4. SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY

1. The literature survey in general is an attempt to bring together information till 1992 on the shrimp culture practices carried out in different countries. The review calls for a scientific study on the state of art of traditional practices along with the economics of operation in Kerala.

2. State of art of aquaculture practices is presented under five heads with particular reference to South East Asian countries followed by that of India in detail. The technology adapted within India varied from area to area.

3. The shrimp farming cycles consisting of hatchery, nursery and grow out phases are described.

4. The different types of culture systems in vogue viz. impoundments, pens, cages, tank farms and sea ranching are properly enumerated.

5. The levels of culture in the grow out systems classified as a) Traditional/modified traditional b) extensive/improved c) semi-intensive d) intensive and e) super-intensive are dealt in detail.

6. The levels of culture are related to the following criteria 1) Species used and stocking densities 2) Engineering design and layout 3) Fertilizers used 4) Food and feeding regime 5) Rearing duration and cropping frequency 6) Quantity and quality of production and 8) Harvest, post harvest technology and marketing.

7. Harvest technology, the most labour intensive operation in a farm included draining, trapping, seining, cast netting and hand picking depending upon the species cultured.
8. Scope of aquaculture is aptly described under eight sub heads.

9. The objectives of the study are clearly spelt out as under
1) to undertake a scientific study on existing practices of shrimp farming in central Kerala 2) to analyse economics of operation at different levels 3) to introduce shrimp culture in the untapped backwater areas 4) to come out with an appropriate technology 5) to carry out experimental growth studies and 6) to study the feasibility of a semi-intensive technology.

10. The study areas extending between Munambam baromouth and Anthakaranazhi and comprising the contractor operated six traditional fields, owner operated seven grow out ponds, six mini ponds, six cement tanks and four fibre glass tanks and the demonstration site at Mundapuram are well described.

11. Particulars of culture species, feeds supplied, manures applied, nets and other accessories used are presented under materials.

12. Methods of pond preparation, seed, feed and water management; harvest, data collection and processing and analytical procedures are aptly described.

13. 27 experimental studies are dealt with in detail. Traditional shrimp filtration in a shallow field at Nayarambalam demonstrated poor economic return owing to its remoteness from the main water body leading to low tidal gradient and consequent poor autostocking (A-1). The shallowness of the field led to enhanced entrapping of juveniles during filtration.

14. Shrimp polyculture in a traditional shallow seasonal field at Pooyapilly demonstrated that modifications like clearing of canals and removal of macro-vegetation along with nearness to feeder canal can raise shrimp yield considerably (1119 kg/ha). The better tidal gradient and concomittant higher autostocking were positive factors in this regard (A-2).
15. Increased shrimp yield (1372 kg/ha) was made possible by compensatory feeding apart from structural modification, perennial nature of the field and proximity to feeder source as demonstrated on shrimp polyculture study in Thrikkadakapilly chal (A-3). Higher depth and prolonged culture improved the quality of shrimps.

16. Shrimp polyculture in a traditional extensive deep field at Kuzhupilly showed that by way of improvements in canal system, capacity of a field can be rejuvenated leading to increased shrimp yield (500 kg/ha) (A-4).

17. By way of improved practices - deepening of canals, silt removal, clearing of vegetation predator elimination and additional seed induction along with supplemental feeding - it was possible to enhance quality shrimp yield (927 kg/ha) in a traditional shallow field at Ayyampilly (A-5).

18. Similar study when repeated at Narakkal showed a relatively low rate of shrimp production from unit area (821 kg/ha) indicating the impact of location specific factors (A-6).

19. From an economic view point, the additional stocking of wild seed led to high percentages of P. indicus @ 70 and 91 at Narakkal and Ayyampilly, resulting in high profit of Rs.7406/- and Rs.5521/ha respectively. The lowest profit of Rs.804/ha was at Nayarambalam owing to the exclusively traditional practice adopted.

20. The size of extent determined the level of profit in traditional fields. Thus Kuzhupilly with an extent of 20.25 ha, realised a net profit of Rs.56527/- during season, compared to Pooyapilly with an extent of 0.8 ha realising only Rs.2282/-.

21. Experiments using 3 feeds -- pulverised, commercial pellets and natural food through cowdung manuring, conducted in well set compartments of a large shrimp culture grow out system at Narakkal
indicated that pulverised feed containing clam meat promoted better growth and production of *P. indicus* (402 kg/ha) compared to other feeds (B1).

Similar experiments conducted at Puduveypu in uniform sized independent ponds using above feeds also showed same trend (B2).

22. The yield/ha obtained at Puduveypu was fairly low than at Narakkal even though similarities were there in the stocking density, nature of feed, mode of feeding and other management aspects. This indicated that factors other than above, perhaps the accreted environment at Puduveypu is not much conducive for shrimp culture compared to Narakkal (B2).

23. In spite of cow dung manuring and feeding with clam meat, the adverse factors such as low quality water, insufficient water exchange and absence of diverse benthic faunal generation owing to lack of conditioning affected the production of *P. indicus* (376 kg/ha) at the newly excavated Harijan farm at Narakkal (B3).

24. The differential growth of *P. indicus* between two growouts at Narakkal (B1 & B3) indicated the importance of site selection and conditioning for culture purposes.

25. The suitability of canals in the coconut groves for the successful culture of *P. monodon* (238 kg/ha with mean size of 40.45 g) in spite of a number of constraints high-lighted the importance of undertaking shrimp culture in such otherwise unused water bodies in the coconut groves (B4).

26. The highest rate of *P. monodon* production @ 1170.45 kg/ha within 107 days at Chalippuram is a record in Kerala. Also, the realization of a return of 76.87% as profit on investment from the canals of the newly set up coconut garden in the paddy field indicated the worthness of the endeavour (B5). This type of efficiency of the
saline paddy fields for raising substantial quantity of quality shrimps is an eye opener to the farmers possessing similar sites. The transformation of such areas into shrimp farms might open up employment avenues thereby improving rural economy.

27. The growth measurements of _P. indicus_ made during the study at Narakkal Harijan fish farm revealed higher quantum of growth between 10th and 14th weeks (mean size 4.32 and 9.77 g) compared to earlier phase. This could be accounted to the reduced density after 10 weeks as a result of culling (B3).

28. The high density short duration culture (45-60 days) of _P. indicus_ at Cherungal, Thuravoor resulted in the increased production (677 kg/ha) realizing high profit (Rs. 7252/kg) in spite of their under size (5.88-7.42 g). Hence, the significance of short duration culture, facilitating more crops on an annual basis has been highlighted (B6).

29. At Karumancheri, the attempt to culture _P. monodon_ during monsoon was successful yielding 300.38 kg/ha within 115 days. The _P. indicus_ culture in sequence during regular season also resulted in a production of 622.44 kg/ha. This pointed out the possibility of improved yield @ 922.82 kg/ha by rotational culture of _P. monodon_ during monsoon period followed by _P. indicus_ during usual season (B7).

30. Comparative analysis of economics of culture in 5 growouts indicated differential profits ranging between Rs.904 (newly excavated farm at Narakkal) and Rs.76649/ha (Chalippuram) owing to several factors such as site selection, species, type of feed etc.

31. Of the three different stocking densities of 1, 1.5 and 2.5 lakh/ha fed with commercial pellet feed, 1 lakh/ha was found satisfactory in the production of quality _P. indicus_ in mini ponds at Puduveypu (C1).
32. Similar studies using formulated feed and stocking densities of 1, 1.5 and 2.0 lakh/ha also indicated reduced growth rate with increase in stocking density. Again stocking @ 1 lakh/ha was found satisfactory for the production of quality _P. indicus_ (C2).

33. In the series of experiments using different manures such as poultry droppings, cowdung and buffalo dung, better quality (mean 3.442 g) _P. indicus_ was resulted in the pond manured with poultry droppings and the least (mean 2.334 g) in the pond manured with buffalo dung (C3).

34. In another set of experiments using compounded feeds 1, 2 and 3 and cowdung manuring, all the feeds showed better growth compared to control. However feed 2 with high energy content demonstrated maximum mean weight (5.538 g) of _P. indicus_ during harvest after 6 weeks (C4).

35. In the experimental series using 5 formulated feeds, the efficiency of feeds was in the order 1, 4, 5, 2 and 5 with respect to the quality of _P. indicus_. In terms of quantity also, feed 1 (shrimp meal + detritus + goc + rice bran in the ratio 5:2:2:1) proved to be the best (C5).

36. Culture of _P. indicus_ in the pump fed earthern tank system could produce a higher yield of 800 kg/ha/3 months over that of 241.18 kg/ha realised from tidal ponds thereby indicating its advantage (C6).

37. Growth studies on _P. monodon_ fry in earthern pools showed better survival percentage (27.6) and higher growth rate (2.448 g) in respect of wild fry compared to hatchery fry (16.8% & 1.498 g) (C7).

38. _P. monodon_ juveniles attained a mean size of 44.135 g after 150 days when fed with clam meat in a cow dung manured pond (C8).

39. High mortality (43.3 - 60%), stunted growth and microbial infection were noticed among _P. indicus_ reared in cement tanks at
Puduveypu using turbid silt laden natural waters. However, relatively better growth (3.478 g) was noticed when fed with clam meat (D-1).

40. Experimental culture of *P. indicus* conducted in cement tanks attained only a mean growth of 2.132 g even when fed with commercial pellet @ 10% of body weight (D-2).

41. *P. indicus* in varying densities when reared in fibre glass tanks recorded retarded growth showing inverse relation with increase in stocking density (D-3).

42. High density culture of *P. indicus* juveniles (100/m³) and fry (800/m³) in cement tanks at Puduveypu experienced heavy mortality (81.36 % 73.52%) in spite of feeding with clam meat (D-4 & D-5).

43. *P. monodon* farming was successfully carried out in semi-intensive manner at Mundapuram (Group E). However, the farm shape could not conform to the general pattern with many of the essential points typical of a semi-intensive farm due to its original irregular design.

44. Studies on semi-intensive farming of *P. monodon* (22.5 fry/m³, imported high energy feed, pumpfed system with 6-25.8% daily exchange and paddle wheel aeration) resulted in a record production of 2.4 tonnes/ha/4 months with a mean weight of 28 g, in spite of the low survival rate of 45%.

45. Analysis of economics of operation indicated realization of Rs.52313/ha with 16.9% return on investment (ROI). However, the high investment requirement of over Rs.3 lakhs/ha involving foreign exchange for feed import will be an impediment in the present socio-economic background of shrimp farmers.

46. Successful shrimp farming being location specific, the right selection of site with reference to species, technology, eco-
characteristics (tidal range, soil texture, topography, water quality, turbidity etc.) and support facilities determined the feasibility of viable operations.

47. The tidal fluctuations of 0.3 to 0.75 m experienced in the study area is too feeble against an ideal fluctuation of around 3 m.

48. The acid sulphate problems were not encountered in fields at Vypeen island whereas in other areas - Chalippuram, Karumancheri, Cherungal, Pallithode and Mundapuram its effect was nullified by lime application.

49. The highly turbid silt laden natural tidal water characterised by reduced oxygen level, retarded the growth of shrimps at Puduveypu.

50. The role of environmental parameters in site selection is discussed.

51. P. indicus and P. monodon were found the most appropriate species for culture in the study area.

52. Importance of design, layout and construction along with size and shape of fields/ponds is discussed.

53. The modern concept of layout, design and construction of culture farm has very little relevance in the study area, as shrimp culture rotates with paddy and the ownership mainly rests with agriculturists.

54. The destined nature of the canals to serve the dual purposes of drainage and feeding in the case of tide fed farms is a serious drawback in the study area.

55. Importance of pond preparation and the measures adopted to maintain stability of pond conditions at a level conducive to shrimp
growth and survival are described. The predominant role of lime in this regard is adequately stressed. The need for predator elimination is emphasised.

56. Live feed generation to a limited extent is made feasible by the addition of manures and fertilizers along with planting of dry twigs for periphyton.

57. Role of water quality parameters such as pH, temperature, salinity, dissolved oxygen, turbidity and siltation in the natural and enhanced shrimp production was analysed in detail. Also, the impact of pollution and other environmental factors like mangrove distribution etc. are discussed.

58. Functional role of environment aimed at evaluation of the cause - effect relationship is analysed in detail in order to identify the factors to be reckoned with, during shrimp farming.

59. On account of profound seasonal variations in environmental conditions, shrimp culture was found feasible only between post monsoon and premonsoon months in Kerala.

60. Seed management studies highlighted the importance of selective supplemental seed induction of wild larvae compared to hatchery ones, in addition to autostocking. Factors favouring an optimal stocking density and larval size are discussed. The need for viable shrimp hatcheries is emphasized.

61. The prevailing ecological conditions, profuse availability of seed and the low production cost favour farming of _P. indicus_ in Kerala. However, restricted farming season led to destruction of a large number of juveniles of _P. indicus_ in traditional practices.

62. Problems encountered in the seed recruitment are discussed.
63. Discussion on feed management is centred around increased production through optimal feeding after selective stocking coupled with improved water quality. The need for preparing cheaper nutritive (high FCR) feed using locally available waste material in preference to expensive formulated feed is stressed. The role of sufficient water exchange to bring in required quantity of natural feed and also the role of natural productivity are analysed in detail. Supplemental feeding helped to pave the way for higher stocking densities.

64. Water management was accomplished taking full advantage of tidal effect only in the traditional fields where as pumping was also resorted in other pond systems.

65. The percentage exchange of water always depended upon the duration and amplitude of tidal processes (30-80 cm).

66. Any improvement in shrimp farming in Kerala over the traditional practice necessitates use of a pump owing to the low tidal amplitude.

67. A daily water exchange of over 15% was made possible by way of structural modifications of the field.

68. The various structural modifications, use of pumps and paddle wheels were found efficient for improved water management.

69. The importance of water management in enhancing living space, maintaining optimal water quality, disseminating seed and feed and eliminating waste products is brought out.

70. The success of shrimp filtration in Kerala is due to the selective harvest practised during thakkoms coupled with the high market and export demand. Multiple harvesting is adopted in all the traditional fields.
71. Compared to autostocking in traditional practices wherein metapenaeids dominated, selective seed induction contributed to higher levels of production of _P. indicus_ considerably.

72. Reliable economic data on actual location specific commercial production are made available. The profit depended on capital investment, type of technology, management and lease amount which varied from place to place. The steps to be taken for raising economic returns in the context of increasing variable costs are discussed.

73. Farmers were not able to take full advantage of the growth potential of the shrimps on account of the termination of the contract period during middle of April coupled with the characteristics of lowered water levels.

74. Low tidal amplitude, non existence of viable hatcheries, lack of quality feed etc. warrant only an indigenous technology.

75. By way of system appraisal, the strength prospects and opportunities for shrimp culture have been enumerated. Also several factors classified under technical and non technical constraints, threats and weaknesses have been identified. Non availability of seeds in time, lack of nutritive feed and deteriorating water quality are prominent among them.

76. Inspite of the key role for the farm management in a successful aquaculture system, most of the farms in Kerala are operated employing engaged watch personnel alone.

77. The land use and lease policies along with ownership of lands being vested with the agriculturists, the backwardness of the illiterate traditional fishermen, impact of mangrove destruction etc. are some of the social considerations for an indigenous technology.

78. Economic considerations speak for preferring a culture practice
by reasoning, i.e. to select one which can be adjusted to the demand and which can help in the economic rehabilitation of the rural poor.

79. Extensive pond management is found most appropriate in the central Kerala owing to the vast existing impoundments where new investment is minimal.

80. The technology most appropriate for sustainable development of the study area, taking into consideration various ecological, social and economical factors is explained. The salient features of the technology are enumerated.

The greatness of the technology is that it shows, over and beyond economic profitability, a soundness that will not threaten environmental resources.

The sought after technology being a location specific one, no other technology can be successful in the prevailing ecological condition of the place of study.

4.2 RECOMMENDATIONS

The following recommendations can be made in order to attain success in shrimp farming in the central Kerala.

i) Land reform policy

Under the existing policy, the coastal shallow areas where paddy cum shrimp culture is carried out are generally classified in revenue records of state governments as agricultural lands. There is no classification of special nature permitting fish and shrimp culture in low lying areas alone or as an alternative crop in paddy cultivation. Eventhough thousands of hectares of such areas are available in maritime states of India, all are classified as agricultural lands. Conversion of these lands exclusively for much more
remunerative avocations like fish/shrimp production is not permitted by law. Enactment of special laws for conversion is the need of the hour to tide over the oft repeated social conflict in the farming areas. This necessitates a labour intensive appropriate technology adapted for aquaculture in traditional farms.

ii) **Leasing policy**

In Kerala, the paddy cum shrimp farm is leased out for filtration only for 5 months from November 15 to April 14th, beyond which it is unlawful to carry out shrimp culture. Therefore the contract farmers who take the farm on lease for 5 months are not able to invest more money for scientific methods of farming. The multilevel ownership of most private farms also creates troubles for long term planning.

It is also not possible to take water to all holdings independently in an area where there are many small land owners. Eventhough co-operative farming is ideal in such areas, it is not easy to ameliorate different interests in the existing conditions.

Hence the situation warrants to follow a liberal policy of leasing lands on a long term basis amongst farmers.

Investigations revealed that sociological factors were limiting the yields from Kerala farms using more pond areas compared to the shrimps produced. First is the lack of crop security for shrimp farmers. The present day yield from traditional shrimp farms is around 200-300 kg/ha/yr. To go above this yield, the farmer must pay hard cash for feed to be added to the pond. Also the nonavailability of a dependable quality feed adds to the misery. The farmer can not afford this if a local gang can come and rob him with impunity just prior to harvest as the rule of law is weak. This is a recurring phenomenon in the seasonal shrimp filtration fields during the fag end of operation, ie, between the end of March and middle of April.
The 2nd is that the non capitalist principles apply in the rural areas. It is simply impossible to fence off hundreds of hectares of land and grow shrimps in disregard to social conditions outside the fence. The unwritten law dictates that the crop must be shared with the not too fortunate. The fact that one invested money, effort and risk into the project is irrelevant. These practical aspects of aquaculture are not discussed even in conferences.

iii) Conservation of water bodies

Often unscrupulous measures adopted in the name of developmental programmes seem to hamper shrimp culture in a large way. It should be borne in mind that it is against law of nature to create impediments in the backwater systems affecting the flow patterns in the name of saline ingress and crop protection. The Thannermukkom barrage erected in Vembanad lake during 1974 is a glaring instance in this regard which has practically destroyed the lucrative fishery of Macrobrachium rosenbergii in the Vembanad lake. Adequate laws have to be enacted to protect the natural water bodies which are capable of yielding shrimps and fishes spontaneously.

iv) Considering the significance of mangroves to improve the life supporting capacity of aquatic ecosystems - especially as the natural breeding, nursery and feeding grounds of a variety of faunal assemblages including edible shrimp and fish species - it is highly necessary to re-establish the mangrove vegetation along suitable habitats in Kerala.

v) The need of the hour is setting up of a Kerala State shrimp Development Corporation on the model of KSCD Corporation set up in 1969. At present, the shrimp export industry is exclusively controlled by the private sector which is exploiting helpless fishermen, farmers and workers to make fortunes in the international market. Once the workers become organized they can demand better wages/deals like imposition of minimum wages. This corporation can be made the monopoly
procurer of raw shrimps. This can give ample working days to farmers/workers.

Also a Kerala State shrimp Farm workers Apex Industrial Cooperative Society can be registered for taking over factories and organizing them into co-operatives. This can be appointed as the sole agent for procuring raw shrimps.

vi) The present extension service meant for training necessitates strengthening and modernisation so that it can undertake speedier delivery of innovations from laboratory to the farmers in the field.

vii) Extensive macro and micro level survey has to be done to identify primafacia areas suitable for shrimp farming.

viii) A properly planned approach ensuring adequate discharge of the 41 west flowing large and medium rivers of the state with a catchment area of 20,000 km² is necessary as the monsoons greatly influence the hydrological regime of estuaries and backwaters.

ix) Monitoring of environmental parameters is required to assess economic feasibility of the area commensurate with the cost of development. A series of units under recognised agencies should be set up for this purpose.

x) The effect of man made engineering works and other human interferences on the productivity and quantity of water need critical evaluation, as it prevents shrimps from entering into spawning grounds.

xi) Preparation of shrimp culture project reports mainly centred around engineering works has to be accelerated and made available easily to the farmers.

xii) Extension of feeder canals to interior potential areas to ensure natural seed and quality water availability for better
xiii) Establishment of shrimp parks and sanctuaries or reserve areas as done in the case of Mahseer in Ganga basin for enhanced breeding and production along with setting up of viable hatcheries and seed banks to ensure supply of quality seed in time and in required quantity.

xiv) It is imperative to encourage co-operative ventures for economically feasible indigenous feed manufacture.

xv) Storage facilities are to be set up at selected production centres for the benefit of farmers.

xvi) In the light of ecological economic and social considerations, the author recommends an improved extensive indigenous technology which can raise the present production of 300 kg/ha to the level of 1500-2000 kg/ha as the most appropriate rather than hunting after foreign technology.