals are purposively selected for the study. A village-wise profile is presented in the following.

Vempa

Vempa is a large village in Bhimavaram Mandal of West Godavari District of Andhra Pradesh. It is a Gram Panchayat. The total geographical area of village is 2584 hectares. Agriculture and aquaculture are the main economic activities in the village. The latitude and longitude of the village are 16.4421° North and 81.5750° East respectively. It is situated 17 kilometers away from sub-district headquarter Bhimavaram and 79 kilometers away from district headquarter Eluru. Based on the Census 2011, the profile of the village is provided in Table 2.

Table 2: Profile of Vempa Village

Particulars	Male	Female	Total	%	Comparison with	
					District	State
No. of Families	-	-	1992	-	-	-
Population	3404	3488	6892	-	-	-
Children (0-6)	348	368	716	10.39	9.73	10.8
Schedule Caste	1035	1101	2136	30.99	20.62	16.41
Scheduled Tribe	12	10	22	0.32	2.77	7
Literacy	76.96%	70.35%	73.62%	73.62	74.63%	67.02%
Total workers	2231	1177	3408	49.44	45.04	46.61
						Contd.

Main workers	62.189	0	2974	87.27	38.97	39.06
Marginal workers	53	381	434	12.73	6.07	7.55
Sex ratio	-	-	1025	-	1004	993
Child sex ratio	-	-	1057	-	964	939

Source: Census 2011

The data shows that the literacy rate in Vempa is better than the state average (67.02 %) but a bit behind the district average (74.63 %). In terms of sex ratio, the village is far progressive than the district and the state. It is revealed that only about 50 per cent of the people are engaged in work either as main or marginal workers. The village has a considerable share of scheduled caste population, but the population of scheduled tribe is very meagre.

Tundurru

Tundurru is a large village located in Bhimavaram Mandal of West Godavari district, Andhra Pradesh. It is a Gram Panchayat. The total geographical area of village is 1672 hectares. Agriculture and aquaculture are the main economic activities in the village. The latitude and longitude of the village are 16.4752° N and 81.5850° E respectively. It is situated 13 kilometers away from sub-district headquarter Bhimavaram and 75 kilometers away from district headquarter Eluru. Based on the Census 2011, the profile of the village is given below in Table 3.

Table 3: Profile of Tundurru Village

Particulars	Male	Female	Total	%	Comparison with	
					District	State
No. of Families	-	-	1626	-	-	-
Population	2740	2678	5418	-	-	-
Children (0-6)	288	250	538	9.93	9.73	10.8
Schedule Caste	365	374	739	13.63	20.62	16.41
Scheduled Tribe	30	34	64	1.18	2.77	7
Literacy	77.61%	70.30%	73.98%	73.98	74.63	67.02
Total workers	1735	890	2625	48.44	45.04	46.61
Main workers	2215	0	2215	84.38	38.97	39.06
Marginal workers	51	359	410	15.61	6.07	7.55
Sex ratio	-	-	977	-	1004	993
Child sex ratio	-	-	868	-	964	939

Source: Census 2011

The data reveals that Tundurru is an advanced village with a literacy rate of 73.98 per cent, which is higher than the state but a little lower than the district. Just less than half of the population are engaged in work. The adult sex ratio and the child sex ratio raise doubts about the villagers' awareness about the protection of girl child, in spite of large-scale campaign against gender discrimination by the governments and Non-Governmental Organizations.

Kollaparru

Kollaparru is a small village located in Akividu Mandal of West Godavari district, Andhra Pradesh. It is under Rajulapet Gram Panchayat. The total geographical area of village is 1087 hectares. Agriculture and aquaculture are the main economic activities in the village. The latitude and longitude of the village are 16.6241° North and 81.3867° East respectively. It is situated 7 kilometers away from Akividu and 52 kilometers away from district headquarter Eluru. Based on the Census 2011, the profile of the village is presented in Table 4.

Table 4: Profile of Kollaparru Village

Particulars	Male	Female	Total	%	Comparison with	
					District	State
No. of Families	-	-	872	-	-	-
Population	1479	1415	2894	-	-	-
Children (0-6)	152	124	276	9.54	9.73	10.8
Schedule Caste	74	82	156	5.39	20.62	16.4
Scheduled Tribe	5	3	8	0.28	2.77	7
Literacy	70.76	68.24	69.52	69.52	74.63	67.02
Total workers	936	502	1438	49.7	45.04	46.61
Main workers	734	0	734	51	38.97	39.06
Marginal workers	367	337	704	48.95	6.07	7.55
Sex ratio	-	-	957	-	1004	993
Child sex ratio	-	-	816	-	964	939

Source: IndiKosh Website

The data displays that Kollaparru has better literacy rate than the state average, but is behind the district average. Almost 50 per cent of the population are engaged in economic activities of some sort. Surprisingly, the percentage of marginal workers is much closer to that of main workers in the village. The adult sex ratio and child sex ratio are disappointing. There is only a marginal percentage of scheduled castes and tribes in the village.

Chinakapavaram

Chinakapavaram is a large village located in Akividu Mandal of West Godavari district, Andhra Pradesh. It is a Gram Panchayat. The total geographical area of village is 3290 hectares. Agriculture and aquaculture are the main economic activities in the village. The latitude and longitude of the village are 16.6348° North and 81.4162° East respectively. It is situated 8 kilometers away from Akividu and 53 kilometers away from district headquarter Eluru. Based on the Census 2011, the profile of the village is provided in Table 5.

Table 5: Profile of Chinakapavaram Village

Particulars	Male	Female	Total	%	Comparison with	
					District	State
No. of Families	-	-	892	-	-	-
Population	1573	1538	3111	-	-	-
Children (0-6)	166	156	322	10.35	9.73	10.8
Schedule Caste	16	14	30	0.96	20.62	16.41
Scheduled Tribe	3	5	8	0.26	2.77	7
Literacy	73.49	68.38	70.96	70.96	74.63	67.02
Total workers	1040	392	1432	46.03	45.04	46.61
Main workers	616	0	616	43.02	38.97	39.06
Marginal workers	509	307	816	56.98	6.07	7.55
Sex ratio	-	-	978	-	1004	993
Child sex ratio	-	-	940	-	964	939

Source: Census 2011

The profile reveals that Chinkapavaram is an advanced village with a good literacy rate of 70.96 which is higher than the state average, but lagging behind the district average. Only a minor share of scheduled castes and tribes are noticed in the village. The village is mostly populated by forward communities. The sex ratio is poor in comparison with the district sex ratio. Only 46 per cent of the population is engaged either as main workers or marginal workers.

Overview of Shrimp Culture

Before studying the farming practices of the sample shrimp farmers, it is felt that an overview of the usual practices of shrimp culture is necessary to put the discussion into proper perspective. Shrimp culture has grown enormously in the recent years for the high economic value and exports demand of its produce. It is a high investment activity and consequently, corporate companies have also undertaken shrimp culture on large scale, introducing most advanced and scientific methods of farming into the sector. Right from the digging of the pond to the harvesting, a variety of farming operations are conducted with a meticulous care and precision for reaping the best harvest from the crop. Even pond size and design make a lot of difference in terms of safety, security and productivity.

Since shrimp are bottom dwellers, the bottoms of the ponds are taken special care in the beginning. They are treated with quick lime, agricultural lime and dolomite. They are thoroughly ploughed at a depth of 30 cm to remove the noxious gases in the soil. The water is pumped into the pond through effective filtration systems to a depth of 3-4 feet. It is treated with chlorine and left for a week. It is also treated with minerals probiotic yeasts before stocking. Biosecurity arrangements like bird netting and crab fencing are made. After quality and PCR tests, post-larvae in the range of 12-16 are procured from hatcheries.

They are stocked in the ponds after a suitable acclimatization process. The stocking density range is 70-100/m² and 120-150/m², depending on the culture system (intensive or semi-intensive).

Feeding is a major activity in shrimp culture. Farmers use formulated commercial pellets four times a day for feeding purpose. Other feed supplements are also supplied to promote the growth of the animals, avoid soft shell, and prevent diseases. Water management also plays a crucial role through culture period. Water is maintained at a depth of 1-1.3 m., and it is exchanged when the quality drops low or when health conditions of shrimp demand. Aerators are used to increase the percentage of oxygen and create water current for the accumulation of wastes in the center of the pond. At regular intervals, probiotics, minerals, zeolites, compounds that enhance dissolved oxygen, compounds that reduce ammonia and disinfectants are extensively applied to treat water and soil.

During the growth of the animals, weekly sampling is undertaken to check their health, growth and survival. Drag nets are used in most of the ponds for harvesting. The harvested shrimp are washed and packed with ice in trays. Labor management is very important in the day to day activities, and particularly during harvesting.

In spite of the effective management practices being applied, there are many risk factors in shrimp culture. Environmental problems like floods, cyclones, prolonged high temperatures pose a big threat to farmers because shrimp are highly sensitive to climatic changes. The farmers are deprived of their due share of profits because of shrimp health problems like poor quality seed, mortality in early days of culture, undersized growth, and outbreak of diseases. Market-related complaints like low price and non-availability of buyers also impact the fortunes of the shrimp farmers. As shrimp are highly perishable by nature, farmers are forced to sell the produce even at low price. If they wish to wait till the prices shoot up, they need immediate processing and storage facilities for the produce.

Farming Practices of Sample Farmers

Farm management is highly crucial in shrimp culture since the species are very much sensitive to climatic conditions, changes in water quality, dissolved oxygen (DO) levels, wild life, pathogens etc. Many a time, disease outbreak is one of the principal reasons for inordinate losses in shrimp farming. Therefore, it is inevitable for the farmers to take care of everything from pond preparation to harvesting. The key risk pathways usually identified for pests and diseases are water, wildlife, feed (raw materials contaminants), people and stock. Efficient farm management helps in increasing the economic and environmental efficiency of the farm and ultimately makes shrimp farming sustainable.

Core Farm Operations

Pond Preparation

Pond preparation is the first activity taken up in shrimp culture. It is observed in the study area that almost all the farmers in the sample group attempt drying of pond, peeling off the outer layer, bleaching of pond, mineral application, water filling and water testing before filling, water disposal mechanism, crab fencing and setting-up of aerators. Biosecurity nets are observed in negligible number across the four villages.

Water Treatment

Water treatment and quality control in shrimp farms can be subdivided into three phases namely Inlet Water Management, Daily Water Management and Discharge Water Management. Inlet water is managed to promote an optimal ecosystem. But most ponds are not able to exchange their water on a regular basis due to their limited access to quality water. Probiotics, minerals, zeolites, ammonia reducer compounds, dissolved oxygen enhancer compounds and disinfectants are widely used at regular intervals to maintain pond water quality. In relation to discharge water management, it is observed that no proper arrangements are made across all the four villages. The farmers, except a few from Vempa village, discharge the water into a canal which is the source of water for cultivation. Ultimately it causes severe water pollution in and around the study area.

Water Testing

Regular water testing is necessary for maintaining the required water environment suitable for the shrimp. However, it is found in the sample villages that, due to lack of field-testing instruments, test kits and Polymerase Chain Reaction (PCR) labs, regular water testing is not fully followed in the study area.

Feeding

Feeding is one of the major activities on farm. As intensive system of culture is followed in the study area, all the sample farmers reported that they usually supply formulated commercial pellets four times a day for feeding purpose.

Weekly Sampling

After the seed are stocked in the pond, weekly sampling is a usual practice in shrimp culture. It is necessary to check their health, growth and survival. It is followed by all the farmers.

Drying of Pond

After every harvesting, pond drying is considered essential in shrimp culture. This practice, known as depopulation, is aimed at breaking reinfection cycle by

eliminating disease sources from ponds. But, in a rush for next crop, ponds are hardly dried between the crops in the study area.

Scale of Farming

The distribution of the respondents by scale of farming is given in Table 6. On the basis of scale of farming, the farmers in the study area are divided into three groups namely small, medium and large with below 2, 2 to 5 and above 5 acres respectively.

Table 6: Distribution of Respondents by Scale of Farming

Name of the Village	Scale of Farming (in acres)			Total
	Small (< 2)	Medium (2 to 5)	Large (> 5)	
Vempa	82 (63.07) (42.93)	20 (15.38) (16.26)	28 (21.53) (20)	130 (100) (28.63)
Tundurru	38 (36.53) (19.89)	46 (44.23) (37.39)	20 (19.23) (14.28)	104 (100) (22.90)
Kollaparru	60 (49.18) (31.41)	32 (26.22) (26.01)	30 (24.59) (21.42)	122 (100) (26.87)
Chinakapavaram	11 (11.22) (5.75)	25 (25.51) (20.32)	62 (63.26) (44.28)	98 (100) (21.58)
Total	191 (42.07) (100)	123 (27.09) (100)	140 (30.83) (100)	454 (100) (100)

Source: Primary data. (Figures in parenthesis are percentages)

Figure 1. Comparison by Scale of Farming

The data displays that about 42 per cent of the ponds belong to small scale while 27 per cent of them are medium in scale. Large scale farmers occupy 30.83 per cent of the ponds. The highest percentage of large size ponds were found in Chinakapavaram village of Akividu Mandal, which accounts for 44.28 per cent in the village. Tundurru village of Bhimavaram mandal has a low number of large size ponds, whereas small size ponds are high in Vempa and low in Chinakapavaram.

Type of Farming

Usually shrimp farming is divided into three types. They are extensive or traditional farming, semi-intensive and intensive farming. Extensive culture is considered as the simplest form of culture where seed stock come from the wild and supply is season-dependent. Stocking density is usually low i.e., in the range of about 3000-5000 fry per hectare. Further, supplementary feed is not given and water management is carried out by tidal exchange. In improved traditional or semi-intensive culture, stocking density varies from 20,000 to 50,000 per hectare. Supplementary feed, either formulated or fresh, is offered daily in addition to the existing natural food produced through the application of fertilizers. Water exchange is done by use of water pump.

Intensive type of culture is more sophisticated, which requires very high financial and technical inputs. The rearing facilities are provided in either earthen ponds or concrete tanks. The salient features of this culture are the complete dependence on hatchery-bred fry, high stocking density, use of formulated feeds, application of aeration to increase dissolved oxygen level in pond water and intensive water management. To gain high productivity from the unit of land, all the sample shrimp farmers are practicing intensive culture.

Species Cultured

P. Monodon, domestically called Black Tiger Shrimp, was the dominant species selected for farming in the study area till a decade ago. L. Vannamei, the dominant species now was introduced in 2006 in India. As the farmers reported, high duration of crop when compared to L. Vannamei and harvesting troubles are the major reasons for the farmers to shift from P. Monodon to L. Vannamei which is more resistant to diseases and has an excellent international demand. For all these reasons, L. Vannamei is grown as a single dominant species in the study area.

Table 7: Distribution of Respondents by Species Cultured

Name of the Village	Species		Total
	L. Vannamei	P. Monodon	
Vempa	122 (93.9) (28.11)	8 (6.1) (40)	130 (100) (28.63)
Tundurru	97 (93.26) (22.35)	7 (6.73) (35)	104 (100) (22.90)
Kollapurru	121 (99.18) (27.88)	1 (5) (1.31)	122 (100) (26.87)
Chinakapavaram	94 (95.91) (21.65)	4 (4.08) (20)	98 (100) (21.58)
Total	434 (95.59) (100)	20 (4.4) (100)	454 (100) (100)

Source: Primary data. (Figures in parenthesis are percentages)

Figure 2. Comparison by Species Cultured

Table 7 shows that 95.59 per cent of the respondents are farming L. Vannamei and only 4.4 per cent have chosen P. Monodon in the study area. It is noticed that 75 per cent of P. Monodon shrimp farmers belongs to Bhimavaram Mandal, and around 21 per cent belongs to Akividu Mandal. There is no specific reason found for this variation.

Source of Seed Purchase

Seed is the most important input in any farming in general and shrimp farming in particular. Successful shrimp culture depends mainly on the availability of healthy and quality shrimp seed. Lack of quality seed is one of the main constraints for scientific shrimp culture.

Table 8: Distribution of Respondents by Source of Seed Purchase

Name of the Village	Purchase of Seed			Total
	Local Hatcheries	Registered Hatcheries		
Vempa	52 (40) (29.71)	78 (60) (26.98)		136 (100) (28.45)
Tundurru	47 (45.19) (26.85)	57 (54.80) (19.72)		104 (100) (22.94)
Kollaparru	53 (43.44) (30.28)	69 (56.55) (23.87)		122 (100) (26.87)
Chinakapavaram	23 (23.46) (13.14)	75 (76.53) (25.95)		98 (100) (21.94)
Total	175 (38.54) (100)	279 (61.45) (100)		454 (100) (100)

Source: Primary data. (Figures in parenthesis are percentages)

Figure 3. Comparison by Purchase of Seed

The data in Table 8 shows that 38.54 per cent of the respondents purchase seed from local hatcheries where quality of seed is questionable, whereas 61.45 per cent of the respondents purchase seed from the registered hatcheries from Nellore, Vishakhapatnam etc. However, the farmers reported that they had experienced crop failures due to low quality of seed even when they used certified seed. And it is noticed that most of the local seed users are small farmers. Due to price differences, they buy from local hatcheries.

Sale of Produce

All the sample farmers reported that they sell their produce to the mediators who are sometimes input suppliers themselves. They do not have direct access to the importing agencies/states/countries. There are established traders who maintain strong ties with importing markets and who run exporting agencies in the nearby towns and cities.

Source of Knowledge Extension

As shrimp culture is a scientific activity, extension of knowledge about farming practices to the farmers is necessary. Marine Products Export Development Authority (MPEDA), Regional Office, Bhimavaram, Fisheries Research Center, Undi and Fisheries Development Officers in the district are the main sources from the government side to extend scientific knowledge to the farmers in the study area. Private input supply companies and processing industries are the private sources.

Table 9: Distribution of Respondents by Source of Knowledge

Name of the Village	Source of Knowledge		Total
	Govt. Agencies	Private firms	
Vempa	17 (13.07) (36.17)	113 (86.92) (27.76)	130 (100) (28.63)
Tundurru	11 (10.57) (23.40)	93 (89.42) (22.85)	104 (100) (22.90)
Kollaparru	7 (5.73) (14.89)	115 (94.26) (28.25)	122 (100) (26.87)
Chinakapavaram	12 (12.24) (25.53)	86 (87.75) (21.13)	98 (100) (21.58)
Total	47 (10.35) (100)	407 (89.64) (100)	454 (100) (100)

Source: Primary data. (Figures in parenthesis are percentages)

Figure 4. Comparison by Knowledge Source

The data reveals that 10.35 per cent of the sample farmers receive knowledge inputs from Government agencies while around 90 per cent of them said they approach private firm officials to clear their queries. Charoen Pokphand foods (CPF), located in Saripalle village which is 25 kilometers from Bhimavaram, is the leading private company helping farmers for doing culture scientifically. The farmers are happy that the private companies arrange seminars and workshops regularly to enhance awareness among farmers. They seek advice and guidance from their experienced peers in the field.

Number of Crops per Year

Shrimp culture has a duration of maximum four months. Due to high climatic fluctuations, it is said that rainy season is not suitable for shrimp culture which is highly sensitive to climatic changes.

Table 10: Distribution of Respondents by Number of Crops Per Year

Name of the Village	No. of Crops Cultured		Total
	2 crops	3 Crops	
Vempa	23 (17.69) (19)	107 (82.30) (32.13)	130 (100) (28.63)
Tundurru	32 (30.76) (26.44)	72 (69.23) (21.62)	104 (100) (22.90)
Kollaparru	28 (22.95) (23.14)	94 (77.04) (28.22)	122 (100) (26.87)
Chinakapavaram	38 (38.77) (31.40)	60 (61.22) (18.01)	98 (100) (21.58)
Total	121 (26.65) (100)	333 (73.34) (100)	454 (100) (100)

Source: Primary data. (Figures in parenthesis are percentages)

Figure 5. Comparison by Number of Crops per Year

In the study area, 73.34 per cent of the sample shrimp farmers culture three crops per year. They reported that they want to put the land to the maximum use. However, with three crops in a year, they could not give any break between two crops and ponds cannot be dried. On the other hand, 26.65 per cent of the sample farmers culture two crops per year as they are afraid of losses. Thus, a great majority of the farmers do not give a crop holiday between crops and based on seasonal suitability.

Lease Practices

As the sample for the present study consists of all 454 registered shrimp farmers from the four villages, there are no leaseholders among the sample group. However, it is noticed in the study area that a number of large farmers, besides their own registered ponds, have taken land on lease for aquaculture. This reveals the gap between the spread area of registered ponds and the spread area of actual ponds. There are both individual farmers and group of farmers who have taken around 300 acres on lease for culture. Small and medium farmers do not figure in considerable number among lessees due to huge investment requirement and higher risk rate. Lease rates vary from Mandal to Mandal. In Bhimavaram Mandal, they are in a range of 30,000 to 80,000, whereas in Akividu Mandal, they range from 1 lakh to 1.3 lakhs. Major determinants of lease rates are access to water and transport. On the other hand, small land owners lease out their land as they get better profits when compared to returns in paddy culture, without much risk and investment.

Findings of the Study

The findings of the present study with regard to the objectives specified like finding out and analysing the farming practices and finding out the farmers' perceptions, and the problems and prospects of shrimp culture are presented in the following sections.

Management Practices

Regarding the best management practices being implemented in the study area, the data on the farming practices of the shrimp farmers in the sample villages shows that, among the sample farmers, above 45 per cent have more than 15 years' experience in shrimp farming.

In regard to core farm operations, it is revealed that almost all the farmers prepare ponds for the culture following uniform practices like drying of pond, peeling off the outer layer, bleaching of pond, mineral application, water filling and water testing before filling, water disposal mechanism, crab fencing and setting-up of aerators. Inlet water is managed by all to promote an optimal ecosystem. But most ponds are not able to exchange their water on a regular

basis due to their limited access to quality water. It is found in the sample villages that, due to lack of field-testing instruments, test kits and PCR labs, regular water testing is not fully followed in the study area. As intensive system of culture is followed (100 %) in the study area, all the sample farmers reported that they usually supply formulated commercial pellets four times a day for feeding purpose. Weekly sampling is also done by all, but pond drying between two crops is not attempted as they go for next crop immediately.

Regarding the scale of farming, it is found that about 42 per cent of the ponds belong to small scale while 27 per cent of them are of medium scale. Large scale farms occupy 30.83 per cent of the ponds. *L. Vannamei* is the dominant species (95.59 %) cultured in the study area. About seed purchase, 38.54 per cent of the respondents purchase seed from local unregistered hatcheries where quality of seed is questionable, while 63.65 per cent of the respondents purchase seed from the registered hatcheries from Nellore, Vishakhapatnam etc. It is also found that all the sample farmers sell their produce to the mediators who are sometimes input suppliers themselves. Almost 90 per cent of the sample farmers receive knowledge support from private agencies and feed companies. It is observed that 73.34 per cent of the sample farmers culture three crops per year.

Farmers' Perceptions, Problems and Prospects

In the study of the farmers' perceptions, problems and prospects in shrimp culture, it is revealed that the impact of shrimp culture can be understood from different perspectives by varied individuals and groups. Nevertheless, as the shrimp farmers are immediate stakeholders, an attempt was made to understand and analyze this impact from farmers' perspectives.

The commonest opinions expressed by them include: shrimp culture increased the standard of living of the people involved directly or indirectly. It developed the employment opportunities for the local people in particular. The infrastructure and logistics like roads, storage and transport facilities were provided to the remote villages. With the large-scale establishment of processing industries, livelihood for women and others was enormously enhanced. Through its vast supply chain activities, a great number of self-employment opportunities were generated. The overall industrial development began progressing. The villages acquired special identity. On the whole, shrimp culture played a key role in reducing rural poverty.

The other side of the sector was also frankly revealed by the sample farmers. Shrimp culture caused water contamination in the rural areas where protected water facilities are already poor and scarce. Disposal of pond water into the source of water for the pond is the main reason for water pollution. As it is observed in all the four villages, the canal water cannot be used for drinking.

With the rapid growth of shrimp culture, cost of living and land values are increased. The major problems as expressed are: low quality seed, non-availability of quality water, unregulated prices of inputs like feed and seed, inadequate institutional finance, output price fluctuations, lack of storage facilities, insufficient knowledge extension by public agencies, unbearable electricity bills, monopolistic attitude of mediators etc. Recently, the State Government has slashed power tariffs to aqua farmers from Rs. 3.75 to 2.00 per unit for one year with effect from 1 August 2018, which slightly decreases the farmers' burdens.

It is also found that the farmers are quite aware of the prospects of shrimp culture sector like growing international and domestic market for shrimp, likelihood of higher returns in comparison with other crops, increasing focus of the governments on the sector, industrial development in the region, identifying nearby towns like Bhimavaram as 'Towns of Export Excellence' for seafood, establishment of value chain units like Godavari Aqua Mega Food Park, and proposal for Aqua University. Hence, they are encouraging next generations to continue in the sector.

Suggestions

- The Governments are required to take necessary measures to spread awareness about the ill-effects of antibiotics, high use of fertilizers, and disposal of unwanted material from different operations in the sector.
- Social licence may be given to those who resort to proper waste management.
- The benefits of organic shrimp farming need to be explained to farmers.
- Leasing guidelines must be framed and implemented, taking inputs from experts in the field and experienced farmers.
- Cooperative farming is to be developed for encouraging small and medium farmers to continue in the sector.
- The governments need to focus on knowledge extension by creating help-desks and kiosks.
- Research on developing sustainable farming practices without causing any social and environmental issues is to be encouraged.

Conclusion

As the study area is highly concentrated for shrimp culture, and as majority of the farmers are following better management practices, it is the responsibility of the Governments to support the farmers in all aspects. If the management efficiency is increased, it will have positive result on production capacity, financial returns, and sustainability of the sector. Consequently, the economy of the state as well as the country is further strengthened.

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At a Global Level aquaculture is one of the fastest growing food production sectors. The spread of aquaculture as a dynamic economic activity is witnessed across the world. Aquaculture is one of the major foreign exchange earners for India. Andhra Pradesh is the leading state in the country in production as well as exports of aqua products. The aquaculture sector, though acclaimed for its profits and protein-rich food supply, has its own problems which need to be addressed for achieving sustainability in the business.

The present book manifested itself with a repository of many chapters of different scholars focuses on the development of fisheries and aquaculture in India as well as in Andhra Pradesh and the challenges and opportunities in this field. A comprehensive range of articles on important issues in this areas of research such as growth of fisheries, status of fishermen in the country, problems of aqua farmers, production and exports trends of aqua products, linkages to aqua industry, women in the processing industry, employment opportunities, sustainability of the sector, environmental issues, processing and marketing of fish products etc. This book is produced specifically for the benefit of students of aquaculture, zoology, agricultural economics, applied economics, researchers, academicians, aqua farmers and policy makers. Every chapter in this book is reviewed and updated with reference to new developments and initiatives.



Prof. M. Koteswara Rao is a Professor of Economics having put up three and half decades teaching and research experience published very widely in National and International Journals of repute and presented papers in National and International Conferences. Guided 28 Ph.D's and 26 M.Phil's so far for the award of Research Degrees. Specialized in the areas of Urban Development and Labour Economics. Carried out 6 Research Projects sponsored by UGC and other Agencies. Prof. Rao is currently the Dean of Faculty of Social Sciences, Dean, College Development Council and Vice-Principal, University College of Arts, Commerce & Law, Acharya Nagarjuna University, Nagarjuna Nagar, Guntur District.



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