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Project Completion Evaluation Report

062/04 VIE

Intensive In-pond Raceway Production of Marine Finfish

(4^{th} – 6^{th} June, 2009)

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Executive Summary

This project aimed to develop the larval rearing and nursery capacity of marine finfish production in Vietnam through the use of accessible, cost effective and environmentally sustainable technologies. Through the development and use of in pond floating raceways (FR) this project has assisted farmers to develop their own intensive but durable and manageable larval rearing capacity. This capacity will be used to improve fingerling supply to the industry which is currently both costly and limited. In addition, advanced nursery capacity was developed using the same principles. Grow-out of finfish in raceways to market size was investigated in the Australian component of the research where researchers from the Queensland DPI&F provided expertise in systems management, water quality management and waste remediation. Species selected for study included cobia, barramundi, mulloway and whiting. All activities were mindful of environmental sustainability issues and strategies were investigated to limit water discharge. Information from these activities was used to train staff from the UoF, its students, industry and other relevant stakeholders. This project encouraged active involvement and contribution of different stakeholders to make this research highly relevant and applicable to the local aquaculture industries.

1. Introduction

1.1. Project's general information

Project Number and Name:	062-04VIE. Intensive In-pond Raceway Production of Marine Finfish	
Vietnamese Institution	Nha Trang University (the former University of Fisheries)	
Vietnamese Project Team Leader	Dr. Hoang Tung, Director, International Centre for Research and Training, Nha Trang University, Email: htunguof@gmail.com	
Australian Organisation	Queensland Department of Primary Industries & Fisheries	
Australian Personnel	Mr Michael Burke, Fisheries Biologist, Michael.burke@dpi.qld.gov.au	
Date commenced	15 April 2005 (01 August 2005 in Vietnam)	
Completion date (original)	15 April 2007	
Completion date (revised)	December 2007	
Project location	Khanh Hoa province	
Project Budget (A$):	Total: 292,520	From: AusAID: 176,220 Vietnamese institution: 42,600 Australian institution: 73,700

Project goal:

This project aims to develop the larval rearing and nursery capacity of marine finfish production in Vietnam through the use of accessible, cost effective and environmentally sustainable technologies.

Project Objectives:

1. Trial a cost effective larval rearing system for small to medium scale hatchery operations and fingerling producers in Vietnam
2. Demonstrate capacity for fingerling and on-growing production in FR's Vietnam and Australia.
3. Demonstrate possibility to develop a zero-discharged system with additional yield of by-products
4. Deliver benefit to stakeholders and beneficiaries (local farmers, marine-culture industries, disadvantageous groups, feed producers, aquaculture students, staff of UoF and DPI&F.) and capacity building for both sides.

1.2 Purpose of Project Completion Evaluation

The purpose of this project completion evaluation is to identify outputs/results that the project has achieved and to evaluate the quantitative and qualitative achievements against the project's objectives. It also addresses and assesses the relevance, effectiveness, efficiency, impact and sustainability of the project. Furthermore, this evaluation identifies some lessons learned from the project and gives recommendations in terms of government policy that may promote the application of the project results as well as scale up the technology of in-pond floating runway for fish rearing and nursing in practice.

1.3 Evaluation Methodology

The evaluation undertaken by evaluation team includes the following steps:

- Review all project documents such as the project proposal, milestone reports and completion report, the PMU appraisals to clarify all project objectives, outputs and indicators, and then complete an initial review of project performance.
- Prepare a work plan for evaluation and compose semi-structured questions for interviews during the field trip.
- Undertake a field trip to the project site to collect the primary information through meetings and discussions with relevant stakeholders at project areas (including trial sites with equipment and technology, project staff at Khanh Hoa Fisheries promotion center, Fisheries Division of Tuy Hoa Department of Agriculture and Rural Development, and local beneficiaries in the project area)
- Analyze collected primary data and secondary information of project activities and project results.
- Prepare draft evaluation report and finalise the report.

2. Project Implementation Review

2.1 Review of Log-frame

The log-frame is assessed to be appropriate with its performance indicators, assumptions/risks to achieve the overall goal as well as specific objectives. However, three first objectives should be revised to indicate objectives. In the log-frame, they seem to indicate activities. They could be changed to be as follows:

Objective 1: Develop a cost effective larval rearing system for small to medium scale hatchery operations and fingerling producers in Vietnam

Objective 2: Build capacity for fingerling and on-growing production in Australia and possibly in Vietnam.

Objective 3: Develop a zero-discharged system with additional yield of by-products.

2.2 List of milestones scheduled and completed

Milestone	**Scheduled**	**Completed**
MS2: In-pond raceway technology for larval rearing of marine finfish developed and tested (Outputs: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 2.4)	Aug 2006	March 2007
MS3: First six-month report	Sep 2005	July 2006
MS4: In-pond raceway technology for marine finfish nursery production and grow-out developed / tested (Outputs: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 2.4)	Aug 2006	March 2007
MS5: Demonstration of zero-discharge system using Floating Raceways (Outputs: 4.1, 4.2,)	Feb 2007	March 2008
MS6: 2nd six-month report	Sep 2006	Jan 2007
MS7: 3rd six-month report	Feb 2007	Dec 2007
MS8: Analysis of benefits to local farmers and marine-culture industries (2.1, 2.2, 2.3, 2.4)	Jun 2006	Jan 2007
MS9: Analysis Improvement of competence of Nha Trang University' staff in research and analytical techniques as an direct impact of the CARD VIE 062/04 Project (Outputs: 7.1)	March 2007	June 2008
MS10: Research/technical reports	March 2007	June 2008

3. To confirm if the project has achieved its objectives

3.1 Findings from PCIE in relation to project outputs (see project log frame Annex 3):

Each output is assessed to achieve its objective and ranked in four levels of High satisfactory; Satisfactory; Moderately satisfactory; and Un-satisfactory, as follows:

Output 1: Technology for larval rearing, fingerling and grow-out production developed

The PCIE evaluation team visited the building and testing site of the technology (field photos in Annex 2) and interviewed the implementing organisation and staff, as well as meet with a representative farmer in local area. The evaluation team could not meet and discuss with the project team leader, Dr Hoang Tung, because he has changed his job and moved to Ho Chi Minh City (after the completion of the project).

Based on the information from written reports and interviewing relevant people, the evaluation team found that the project has successfully achieved its Output 1. The following outputs have been produced:

Contract Deliverables for Output 1 (Milestones 2 & 4):

Milestone 2: In-pond raceway technology for larval rearing of marine finfish developed and tested.
Deliverables include:

- Floating Raceway design specifications using externally and locally sourced materials
- Technical guideline manuals (English & Vietnamese)
- Physical and financial analysis of performance of floating raceways for larval production

Milestone 4: In-pond raceway technology for marine finfish nursery production and grow-out developed / tested
Deliverables include:

- Raceway design specifications using externally and locally sourced materials
- Technical guideline manuals (English & Vietnamese)
- Physical and financial analysis of performance of floating raceways for fingerlings and grow-out of selected species
- Scientific report (conference papers) documenting results of floating raceway research on larval and fingerling rearing and grow-out of selected species.
- 1st annual project workshop and associated training / extension activities completed.

The project team has successfully developed the in-pond raceway technology and tested. Two examples support this conclusion 1)design and performance of floating raceways used to nurse fingerling of marine fish in Central Vietnam and 2) In-pond Raceway technology for marine fish nursery and grow-out developed and tested in Australia.

The authors presented comprehensively from principles, guidelines for installation and operation of the SMART-1 (technical manuals), experimental results covering both financial assessment and dynamic of raceways in Central Vietnam for the first paper. While in second paper, the authors discuss in depth the development of innovative designs including the concept of bioremediation and more emphasis on cost effectiveness such as cheaper materials, lower capital and operation costs etc. related to different species and different raceway size and volumes.

In summary, the first floating raceway version SMART-01 was developed, used to nurse marine finfish from small sizes to fingerlings. It was made of a fiberglass composite – the most appropriate material in Vietnam which is durable, weather proof and easy to clean or move around. Despite its higher cost than other simple materials, fiberglass composite raceways have been evaluated as a worthy investment.

The second FR version SMART-2 was developed to improve shortcomings of the first version. This FR has been adopted by a number of producers to nurse fingerlings in different provinces.

In conclusion, the Output 1 is assessed to be "High satisfactory".

Output 2: Higher production at lower cost by FRs for all phase of culture

Fingerlings nursed in raceways were assessed as growing very fast; therefore creating higher production with lower cost of rearing or nursing.

Operation costs for the first and the second trials was VND 28,802,500 and VND 37,040,000. At harvest, the current price was VND 2,500/fish for the first trial and VND 3,000 /fish for the second trial. The calculated benefit for the trial was VND 61,750,000 and for the second trial was VND 48,000,000. The benefit-cost ratio of the two trials was 2.14 and 1.30, respectively. The shorter nursing time is more economically efficient than a longer one because of operation costs such as electricity and labour.

The survival rate of fish nursed in floating raceways is much higher that that in ponds, as assessed by the Khanh Hoa Fisheries Extension Center. It is about 80% of fish survival as nursed in FRs in compared with about 50% nursed in ponds.

In the Australian component, there no economic analysis has been undertaken; therefore, there is no evaluation of the economic efficiency of the floating raceways to grow out fish.

In conclusion, the Output 2 is assessed to be "High satisfactory".

Output 3: Developed technology or research concepts applied by local farmers

The floating raceway technology and research has been applied by a number of farmers/ producers in both Australia and Vietnam.

In Australia: from the final period report, the Integrated Recycle International Ltd (IRI) has adopted a modified raceway design for a new Queensland enterprise that aims to produce fish in wastewater for fishmeal production. The raceway design is based on the low-cost HDPE configuration developed in this CARD project. Several prawn farmers in Queensland have requested specific information on raceway specifications for future diversification opportunities.

In Vietnam: the technology is applied in only companies or investors with high capacity. Small-scale fish farmers can only access large-size fingerlings produced by floating raceways from the Khanh Hoa Fisheries Extension Center. The technology requires too high initial costs for local farmers to adopt. A lower cost FR version could be developed to be appropriate for disadvantaged farmers. However, the project outcomes were

disseminated to local farmers (50 persons) through an extension workshop in Cam Ranh in early August 2007; and to 1,200 attendants of the Asian Pacific 2007 Aquaculture Conference in Hanoi.

Visitors in workshops or exhibition organised by the project have applied this new technology after discussing with the Project staff at the Conference including: Minh Thuan Co. (Vietnam): using floating raceways for barramundi fingerling production in Phan Rang and Ben Tre provinces; Truong Thanh Co. (Vietnam): using floating raceways for eel production in reservoirs in Phu Yen province; Viet Seabass Co. (Vietnam): using floating raceways for barramundi fingerling production in Vung Tau province; Australis (USA): using floating raceways for barramundi fingerling production in Nha Trang, Vietnam. Coral Seafood (Bundaberg, Australia) plans to use floating raceways for cobia fingerling production inBinh Dinh Province's Fisheries Extension Center (Vietnam): using floating raceways for single sex tilapia fingerling production.

In conclusion, the Output 3 is assessed to be "Satisfactory".

Output 4: A zero-discharge system using FRs in existing ponds and bioremendiating species for local industries

The project team has successfully developed the model of floating raceways, "SMART-2", with more proficient performance characteristics in comparison with the first version, SMART-01. After SMART-2 was developed, many commercial companies have applied the model in practice. Australis (USA) is a big corporation and with a branch in Khanh Hoa which has been using SMART-2 for its fingerling production.

However, according to Mr. Quy's comments, the floating raceways may only be appropriate for fingerling production, as for fish production (grow-out), because it will require a too large or too small scale of production. Therefore, it is considered as a limitation of the technology for grow-out fish production.

Contract deliverables for Output 4 (Milestone 5):

- Zero-discharge design and guidelines and methodology for measurement of water quality and production of by-product established.
- Scientific report (conference papers) documenting results of application of zero-discharge system including productivity and cost benefit analysis.

In conclusion, the Output 4 is assessed to be "High satisfactory".

Output 5: Higher production of marine fish fingerlings by the local industries

The FRs have been tested and proved that per cubic meter of water; it can produce approximately 100kg/m^3 of fish. This is very high (about 3 to 5 times) compared with nursing in ponds as traditional methods.

The field visit indicated that high quantity and quality of marine fish fingerlings can be produced by local organizations. Currently, because of economic crisis, the requirement for marine fingerlings has decreased and very few farmers farm fish at this time. Consequently

as with traditional rearing systems demand for fingerlings is low and ponds and FRs are idle.

According to Mr. Long, Ninh Ich commune, Ninh Hoa District, the consumption of marine fish has decreased; therefore, farmers preferred to raise white leg prawn because it can bring them a higher profit than raising fish. The government needs to address, issues, especially for fish export, as the market for marine fish is facing difficulties as there is only Australis (which has a monopoly position) that is active in buying and selling fish for export.

In conclusion, the Output 5 is assessed to be "Satisfactory".

Output 6: A network among project participants

According to Mr. Quy's and Mr. Khanh's assessemnt (Khanh Hoa Fisheries Extension Center), a network among project participants has been established and functioned very well. Each participant has significantly contributed to the success of the project.

Several project staff changes in Australian component, but they have been managed after the resignation of key project personnel. Luke Dutney, Stephen Nicholson and Dan Willett remained to manage daily on-ground activities and finalise the project. Regular information exchange has been made between the senior Australian and Vietnamese project staff.

In overall, both sides have made great efforts to create a network to coordinate and finish all missions of the project.

In conclusion, the Output 6 is assessed to be "High satisfactory".

Output 7: Effective training and capacity building

The project has achieved success in terms of training and capacity building. During the project, two MSc. students finished their theses with the topics "Effects of stocking densities, stocking size and feeding regime on survival and growth of barramundi *(Lates calcarifer)* nursed in in-pond floating raceways" and "Trials to nurse barramundi *(Lates calcarifer)* from 2 cm to 10 cm total length in in-pond floating raceways" with excellent results. There are also 6 BSc students from Nha Trang University who have finished their theses using the results of the project.

Some scientific papers were published in both national and international journals such as (Tung Hoang, Luu The Phuong & Huynh Kim Khanh (2007) Trials to rear the Asian seabass *Lates calcarifer* in floating raceways in coastal earthen pond. *Journal of Fisheries Science and Technology* 2007-1: 12 - 18 (in Vietnamese); and Ngo Van Manh & Tung Hoang (2008) Effects of stocking densities, stocking size and feeding regime on survival and growth of barramundi *(Lates calcarifer)* nursed in in-pond floating raceways. *Journal of Fisheries Science and Technology*). Project outcomes were disseminated to local farmers as mentioned in the Output 3 above.

The exhibition booth of the CARD VIE062/04 Project at the International congress in Hanoi was one of the most successful booths at the Exhibition in terms of attracting people to attend. The Australian Project Leader and the Vietnamese Project Leaders both had to spend a substantial amount of time providing information and consultancy to many visitors. The research outcomes of the project have been published in several papers; thus

could be used for teaching where appropriate. At Nha Trang University, information about floating raceway concepts, operation and management, limitation and future research have been incorporated into the teaching materials.

Contract deliverables for Output 7 (Milestone 9) include:

- Supervisor reports for MSc student
- Summary of SE Asian International Conference including partner institution contributions to conference agenda
- Competency assessment of participating UoF staff and incorporation of technologies into fisheries education curriculum and future research programs.

It is assessed that all project staff gained much from the project, not only the technical experience and knowledge, but also the managerial experience. This may increase the competency of UoF staff.

In conclusion, the Output 7 is assessed to be "High satisfactory".

Output 8: Significant improvement of environmental sustainability of farming system in coastal area

In Australian component, the promotion of raceway technology did address environmental compliance issues. While the research has demonstrated that raceways facilitate higher production efficiencies per hectare, uptake of the technology by existing coastal pond-based farmers had to be restricted to minimising nutrient discharge. This is because of State EPA discharge regulations. Research activities conducted during this reporting period focused on the issue with trials evaluating waste collection sumps within raceways, seaweed bio-filtration and the use of bacterial-based 'biofloc' treatment to progress towards zero water discharge.

Similarly, in Vietnam an integrated model with intensive nursing of marine fish in floating raceways and low-density prawn farming in the reservoir pond was developed and tested. Results showed that pond water quality was good and stable with no exchange for four months during which several batches of barramundi, grouper and cobia were nursed in raceways. This study establishes important steps to further development of the proposing integrated model, which allows water reuse and thus imposes no environmental impacts on the surrounding environment.

As a result of higher production over a nursing unit and no environmental impact, the floating raceway technology has been applied by many new producers in practice as mentioned in the Output 3 above. This proved the environmental sustainability of farming system in coastal area.

In conclusion, the Output 8 is assessed to be "High satisfactory".

Output 9: The developed technology made available to disadvantageous groups

The investigation through a field visit showed that the FR technology requires a high technical skill to operate and control the system. Furthermore, the initial cost of investment is quite high compared with traditional nursing in ponds. Therefore, the technology is

viewed by most interviewees as not be appropriate for poor farmers or disadvantaged groups. During the time of the project, although the extension activities have been promoted to smallholder groups, no disadvantageous people have had access to the technology.

The benefit to be gained from smallholder and disadvantaged groups could be through from buying cheaper fingerlings with higher quality as a result of better survival rates (about 80% nursing in FR compared with about 50% nursing by traditional fishponds. Furthermore, some disadvantaged people could be employed as workers in fingerling production units and get income from the job.

Contract deliverables for Output 9 (Milestone 8) include:

- 2nd project workshop and associated training / extension activities completed.
- Analysis of changed behaviour including completion of disaggregated stakeholder beneficiary analysis (pre and post project survey). This analysis will include assessment of economic (smallholder financial analysis) benefits, social, and environmental impacts.

In conclusion, the Output 9 is assessed to be "Moderate satisfactory".

3.2 Project Progress & Implementation Issues

In general project implementation progressed smoothly and almost all activities were completed on time although there was a delay of about 5 months as a consequence of contract negotiations at initial stage that delayed project progress by about that amount.

Steady implementation progress was greatly aided by a strong communication strategy between project partners and high level of commitment to achieving project objectives on both sides.

3.3 Major Problems Identified and ranked in four levels of High satisfactory; Satisfactory; Moderately satisfactory; Un-satisfactory:

Some major problems identified regarding the in-pond floating raceway technology include: 1) the using of FR technology imposes a risk of failure in the operation of air-blowers and electricity system. Because fingerlings are reared with a very high density of fish, if the air pumping system does not work for about 5 minutes, fish may die. Therefore, it requires a very strict control with regard to technical issues. 2) The technology also imposes a risk of failure in some situations of weather extremes, such as floods or strong winds, etc.; 3) the cost of FR is high so that not many small farmers can invest meanwhile they have to learn/ care much about technical aspects to use the technology.

The field investigation shows that the main beneficiaries currently include companies who have a good capital for investing in production systems. Small farmers or disadvantaged groups receive lower benefits indirectly from high quality and uniformity of fingerlings. This implies that the main objective of the project to benefit those stakeholders does is not fully met. A risk is that in the case of a monopoly of one or some seed producers in one area, the price of fingerlings can be still high meanwhile the price of output (market fish) from fish farmers remains at lower prices.

The evaluation of the project achievements in relation to its objectives is as follows:

Code	Narrative	Assessment
Objective 1	Trial a cost effective larval rearing system for small to medium scale hatchery operations and fingerling producers in Vietnam	H
Output 1.1	• Technology for larval rearing, fingerling and grow-out production developed	H
Output 1.2	• Higher production at lower cost by FRs for all phase of culture	H
Objective 2	Demonstrate capacity for fingerling and on-growing production in Australia and possibly in Vietnam.	H
Output 2.1	• Developed technology or research concepts applied by local farmers	S (The technology mostly applied by big companies)
Objective 3	Demonstrate possibility to develop a zero-discharged system with additional yield of by-products.	H
Output 3.1	• A zero-discharge system using FRs in existing ponds and bio-remedial species for local industries	H
Output 3.2	• Higher production of marine fish fingerlings by the local industries	S
Objectives 4	Deliver benefit to stakeholders and beneficiaries (local farmers, marine-culture industries, disadvantageous groups, feed producers, aquaculture students, staff of UoF and DPI&F.) and capacity building for both sides	H (The benefits to stakeholders outweigh disadvantaged group)
Output 4.1	• A network among project participants	H
Output 4.2	• Effective training and capacity building	H
Output 4.3	• Significant improvement of environmental sustainability of farming system in coastal area	H
Output 4.4	• The developed technology made available to disadvantaged groups	M (we do not see much impact on these groups)

In short, the overall goal of the project was achieved. However, two of the objectives have been satisfactorily completed and one considered as Moderate satisfactory.

4. Project Evaluation

Five key evaluation questions: Relevance, Effectiveness, Efficiency, Impact and Sustainability were asked for answers.

4.1 Relevance:

Key Question: Does the design of the project correctly address problems or real needs? Were the objectives clear, realistic and measurable and was the project design adequate to achieve the objectives?

The project objectives were and still remain highly relevant to Vietnam in the context of development of fisheries sectors as Vietnam is still one of the leading fish exporting countries of the world, and it has a competitive advantage in producing marine fish. The design of the project, which focused on the development of the technology and testing at site with larval rearing and then in combination with training and information dissemination activities, is evaluated being as a good approach to achievement of its objectives. The floating raceway technology is considered appropriate in the testing area as well as other regions of Vietnam.

However, the technology is most appropriate for rearing fingerlings but not as appropriate for fish production since it requires FRs of a very large scale. It can be used for rearing both marine fish and brackish fish. The model is appropriate for individuals or companies that have the financial capacity and initial investment ability. Poor farmers/ producers can only benefit from the technology if the price of fingerling decreases and higher quality of fingerlings increase fish yield for farmers.

There may be a need to extend the research with smaller scale of floating raceway to be suitable with small farmer households and bigger scale for marine-aquaculture. The technology can use HDPE for rearing fingerlings in brackish waters.

The approach of the project was good but in the context of an un-identified plan for marine fish production, it does not seem fit with highly required quantity of fingerlings since Vietnam does not have a master plan for producing marine fish. However, the technology can be applied for areas where producers are producing brackish fish. At the current time, the demand for fingerlings has decreased sharply therefore the technology of floating raceways faces difficulties into scaling up or being further extended.

4.2 Effectiveness:

Key Question: did the project do the right things to address the purpose or objectives? Need to consider progress in achieving objectives, quality of outputs, and extent of benefit to target population.

The project has succeeded in achieving its objectives. Two versions of floating raceway for rearing fingerlings have been developed and tested successfully. The floating raceway can produce fingerlings and market-fish with a very competitive cost and good quality in both Vietnam and Australia. The environmental issues in producing fish are improved significantly when the floating raceways are used in comparison to rearing/growing in ponds.

The evaluation found that this project can be considered to be very effective. The implementation of the project was delayed about 5 months as the delay of signing contract caused a delay of equipment investment and testing. During the trials of fingerling rearing, there were two failures as a consequence of improper design of the air pumping system. However, the final versions of floating raceways have fixed the problems.

In general, the technology has been developed successfully in the pilot area (at Brackish Water Research Station) however it could prove the effectiveness more and its reliability if it was piloted and tested in another area. The beneficiaries from the technology would be most suitable for companies that invest in production and fish farmers are considered to

benefit less from the technology. At this time all stakeholders applying the technology have interrupted their production as the result of a low demand for fingerlings. The demand is largely depended on the market but also a strategy plan of the government to boost the industry.

4.3 Efficiency:

Key Question: Were the resources used in the best possible way or could things have been done at lower cost? Timeliness of implementation processes, efficiency by contractor, strength of partner support and value of dialogue etc.

The project team is considered to be very successful in organizing and cooperating with relevant stakeholders during the implementation of the project. The team leader is assessed a good planner and organizer to promote activities of the project. Resources used in the project are appropriate with respect to equipment/ technology as well as human resources. The floating raceways made from fiberglass composite material (life could last for over 50 years) is considered the best in terms of efficiency although initial investment of this material is relatively high compared to other materials such as HDPE plastic. However, for poor fish farmers, their investments often imply for a short term; therefore, it may need to find other options with cheaper material. The cost of investment would be very competitive if we make an assumption of the floating raceways life lasting for "at least" 20 years. In the future the technology could be widely applied and scaled up depending on the market demand for fish fingerlings.

The timeliness of the implementation of the project was considered good at the beginning stage of the project, even now although it is in the context of global economic crisis.

Beneficiaries from the project include: commercial fingerling producing companies, farmers, fisheries extension staff, technicians from commercial companies, students who are trained, with direct benefits from good fingerlings at a low cost.

According to Mr. Vu Duc Quy, Director of Khanh Hoa Fisheries Extension Center: This technology brings benefit to all relevant stakeholders: fish farmers benefit from buying fingerlings with cheaper prices and higher quality. The cost price of producing "chem" fingerling from the Center is about 1,800 VND/fish meanwhile the market price is about 7,000 VND/fish. If the fingerlings are produced by farmers following traditional methods, the cost price is about between 3,000 and 4,000 VND/fish depending on the survival rate. In terms of economic efficiency, at this time, because the technology has not been scaled up, his personal evaluation for the technology is 7 out of 10 marks.

4.4 Impact:

Key Question: To what extent has the project contributed to the improvement of livelihoods and overall CARD objectives? Should consider: financial impacts (increased income or decreased cost); social impacts; environmental impacts.

In this stage of project completion, it has a significant impact of the project in relation to stakeholders and beneficiaries (local farmers, marine-culture industries, feed producers, aquaculture students, staff of UoF and DPI&F, and partly for disadvantageous groups). In terms of capacity building (research activities and training), there are about 60 people taking part in training workshops on with the floating raceway technology. In addition, 2 presentations at the Ministry and exhibition about the technology have disseminated the information to potential users in Vietnam as well as international partners.

The number of people/producers using the technology is evaluated to have increased since the quality of seed and the level of cost-effectiveness of the technology is considered higher compared with that from traditional methods.

In the future, if the market for marine fish increases and export fisheries processing units are promoted, the impact of the technology will be very high, in terms of creating jobs for local people, providing cheaper and better fingerlings for fish producers/ including poor farmers, and especially ensuring the mitigation of environmental impact caused from rearing fish. The technology could promote the development of fish feed production industry as fish production from the FR technology uses feeds made from industrial production.

Greater awareness of fish farmers with regard to the importance of using good fingerlings will boost the development of FR technology since it can produce fingerlings with high quality. Therefore, the impact of FR will have a chance to be extended. The impact of the project could be re-evaluated in several years.

4.5 Sustainability:

Key Question: Are the positive outcomes from the project likely to be maintained, replicated or extended?

As the evaluation mentioned above, the project has produced positive outcomes which are likely to be maintained and replicated. The indicators that were identified during the field trip include:

1) There are many units/companies that have applied the technology of in-pond floating raceways for over a year since the project was finished. For example: Australis (USA) in Khanh Hoa Province, Minh Thuan Co. in Ninh Thuan and Ben Tre Provinces, Viet Seabass Co. in Vung Tau Province, Truong Thanh Co. in Phu Yen City, Brackish Water Fisheries Station of Phu Yen Fisheries Extension Center, and others. However, over the last six months the production of fingerlings using floating raceways has been interrupted as a consequence of global economic crises as the export of fish has decreased significantly and the demand for fingerlings has gone down since then and not yet recovered;

2) The survival rate of fish rearing from floating raceways is assessed much higher than that from using traditional methods (about 80% in comparison with about 50%, respectively); fish are much easier to treat for diseases than rearing in ponds; productivity is higher in one square metre of water surface, cost-effectiveness is higher; and, less environmental impact is expected. Fish reared in floating raceways can be fed with industrial feeds therefore fingerlings will continue to be fed with the feeds in the grow-out stage of fish production. In traditional rearing, fish is fed with flake food. . Therefore, using FR technology can limit or prevent the exhaustion of natural fish sources;

3) Most people asked who know the technology believes that the technology is more practical and profitable than traditional methods and could be scaled up/ extended. Many people/companies are interested in applying the technology;

4) The information on floating raceway technology is circulated through training workshops, exhibition and training MSc student and technicians from participating organizations (Khanh Hoa Fisheries Extension Center, Fisheries Division of Phu Yen Agriculture and Rural Development, and technicians from companies).

5. Conclusion, Lessons learned and Recommendations

Based on the evaluation team's findings this project can be considered to have successfully achieved its objectives and has demonstrated early signs of positive impact for both the project participants and the fisheries industry. There are also good indicators that project outputs will be sustained and extended. In relation to the relevance, effectiveness and efficiency of the project, the evaluation found that the project was successful when assessed against these factors.

The project team has made good coordination with relevant stakeholders and made the link between university research and practical delivery. Experiments are well organized in Australia and Vietnam especially with support from Australian experts. The combination with provincial staff (from the Brackish Fisheries Center, Khanh Hoa Fisheries Extension Center) is important to reduce costs of experiments as well as to increase the possibility of more technicians/ staff of practical units who can apply project's results. Some activities of the project such as organizing workshops (three extension workshops and four presentations to potential users in Vietnam and overseas) to demonstrate not only efforts of the project staff but are also due to increasing interests of the local aquaculture industry. The national extension workshops and exhibition organized in Hanoi is also to bring more chances for potential investors/ producers to apply the technology.

The delay of the project compared with the anticipated start (as the result of contract negotiations) caused some difficulties with pond water quality as funds were not available in time to build the system in its complete form before it was stocked with fish and this affected the access ability to provide larvae and fingerlings of particular species in both countries.

The information about the technology should be circulated or disseminated across the whole sector for potential producers/ investors to know and apply in practice. The manuals of the technology could be published for investors to apply it for fingerling/fish production. However, technical guidelines and manuals should be modified to be more simple to facilitate the technical transfer process. More presentations on the technology should be integrated in workshops at sector level, the ministerial or provincial.

Further impact would depend on further support from decision makers at provincial level and even MARD in terms of strategy planning and related policies for sustainable development.

The CARD PMU and the project proponent should come to agreement on Intellectual Property rights of FR technology. It's recommended that IP right is not applied in this case. Khanh Hoa Fisheries Extension Center is an appropriate unit to be responsible for transferring the FR technology and they may charge some consultancy fee for the technical transfer.

CARD or Vietnam Government should support for small scale marine aquaculture in Vietnam because there is no research for this field. If marine fish is produced with large scale and exported, it will boost the development of the fishery sector (include rearing fingerlings, distributing, marketing, etc.).

In terms of CARD project management, it needs to process procedures as well as finish contract negotiations at scheduled time since projects with experiments, especially with fisheries trials, they largely depends on seasons with available larvae as well as weather conditions.

Annex 1. LIST OF INTERVIEWEES

1. Principal Officers involved in Project:

- Mr Huynh Kim Khanh – Brackish Water Research Station, Khanh Hoa Fisheries Extension Centre

2. Khanh Hoa Fisheries Promotion center

- Mr Vu Duc Quy: Director of the center

3. Ninh Ich Commune, Ninh Hoa District, Khanh Hoa Province

- Mr Vo Dinh Long, fingerling buyer from the project (floating raceways) and fish farmer.

4. Phu Yen Department of Agriculture and Rural Development

- Mr Nguyen Minh Phat, Vice head, Fisheries Division

Annex 2: PHOTOS FROM FIELDWORK

The evaluation team meeting with Khanh Hoa Fisheries Extension Center

The evaluation team visiting experimental site and discussing with project staff

The technician explaining their renovation of airlift system to work better (left), and introducing the floating raceway models (above).

A floating raceway system set at Khanh Hoa Fisheries Extension Center

A floating raceway is made of HDPE with lower cost used in Australia.

Annex 3: PROJECT LOGFRAME: Progress Against Proposed Objectives, Outputs, and Activities

Project Title: Intensive in-pond raceway production system of marine finfish (062/04 VIE)

Vietnamese Implementing Institution: University of Fisheries, Nha Trang - Vietnam

	PROPOSAL			COMPLETION REPORT
Narrative	**Information Required**	**Performance Measures**	**Assumptions/Risks**	
OBJECTIVES	1. Trial a cost effective larval rearing system for small to medium scale hatchery operations and fingerling producers in Vietnam	1.1. Availability of technical guidelines 1.2. Cost-benefit analysis & actual FR production 1.3. Records of the KH's Fisheries Promotion Centre	• Fish larvae can be reared in FR • Fertilized eggs or larvae available as required by trials • Diseases are managed effectively • Dissemination is effective	Trials have been conducted successfully. Performance indicators have been reported. See MS Reports 2, 4 and 8.
	2. Demonstrate capacity for fingerling and on-growing production in Australia and possibly in Vietnam.	2.1 Availability of technical guidelines 2.2 Cost-benefit analysis & number of fish harvested from FR 2.3 Records of the KH's Fisheries Promotion Centre	• Target species tolerate very high stocking densities and available as required by trials. • Diseases are managed. No natural disasters. • Market prices remain unchanged • Dissemination is effective	Trials on nursing and grow-out were completed. Both technical guidelines and cost analysis were made available through Milestone reports 3 and 4. See also MS Reports No. 8 and 9. In Vietnam, it only demonstrated for fingerling production, not on-growing.
	3. Demonstrate possibility to develop a zero-discharged system with additional yield of by-products.	Frequency of water exchange Water quality Production of by-product species Cost-benefit analysis	• Bioremediation means available on request and function as expected. • No natural disasters, e.g. flooding, cyclones	Trials in Australia and Vietnam were completed – reported in MRs 2, 4 and 5. The newer version of FRs has prominent characteristics. Cost analysis is provided in MS Report No.8.
	4. Deliver benefit to stakeholders and beneficiaries (local farmers, mariculture industries, disadvantageous groups, feed producers, aquaculture students, staff of UoF and DPI&F.) and capacity building for both sides	Involvement of stakeholders in the project. Availability of training materials. Extension workshops organized. MSc training, short-training courses conducted for UoF. Number of farms, farmers applied floating raceway technology for aquaculture production.	• Initial interests of stakeholder remains or increases • UoF release staff at appropriate time scheduled for training	Training and extension activities took place according to plans and had good outcomes. See MS Reports No. 8 and 9. However, disadvantageous groups are expected not gaining much from the results of the research.

Project Title: Intensive in-pond raceway production system of marine finfish (062/04 VIE) **Vietnamese Implementing Institution: University of Fisheries, Nha Trang - Vietnam**				
	PROPOSAL			**COMPLETION REPORT**
Narrative	**Information Required**	**Performance Measures**	**Assumptions/Risks**	
OUTPUTS	5. Higher production of marine fish fingerlings by the local industries	Through comparison of production of 2004 and that of 2007, data from KH Fisheries Promotion Centre	• Local farms and hatcheries started applying this technology from 2005	Fingerlings were distributed to the farmers with higher quality and better price. See MS Report No. 8.
	6. A network among project participants	Participation and contribution of each party documented.	• Great level of interest of invited participants remains unchanged.	Communication has been well maintained among participants.
	7. Effective training and capacity building	Documentation of project activities; number of scientific presentations of project staff at international/national conferences	• DPI&F and UoF make human resource and time available for training and research activities under this project.	Good effective training and capacity building has been made through out the project time. See more details and achievement in MS Report No. 9
	8. Significant improvement of environmental sustainability of farming system in coastal area.	Through monitoring after the completion of the project	• No other emerging threats to coastal aquaculture. • Government policies remain supporting to coastal aquaculture.	A zero-discharge system for fingerling production was successfully tested in Vietnam while important ground works for biofloc technology have been set up in Australia. This is evaluated as a good technology in improving the quality of the environment in fisheries sector.
	9. The developed technology made available to disadvantageous groups	Through post-project extension activities including technology transfer conducted by DPI&F and UoF and other relevant agencies, e.g. Ministry of Agriculture and Rural Development, National Fisheries Promotion Centre, etc.	• Disadvantageous groups are capable of absorbing this technology technically • Sufficient financial support made available to these groups by the two governments.	Extension workshops were organized in Jan and Dec 2006, Aug 2007. Exhibition of technology organized at APC 2007. It is difficult to say it is made to disadvantage groups.

Project Title: Intensive in-pond raceway production system of marine finfish (062/04 VIE) **Vietnamese Implementing Institution: University of Fisheries, Nha Trang – Vietnam**				
	PROPOSAL			**COMPLETION REPORT**
Narrative	**Information Required**	**Milestone**	**Time frame**	
ACTIVITY	1. Development of full project proposal	• Stakeholders identified • Agreements reached for supports/participation by stakeholders • Target groups identified • Full proposal submitted	• 20-30 Oct 2004 • by 15 Nov 2004, finalized 2 weeks after approval of project application by CARD • 25-10 Nov 2004 • by 19 Nov 2004	• All done (MSR 1)
	2. Finalization of research site	• The research sites and other satellite sites selected	• By 15 Feb 2005 (project starts officially 1 March 2005)	• All done (MSR 1)
	3. Constructing raceways with local materials	• Suitable materials identified with details of cost • Plans completed • Raceways installed and tested in selected reservoir ponds.	• Started mid Nov 2004, completed by Jan2005 • Started mid Nov, completed by Feb 2005 • Completed May 2005	• All done (MSRs 2, 4)
	4. Trials on larval rearing and nursing fingerlings	• Sources identified with details of cost and availability • Research facilities ready • Ample number of eggs, larvae or fingerlings obtained • 1 full-scale trial for each species	• Started Nov 04, finalized by Feb 05 • Started Mar 05, completed by Jun 05 • Mar-Jun05, Sep 05-Jun 06, Sep 06 – Feb 07 at BIARC; Jun 05 – Aug 06 at UoF	• All done (MSRs 1, 2, 3, 4, 5, 6 & 7)
	5. Trials on development of zero-discharge system	• System established and tested • Necessary materials obtained • 1-2 full-scale trial(s) conducted at each place, BIARC and UoF	• By Jun 06 at BIARC and UoF • By Jul 06 at BIARC and Aug 06 at UoF • Between Sep 06 – Feb at BIARC and UoF	• All done (MSR 5)
	6. Training	• Training organized and conducted • MSc thesis research conducted and published • At least two presentations	• Mar-Jun 05 • Aug 05 – Jan 06 • Aug-Nov 06	• All done (MSR 9)
	7. Dissemination of project concepts and results	• Principles of FR are made accessible to local industries • Attended by local extension officers and local farmers • At least 04 papers published	• Mar 05 • Jan 06 • Intermittently during project	• All done (MSRs 1, 3, 6, 7 and 9)
	8. Reporting	• Submitted on time to CARD, satisfy all requirements	• Sep 05, Sep 06 • Feb 06, Feb 07, Mar 07	• All done (MSRs 1..10)