



Aquaculture Nutrition



**Report on the Aquaculture Nutrition Master Class held
at Asian Institute of Technology, Bangkok, Thailand
7-19 August 2006**

Geoff Allan, Helena Heasman and Paul Ferrar



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Aquaculture Nutrition: Report on the Aquaculture Nutrition Master Class held at Asian Institute of Technology, Bangkok Thailand 7-19 August 2006

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1. EXECUTIVE SUMMARY

The ATSE Crawford Fund Aquaculture Nutrition Master Class was held at the Asian Institute of Technology, Bangkok, from 7-19 August 2006. The two week live-in intensive course for 27 invited participants from 10 south-east Asia and Pacific Island countries offered comprehensive training in all aspects of grow-out aquaculture nutrition. Fourteen guest lecturers (seven from Australia and seven from other countries), delivered lectures and conducted practical laboratory tutorials followed by discussion and revision sessions and enhanced by field trips to farms and feed mills. All participants had their travel, accommodation and other expenses paid for by the Master Class and in addition students were provided with extensive reading material, T-shirts and satchels. Student feedback from the course evaluation survey was very complimentary and most found the standard of content and delivery to be outstanding.

This intensive two-week course will be condensed and repackaged as short 3-day workshops providing a summary of topics covered at the longer Master Class or cover a selection of key topics of particular interest to target audiences. For example, the first of these mini-workshops will be delivered in Papua New Guinea in November this year by two students and two lecturers from the inaugural Master Class and will focus on small-scale feed manufacture.

The success of the Aquaculture Nutrition Master Class can be attributed to a number of factors including the close working relationship and good humoured camaraderie of lecturers that resulted in the compilation of a well-rounded and comprehensive program; the mutual respect and admiration that developed between lecturers and students from vastly different backgrounds resulting in friendships being forged; the cooperative and collegiate attitude of organizations like NACA, AIT and ACIAR working together to ensure the Master Class achieved its primary aim:

IN ACKNOWLEDGING THAT SMALL SCALE AQUACULTURE IN SOME DEVELOPING COUNTRIES IS AN IMPORTANT SOURCE OF PROTEIN TO SUPPLEMENT OTHERWISE MEAGER DIETS, THE MASTER CLASS AIMS TO EQUIP STUDENTS WITH THE BASIC UNDERSTANDING AND IMPORTANCE OF FISH NUTRITION AND HOW TO PRODUCE COST-EFFECTIVE AQUAFEEDS BY UTILIZING LOCALLY AVAILABLE AGRICULTURAL INGREDIENTS.



2. SPONSORS AND CONTRIBUTORS

 <p>ATSE CRAWFORD FUND</p>	 <p>Australian Government Australian Centre for International Agricultural Research</p>		
 <p>CSIRO MARINE RESEARCH</p>	 <p>NSW DEPARTMENT OF PRIMARY INDUSTRIES</p>	 <p>Australian Government Fisheries Research and Development Corporation</p>	 <p>GOVERNMENT OF WESTERN AUSTRALIA Department of Fisheries</p>
 <p>Thai Luxe</p>	 <p>ASIAN INSTITUTE OF TECHNOLOGY 1959</p>	 <p>FAO FIAT PANIS</p>	
	 <p><i>Aquaculture without Frontiers</i></p>		

3. MASTER CLASS BROCHURE

ATSE CRAWFORD FUND

Announcing...

AQUACULTURE NUTRITION MASTERCLASS

An initiative of
THE ATSE CRAWFORD FUND
 SUPPORTING INTERNATIONAL AGRICULTURAL RESEARCH

to be held at
ASIAN INSTITUTE OF TECHNOLOGY
 Klong Luang, Pathumthani 12120
BANGKOK

7-20 August 2006

Proudly sponsored by...

ATSE CRAWFORD FUND
AUSTRALIAN CENTRE FOR INTERNATIONAL AGRICULTURAL RESEARCH
FISHERIES RESEARCH AND DEVELOPMENT CORPORATION
FAO
ASIAN INSTITUTE OF TECHNOLOGY
AQUACULTURE WITHOUT FRONTIERS

Small scale aquaculture in some developing countries is providing an important source of protein to supplement otherwise meager diets. It is therefore important to have an understanding of fish nutrition and how to produce cost-effective aquafeeds by utilising locally available agricultural products. This live-in 2 week intensive course for invited participants from south-east Asia and Pacific Island countries will offer comprehensive training in the following aspects of grow-out aquaculture nutrition:

- PRINCIPLES OF AQUACULTURE NUTRITION
- INTRODUCTION TO DIET FORMULATION
- PELLETING & EXTRUSION OF COMMERCIAL FEEDS
- NATURAL FEEDS & INTEGRATED AQUACULTURE
- ANALYTICAL TECHNIQUES
- POTENTIAL FEED INGREDIENTS
- FARM MADE & LABORATORY FEEDS
- FEED MANAGEMENT - STORAGE
- FEEDING STRATEGIES
- RESEARCH METHODS

TOPICS TO BE PRESENTED AS LECTURES, PRACTICAL LABORATORY TUTORIALS, DISCUSSION & REVISION SESSIONS, FIELD TRIPS TO FARMS & FEED MILLS. COURSE MATERIAL WILL INCLUDE LECTURE NOTES, TEXT BOOK & BIBLIOGRAPHIC LITERATURE.

GUEST LECTURERS, PRE-EMINENT IN THE AQUACULTURE NUTRITION FIELD, INCLUDE:

DR GEOFF ALLAN, NSW DPI	DR BRETT GLENCROSS, WA FISHERIES
DR MALI BOONYARATPALIN, THAILAND MOP	DR SENA DE SILVA, DEAKIN UNIVERSITY
DR MARK BOOTH, NSW DPI	MR DAVID SMITH, CSIRO MARINE RESEARCH
DR ROB VAN BARNEVELD, BARNEVELD NUTRITION	DR KEVIN WILLIAMS, CSIRO MARINE RESEARCH
DR PETER EDWARDS, EMERITUS PROFESSOR	DR AMARATNE YAKUPITTYAGE, AIT

CSIRO

Aquaculture without Frontiers

REPORT ON
INTERNATIONAL MASTER CLASS
ON
AQUACULTURE NUTRITION
ASIAN INSTITUTE OF TECHNOLOGY, BANGKOK, THAILAND
7-19 AUGUST 2006

4. INTRODUCTION

Aquaculture remains one of the fastest growing food production industries with growth rates of 7.9% over the ten years to 2004 (R. Subasinghe [FAO], presentation to AQUA2006, Florence, May 2006). Aquaculture now accounts for almost 50% of the total food fish consumed in the world with total production in 2004 estimated to be 59.4 million tonnes (includes animals and plants), worth US\$70.3 billion (Subasinghe, 2006).

Demands for aquatic protein (food fish) are increasing due to increasing global population as well as increasing per capita consumption (occurring both regionally and globally). Aquaculture is recognized as the only way these increasing demands for seafood will be met (Allan, 2004 – Fish for feed vs fish for food).

One of the reasons for the phenomenal growth of aquaculture is the progressive intensification of many production systems. The key driver for intensification is the use of increasingly sophisticated diets that meet nutritional requirements of target species. For many species, particularly in Asia, these diets have been based on the use of “trash fish” (low value fish species) fed either as a single ingredient or in combination with other ingredients (e.g. rice bran). Unfortunately, supplies of trash fish are not adequate to support the current rate of expansion of aquaculture. There are also other problems or potential problems with the use of “trash fish” including reliability and consistency of supply and cost. For example, the price of “trash fish” in Vietnam has doubled over recent years (Edwards *et al.*, 2004). The environmental impacts of aquaculture, particularly cage aquaculture, are also usually greater when “trash fish” is used.

The alternative to feeding with “trash fish” is to use formulated diets. The use of formulated diets for aquaculture species has been a rapidly developing industry and now it is estimated that the global market for formulated aquaculture feeds (aquafeeds) is about 15 million tonnes (Tacon 2003). For most carnivorous and omnivorous species, the protein and lipid sources of choice for formulated diets have been fishmeal (usually made from dried and ground whole fish) and fishoil. Globally, approximately 6 million tonnes of fishmeal and 1 million tonnes of fish oil are produced annually and while production has been relatively stable over several decades, the proportion of these ingredients being used in aquafeeds has increased rapidly (34 and 47% of total global supplies in 2002; Tacon, 2003) and cannot continue to support the aquaculture growth rate that will be needed to meet demand.

For these reasons, there is an urgent need to better understand nutritional requirements of aquaculture species and to evaluate a wide range of alternative ingredients. Feeds and feeding are key priorities for aquaculture generally, including for many countries in south-east Asia and the Pacific.

The aim of the Aquaculture Nutrition Master Class is to share information on aquaculture nutrition and train participants in nutritional requirements, ingredient evaluation, feed formulation and manufacture, research methods and how to interpret analytical results.

5. ADMINISTRATIVE ORGANISATION

The Director of the Master Class was Dr Geoff Allan.

Initial planning of the structure and class program was undertaken by a committee comprising:

Geoff Allan and Mark Booth (NSW Department of Primary Industries)
Kevin Williams and David Smith (CSIRO Marine Research)
Brett Glencross (WA Fisheries)
Amararatne Yakupitiyage (Asian Institute of Technology)
with assistance from Helena Heasman (NSW DPI) and Paul Ferrar (Crawford Fund)

The venue for the Master Class (accommodation and lectures) was the Conference Centre of the Asian Institute of Technology (AIT). Practical classes were held in a nearby computer laboratory of AIT, and feed preparation facilities in the Aquaculture & Aquatic Resources and Development department of the School of Environment, Resources & Development at AIT. Local arrangements for all of this were made by Dr Amararatne Yakupitiyage and his staff at AIT.

The Network of Aquaculture Centres in Asia-Pacific (NACA) was engaged to arrange participants' travel, issuing of meals/incidentals allowances and reimbursement of participants' expenses for visas, taxis and other miscellaneous expenses. Funds for this were transferred in advance by the Crawford Fund, and the arrangement worked out very well.

Two key people ran the majority of planning work involved with the Master Class. In Australia, Mrs Helena Heasman arranged all planning meetings (teleconferences) and circulated minutes, arranged purchase of all course materials, Master Class shirts, satchels and gifts, was responsible for liaising with NACA staff, AIT and AIT convention centre staff and all lecturers. She also arranged travel for lecturers. In Thailand, Mrs Wella arranged the travel arrangements and managed the financial arrangements (e.g. the per diems and reimbursements for taxis, etc) for all participants, a difficult task because of poor communication facilities in several countries.

The Class also owes great thanks to Dr Amararatne Yakupitiyage and his staff at AIT, who made all the arrangements at the Master Class venue and for the field trips, and also managed the importation and customs clearance of a number of shipments of class materials sent from Australia. Mr Apiyut Siyapan, Laboratory/Field Supervisor at AIT, gave significant help during the field trips and practical classes.



*Drs Geoff Allan & Paul Ferrar
welcome Master Class participants*

6. LIST OF PARTICIPANTS

A full list of participants from the following countries is presented in Appendix 1

Thailand	7
Vietnam	5
PNG	3
Indonesia	3
Cambodia	2
Laos PDR	2
Philippines	2
India	1
Bangladesh	1
New Caledonia	1
Fiji	1 (travel approval was not granted at the last minute and this student did not attend)

7. LIST OF LECTURERS

Brief biographies of all lecturers with contact details are presented in Appendix 2.

From Australia

Dr Geoff Allan (NSW Department of Primary Industries, ACIAR and Aquaculture without Frontiers)

Dr Mark Booth (NSW Department of Primary Industries)

Mr Igor Pirozzi (NSW Department of Primary Industries)

Dr Kevin Williams (CSIRO Marine Research)

Mr David Smith (CSIRO Marine Research)

Dr Brett Glencross (WA Department of Fisheries)

Dr Rob van Barneveld (Barneveld Nutrition and Fisheries R&D Corporation)

From other countries

Dr Amaratne Yakupitiyage (Asian Institute of Technology)

Dr Thomas Wilson (Thai Luxe Enterprises Public Co Ltd)

Dr Mali Boonyaratpalin (Ministry of Fisheries, Thailand)

Dr Peter Edwards (Emeritus Professor, Asian Institute of Technology)

Dr Nguyen Thanh Phuong (Can Tho University)

Mr Le Anh Tuan (Nha Trang University of Fisheries)

Mr Satya Nandlal (Secretariat of the Pacific Community Aquaculture Officer)



Lecturers and students of the ATSE Crawford Master Class

Front row L-R: Kevin Williams, Brett Glencross, Igor Pirozzi, Paul Ferrar, Geoff Allan, David Smith, Amaratne Yakupitiyage, Peter Edwards, Thomas Wilson.

Back row L-R: Montakan Tamtin, Khamson Sisaath, Ajaya Bhaskar, Josy Joseph, Hopa Simon, Jutamas Chomphunich, Nuchnaree Tongsrri, Satya Nandlal, Somphouthone Phimmachak, Suphol Phantumaophas, Sophia Lasma Sagala, Rosabella Valencia, Nerafe Muyalde, Reza Samsudin, Le Anh Tuan, Usman, Chea Mong, Holl Tharine, Peter Minimulu, Irene Gubag, Ubonrat Limtipsuntorn, Dinh Van Trung

Absent: Mark Booth, Nguyen Thanh Phuong, Rob Van Barneveld, Somnuek Wisuttipongтарworn

8. FUNDING

Major funding was provided by the Australian Centre for International Agricultural Research (AUD 50,000), the ATSE Crawford Fund (AUD 25,000) and the Australian Fisheries Research and Development Corporation (AUD 13,200).

Charoen Pokphand Foods PLC (2 participants), Thai Luxe Enterprises Public Co Ltd (1 participant) and the Secretariat of the Pacific Community (1 participant) all sponsored members of their staff to attend the Master Class.

FAO provided valuable course material for participants. The various other organizations involved made generous in-kind contributions of the time of their staff involved. Much of Dr Allan's time was contributed as a donation to the Charity Aquaculture without Frontiers.



Dr Brett Glencross, one of the lecturers from WA Fisheries

9. MASTER CLASS PROGRAM (SEE APPENDIX 3 FOR FULL PROGRAM & APPENDIX 4 FOR NOTES ON FIELD TRIPS)

Time	Monday 7th August	Tuesday 8th August	Wednesday 9th August	Thursday 10th August	Friday 11th August	Saturday 12th August	Sunday 13th August	Monday 14th August	Tuesday 15th August	Wednesday 16th August	Thursday 17th August	Friday 18th August	Saturday 19th August					
0900-0940	Welcome & intros. Geoff Allan & Paul Ferrar	Recap #1 Intro to Aquaculture Nutrition Kevin Williams	Recap #2 Nutritional requirements Kevin Williams	FIELD TRIP 1: CP Feed Mill in Ban Paj; snakehead/catfish/giant catfish farm, macrobrachium farm	FIELD TRIP 2: Shrimp farms: DoF grouper hatchery	5.1 Analytical techniques David Smith	FREE DAY - PRIVATE STUDY	6.1 Natural feeds & integrate aquaculture Peter Edwards	7. Cont'd: Diet formulation - introduction to feed formulation. 8 x 45 minute laboratory and practical sessions Mark Booth, Igor Pirozzi, David Smith, Rob van Barneveld & Amara Yakupitiyage	8.1 Feed manufacture (farm made & lab feeds) Mark Booth	11. Farm made and laboratory feeds. 8 x 45 minute laboratory and practical sessions Rob van Barneveld & Thomas Wilson	Recap #8, #9, #10 & #11 Geoff Allan & Rob van Barneveld	Recap #12 Research Methods Kevin Williams					
0945-1025	1.1 Introduction to Aquaculture Nutrition Kevin Williams	2.1 Nutritional requirements Geoff Allan	3.1 Assessment of potential feed ingredients Le Anh Tuan			5.2 Analytical techniques Mark Booth		6.2 Natural feeds & integrate aquaculture Peter Edwards		8.2 Feed manufacture (farm made & lab feeds) Kevin Williams		12.1 Research methods Kevin Williams	Review topics identified for further discussion during course.					
1030-1100	Morning Tea					Morning Tea				Morning Tea			Morning Tea					
1100-1140	1.2 Introduction to Aquaculture Nutrition Mali Boonyaratpalin	2.2 Nutritional requirements Amara Yakupitiyage	3.2 Assessment of potential feed ingredients Brett Glencross			5.3 Analytical techniques David Smith		6.3 Natural feeds & integrate aquaculture Peter Edwards		9.1 Commercial feeds - pelleting & extrusion Rob van Barneveld		12.2 Research methods David Smith	Review topics identified for further discussion during course; Course assessment/questionnaire					
1145-1225	1.3 Introduction to Aquaculture Nutrition Mark Booth	2.3 Nutritional requirements Brett Glencross	3.3 Assessment of potential feed ingredients Mark Booth			5.4 Analytical techniques Brett Glencross		7.1 Introduction to feed formulation David Smith		9.2 Commercial feeds - pelleting & extrusion Rob van Barneveld		12.3 Research methods Kevin Williams	PRESENTATION OF CERTIFICATES & PHOTOS; OFFICIAL LUNCHEON					
1230-1345	Lunch					Lunch				Lunch			Lunch					
1345-1425	1.4 Introduction to Aquaculture Nutrition Geoff Allan	2.4 Nutritional requirements Geoff Allan	3.4 Assessment of potential feed ingredients Geoff Allan			5.5 Analytical techniques David Smith		7.2 Introduction to feed formulation Amara Yakupitiyage		9.3 Commercial feeds - pelleting & extrusion Thomas Wilson		12.4 Research methods Brett Glencross	FLY HOME					
1430-1510	1.5 Introduction to Aquaculture Nutrition Brett Glencross	2.5 Nutritional requirements David Smith	4.1 Feeding strategies Brett Glencross			5.6 Analytical techniques David Smith		7.3 Introduction to feed formulation Rob van Barneveld		9.4 Commercial feeds - pelleting & extrusion Thai DoF		12.5 Research methods David Smith						
1515-1545	Afternoon Tea					Afternoon Tea				Afternoon Tea				Afternoon Tea				
1545-1625	1.6 Introduction to Aquaculture Nutrition Brett Glencross	2.6 Nutritional requirements Nguyen Thanh Phuong	4.2 Feeding strategies David Smith (shrimp) Geoff Allan (fish)			Recap #5 Analytical techniques David Smith		Recap #6 & #7 Peter Edwards & David Smith		10.1 Feed management - storage Igor Pirozzi		12.6 Research methods Geoff Allan						
1630-1715		2.7 Nutritional requirements Satya Nandlal	Recap #3 & #4 Geoff Allan	Tour of AIT laboratory facilities Amara Yakupitiyage		10.2 Feed management - storage Thomas Wilson	12.7 Research methods Kevin Williams											

10. RESOURCE MATERIAL PROVIDED FOR STUDENTS

Please see Appendix 5 for full bibliography of all resource and reference material provided to students.

11. FUTURE THREE DAY MINI-WORKSHOPS (AQUACULTURE NUTRITION MASTER CLASS SHORT COURSES) AND OTHER SPIN-OFFS FROM THE MASTER CLASS

Developing the material for the Master Class involved many hundred of hours of work and a very comprehensive set of lecture notes (as PowerPoint presentations) was generated. To help ensure these outputs can benefit as many people as possible, a series of Aquaculture Nutrition Master Class Short Courses will be designed to be delivered in different languages in different countries. These will usually be three-day workshops and provide either a summary of topics presented during the two-week Master Class or a selection of key topics of particular interest to a target audience. Participants from the two-week Master Class will play a key role in delivery of the Short Courses. They will assist with development and condensation of the material to be presented and where required, with translation into other languages. They will also assist with identifying the target audience and arranging logistics of the course.

The development of an Aquaculture Nutrition Master Class Short Course for Australia was a key reason the Australian Fisheries Research and Development Corporation supported the Master Class and a Short Course will be developed for presentation in Australia in 2007. In addition, the following Aquaculture Nutrition Master Class Short Courses are or will be developed and delivered:

- a) Short Course with focus on small-scale feed manufacture (for PNG, to be presented in English in November 2006). Geoff Allan and Mark Booth (NSW DPI) will develop and deliver the course with assistance from Peter Minimulu (PNG NDAL) and Hopa Simon (PNG EHP/ACIAR)
- b) Short Course with focus on use of alternative ingredients and small-scale feed manufacture (for Northeastern Thailand, to be presented in Thai in early 2007). Geoff Allan (on behalf of Aquaculture without Frontiers) will help develop the English version and translation and delivery will be done with assistance from Dr Mali Boonyaratpalin (formally with Thailand Department of Fisheries) and staff from World Vision Foundation Thailand. This particular Short Course is being developed specifically for World Vision Foundation Thailand to assist them expand results from the successful ACIAR/World Vision "low-cost fish feeding" project throughout Northeastern Thailand.
- c) Short Course with focus on bioenergetic modeling and ingredient assessment for *Pangasius* catfish (for Can Tho University to be presented in Vietnamese in early to mid 2007). Dr Brett Glencross (WA Fisheries) and Dr Nguyen Thanh Phuong (Can Tho University) will develop and deliver the course with translation and assistance from Dr Thi Thanh Hien (Can Tho University).

Other Short Courses will also be developed and delivered, particularly in association with ACIAR projects that have an aquaculture nutrition component.

12. PRESENTATION OF MASTER CLASS CERTIFICATES

At the conclusion of the Master Class, both participants and lecturers were presented with certificates of completion or appreciation. Lecturers and key people who assisted with the Master Class were also presented with a small gift. Examples of both certificates are presented below:





A selection of photos showing students and lecturers receiving certificates of appreciation from Geoff Allan.

13. AUSTRALIAN JOURNALIST AT MASTER CLASS

The ATSE Crawford Fund Public Awareness Program (Ms Cathy Reade) supported an Australian journalist to attend the Master Class for three days during the first week. The journalist was Mr Brydon Coverdale of the Rural Press in Melbourne. He attended the first day of the Master Class and the two days of field trips, and was also able to talk individually to participants and teaching staff outside formal Class teaching. On the other days he attended various meetings organized by the ACIAR Bangkok office to meet with representatives of a number of ACIAR projects in the region and learn more about ACIAR's work and its benefits.

Brydon expressed himself as pleased with the visits and the contacts at the end of his mission, and the results will be seen later as he publishes stories relating to the Master Class and Australian work in the region. He took many photographs, especially during the aquaculture field trips, which should add an extra useful dimension to his articles.

14. FEEDBACK FROM PARTICIPANTS

An evaluation form was designed so participants could provide feedback on the course. The evaluation form was anonymous, mainly multiple choice but with sections for comment. A copy of the questionnaire is presented as Appendix 6.

Summary of participants' feedback surveys

A total of 24 sheets were returned. (Not all respondents filled in all questions).

Question	V. helpful	Good	Fair	Not helpful
1.1 Lectures	21	3		
1.2 Computer tutorial (Winfeed)	12	10	2	
1.3 Feed formulation practical session	11	10	3	
1.4 Field trips	7	16	1	
2.1 Introduction to aquaculture nutrition	14	9	1	
2.2 Nutritional requirements of aqua-culture species	17	7		
2.3 Assessment of potential feed ingredients	16	8		
2.4 Analytical techniques	16	6	1	
2.5 Natural feeds and integrated aquaculture	15	7	2	
2.6 Diet Formulation – Introduction to feed formulation	17	7		
2.7 Feed manufacture	12	11	1	
2.8 Commercial feeds – pelleting and extrusion	15	9		
2.9 Feed management – storage	20	2	2	
2.10 Farm made and laboratory feeds	12	11	1	
2.11 Research methods	16	6	1	
2.12 Course revision	16	5	1	

1. What was your opinion of the Class materials (e.g. books, CDs, presentations, etc)?

- Very good; very helpful; well prepared; informative; excellent; satisfactory; very complete; very useful.
- We will transfer to students and people who work in related aquafeed areas. Materials supported presentations of lectures, especially the references, as further readings helps participants to better understand the content.
- Most materials are very useful although some are only applicable to marine species.
- 90% of the content was well prepared and presented. It was easy to understand and follow. Some material was too technical to understand. The best part is we have more downloaded materials to take home and utilise.
- The class materials (hand-outs of printed presentations) should be given in the morning instead of later in the day.

2. Did you have any language problems? If so, please give details.

Most people said no problems. Six respondents said people should have spoken more slowly. One said that at first they had trouble but then they got used to people's way of speaking. Two said that the Australians were OK but some of the other participants (including those who lectured) were harder to understand. One said they had a bit of trouble understanding what was spoken, but the Powerpoints and printouts were fine to read.

3. How has your view of aquaculture nutrition changed as a result of the Class?

- The main comments were that participants had come to realise that aquaculture nutrition is a broader subject with more facets than they had realised. Several mentioned the importance of environmental considerations that they hadn't realised before, and one also said cost, people and sources of fish ingredients were also important.
- Two said their work will become more systematic, and several said they have become more motivated.
- One said: 'Aquaculture nutrition is very interesting and useful. It is main factor to success in culture of any species... it is art.'
- Another said: 'There are many species of aquatic animals that we didn't know all of their nutritional requirements so from this class we know more data to apply.'
- A third wrote: 'I believed that knowledge gained in the course will certainly make me a specialised aquatic nutrition biologist. The course is well suited to my present job and will be fruitful also to my future work plan.'

4. Has the range of your professional contacts changed as a result of this Class? If so, please describe what has happened.

- Most said it had improved a lot. One person said 'No' and one said their range of contacts had improved a bit. They mentioned future networking with other participants, and also being in future contact with the teaching staff (especially if they have any problems).
- One said: 'Yes, because all of the lecturers are the world's predominant aquaculture nutritionists, and they are ready to be contacted any time.'

5. Were the accommodation, meals and general arrangements appropriate? If not, could you provide details?

- Comments ranged from satisfactory to good to excellent. One said 'It has some problem with meals'. [Possibly a vegetarian? There was less vegetarian food available except in the buffets.] One said the food was delicious.

- One said that the location in Thailand was good – it is a convenient regional centre for people to get to.
- One said: ‘A group of people who will act as a Secretariat will be appreciated in future Master Class trainings.’
- One person said: ‘Good. I got more than I deserve.’
- A number of people also included comments here on how the Master Class structure and content could have been better. Several said that more field trips would have been good, including to other types of aquaculture – mariculture and brackish water were mentioned. Some also said that more laboratory work would have been good – one person wanted a lot more. One wanted more on Research Methods, and a practical on Statistics.
- One person asked for ‘Field trip for souvenir and tourism resort.’

6. What should be done now to reinforce the activities of this Class?

- Several people suggested that short follow-up training would be valuable. One suggested that that lecturers/course organisers visit the participants to evaluate how they were getting on, if time and funds were available.
- Several people mentioned that Class participants should keep in touch with each other, partly so that they can keep up with progress in aquaculture, and new developments in the subject. One person suggested a relatively formal network of regional laboratories/scientists (nutritionists) should be set up.
- One person wrote at the end: ‘Thank you for a valuable class.’

15. COMMENT BY DIRECTOR OF MASTER CLASS PROGRAM (PAUL FERRAR)

I believe that this was an extremely successful Master Class, on a subject of great importance and topicality. The need for more attention to the subject was well described at the annual Crawford Seminar at Australia’s Parliament House two years earlier, at which meeting the idea for this Master Class was born.

The participants were of particularly high calibre, with very good English, and all appeared to gain a great deal from the Master Class.

The program was a good mixture of classroom lectures, laboratory and computer practical sessions and field trips. A large amount of material was presented in the two weeks. As participants were unlikely to be able to absorb all of the material at the time, the teaching team made a great effort to provide Xeroxed copies of every lecture, and also held regular recap sessions. At the end of the Class, a CD was burned for each candidate containing all the presented material plus contact details for all participants and other useful information.

The Master Class was also noteworthy for the amount of valuable background material that was provided to candidates, including key publications on aquaculture, a feed formulation software package, etc. This material is listed in (7) above. I consider this to be a particularly valuable form of assistance because this material will go back to participants’ home departments and will be used by many additional people.

By all appearances the Master Class was also valuable for networking. Most of the participants had not met each other previously, and they interacted very well together during the two weeks of the Class. It is likely that contacts will continue in the region – and with Australia – well after the Class, which will be to the benefit of all.

The Master Class was based at the AIT Conference Centre, which proved a good and very convenient venue. The centre has accommodation (2-3 star rooms) at a reasonable price, plus dining room and

other catering, and a good lecture room with some facilities. Equipment can be hired from AIT if not available from the centre. There are banks, a post office and small shops nearby.

The idea of using NACA as a local agency for organizing travel and other administrative arrangements worked very well. There are many activities that cannot be done easily in advance from Australia, and it was good to arrive and find that all that work had been done. We paid NACA 12% of the total monies handled for the service, which proved excellent value. NACA has indicated that it would be prepared to do the same for any other aquaculture Master Classes held in Thailand in the future. They see it as part of their network function for encouraging and assisting aquaculture in the region.

Two people involved with the organization deserve special mention and thanks. Mrs Helena Heasman undertook the critical task of organizing the logistics before the course and negotiating with everyone involved. Her close attention to detail, extreme efficiency and cheerful persistence were fundamental to the success of the Master Class and made the whole exercise a highly enjoyable experience. The second person who really shouldered a large and critical burden in organization was Ms Wella from NACA. Communicating with some of the participants was very difficult. In many areas, email wasn't available to participants (e.g. parts of PNG) and in others participants could not receive attachments. Mrs Wella still managed to organize all the travel arrangements, apart from visa problems over which she had no control (these are discussed below), none of the participants experience difficulty with travel. Mrs Wella also organized all the *per diems* and reimbursements for participants.

Problems that arose

The Master Class was generally free of problems, except in relation to visas. Participants had been advised before the Master Class to check whether or not visas were required, and they generally did this. However, two separate problems (affecting four participants) were encountered.

Mr Satya Nandlal, Aquaculture Officer of SPC, travels on a Fijian passport. He had visited Bangkok on many previous occasions and had not required a visa on any occasion. However, the rules regarding Fijian passports had changed since his last visit, and visas are now required. Satya arrived in Bangkok and was refused entry. He was held at the airport by immigration authorities for two days and then put on a plane back to Auckland.

The problem caused a significant distraction at the start of the Master Class to Drs Geoff Allan and Amaratne Yakupitiyage. They spent much time interceding with immigration authorities to explain Satya's position and legitimate status, including obtaining official letters from AIT. They were given conflicting stories by different people in immigration, which added to the confusion and the work to try to get Satya released.

Satya's initial ticket had been bought by SPC as part of their assistance to the Master Class. As he was a lecturer as well as a key participant in the Class, I agreed that Master Class funds should be used to purchase another ticket, and he arrived (with a visa) a week late. However, he worked hard to catch up on the backlog of lecture material, and his contributions to the remainder of the Master Class were such that it was certainly the right decision to support his return.

His initial flight to Bangkok was with Emirates, and that airline was at fault in allowing him to board the aircraft without an appropriate visa. Had he been refused initial boarding, the total delay to his arrival would have been much less.

A different visa problem was encountered by the three participants from Papua New Guinea. They had ascertained that they needed Thai visas and had obtained these. Their flights were from Port Moresby to Brisbane to Sydney to Bangkok, and they had assumed that they would be in transit in

Australia. However, they were not warned by the airline that the flight between Brisbane and Sydney was a domestic Australian flight, for which they needed an Australian transit visa.

In this case it was Qantas that could be regarded as being at fault for not indicating the additional visa requirement. The participants were refused boarding in Port Moresby, and had to wait there an extra day to obtain the necessary Australian visas. This meant extra cost for an unscheduled overnight stay each in Port Moresby. They arrived a day late, which was also unfortunate in that the first day of the Master Class was a key session with much information presented. However, these participants also worked hard to catch up, with extra tuition and assistance kindly provided by Dr Geoff Allan.

The participant from Fiji, Ms Shalini Singh, employed by the Fijian Ministry of Agriculture Fisheries and Forestry, was unable to attend at the last minute when her travel approval was declined. This decision was based on departmental policy relating to her status as a temporary staff member. Shalini will nevertheless receive a copy of all course material and merchandise.

16. APPENDICES

16.1 List of participants and contact details

16.2 Bionotes of lecturers

16.3 Full program

16.4 Notes on field trips

16.5 Resource and reference material

16.6 Questionnaire

16.1 LIST OF PARTICIPANTS AND CONTACT DETAILS

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Mr	Reza		Samsudin	Jl. Semphur No. 1, Bogor, West Java, INDONESIA P.O. Box 150 16154	62-251-313200	62-81310969139	62-251-327890	jap_oedino@yahoo.com
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Ms	Montakan		Tamtin	Coastal Aquatic Feed Research Unit, 122 Moo 1 Laem-pakbia, Amphoe Ban-Laem, Petch Buri, 76100, THAILAND	00-66-(0)32-478211 (478210)	00-66-(1)8618118	00-66-(0)32-478211	mtamtin@hotmail.com
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Mrs	Nerafe		Muyalde	PNR Site San Miguel Calasiao, Pangasinan, PHILLIPINES	(075) 524-19-04		(075) 523-03-85	nerafe12@yahoo.com
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16.2 BIONOTES OF LECTURERS



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Dr Geoff Allan is employed by NSW Department of Primary Industries as the Research Leader, Aquaculture, and he is Centre Director of the Port Stephens Fisheries Centre, NSW, Australia. He conducts and supervises aquaculture research on freshwater and marine fish, molluscs and crustaceans at PSFC as well as two other research centres. He has coordinated major national and international projects on aquaculture feeds and feeding with a particular emphasis on replacing fishmeal. He is currently a project leader for the Australian Aquafin Cooperative Research Centre for a project on developing feeding technology for temperate marine fish. Geoff is also coordinating a national program to help develop commercial aquaculture industries using inland saline water. Geoff has published over 150 scientific manuscripts and reports and presented more than 50 papers at National and International Conferences over the last eight years.

Geoff is also a Program Consultant on Aquaculture for the Australian Centre for International Agricultural Research (ACIAR) and helps that agency develop collaborative research projects to benefit Australia and developing countries. In this capacity, he has worked in Southeast Asian and Pacific countries, particularly with projects on aquaculture nutrition. Geoff is a founding member and Trustee of the charity, Aquaculture without Frontiers (AwF). He is a Past-President of the World Aquaculture Society (2003/04) and the Asian Pacific Chapter of the World Aquaculture Society. Geoff serves on the editorial board of Aquaculture Research, Asian Fisheries Science, International Aquafeed and the Korean Journal of Aquaculture.



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Dr. Mali Boonyaratpalin is a retired fish nutritionist with over 35 years of experience in Thailand and overseas. She graduated with B. Sc. in Fisheries from Kasetsart University in Bangkok and was awarded USAID Scholarships to pursue her higher degrees at Auburn University. She received her Ph. D. in 1978, with Swingle Award and a few others for excellence in academic and research achievement. Since then, she worked with the Department of Fisheries where she published in excess of 75 papers. The spectacular success in research career has made her one of the best known fish nutritionist in Asia and the Pacific. She chairs countless number of governmental as well as international projects in aquaculture with particular focus on aquatic feed development. She has contributed her research expertise in performing academic role in several tertiary educational institutions in Thailand. More recently she has dedicated to the implementation of technical advancement for more sustainable aquaculture development through alternative candidates for farming such as seaweeds and abalone. She also cares for the livelihood of local inhabitants in remote areas where raw fishery materials are available for processing into value-added products.



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Dr Mark Booth has been employed by NSW DPI Fisheries (PSFC) for approximately 11 years. He was awarded his doctorate for studies on the nutritional requirements of Australian snapper *Pagrus auratus* (= red sea bream) and has authored or co-authored approximately 20 manuscripts in peer reviewed journals and several extensive project reports on the nutrition of the omnivorous silver perch *Bidyanus bidyanus*. Prior to this he completed a BSc (Hons 1st Class) in Aquatic Science at Deakin University Warrnambool. Most recently Mark has been involved in collaborative research between NSW DPI Fisheries and the Aquafin CRC for the Sustainable Aquaculture of Finfish studying the nutrition of temperate marine species including Australian snapper and mulloway. Before this, Mark was involved with collaborative research between NSW DPI Fisheries and the Thailand Department of Fisheries funded by the Australian Centre for International Agricultural Research (ACIAR). In addition he has been involved in the applied and theoretical aspects of both the Fishmeal Replacement and Aquaculture Diet Development sub programs (silver perch) funded predominantly by the Australian Fisheries Research and Development Corporation (FRDC). He has also conducted aquaculture research on *P. monodon* and Atlantic salmon for commercial feed companies. He has co-supervised the projects of several students studying for their honours or PhD qualifications on a range of topics including fatty acid requirements, skin colour, utilization of carbohydrates, feed attractants, impacts of environmental variables on feed intake and the factorial modeling of nutrient requirements. Mark is interested in all aspects of fish nutrition, particularly the use of alternative feed ingredients.



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Professor Edwards has experience in education, research and development in the aquatic environment with emphasis on aquaculture. He studied and held university posts in UK and USA but for the past 30 years has been based at the Asian Institute of Technology (AIT) where he established the aquaculture program in 1981 and currently holds the post of Emeritus Professor. Following an early career in seaweed ecology he became involved in environmental engineering at AIT before specializing in aquaculture. Research into wastewater treatment through aquaculture progressed to treatment of livestock manures, integrated farming systems and systems approaches with emphasis on small-scale farming and poverty alleviation. He continues to be involved in curriculum development and teaching at AIT and with national universities in the region through the Outreach program. He supervised 6 Doctoral and over 30 Master's students and was awarded over 20 research grants. He has published over 100 papers, half in refereed international journals, several reviews, and 2 authored and 3 edited books. Major consultancies include a UNDP/FAO assignment on integrated farming in China in 1981; consultant to UNDP / World Bank to produce state-of-the-art reviews of wastewater-fed aquaculture in 1982 and 1986/7; Chair of Working Group on Research Needs in Aquaculture in Developing Countries through the World Bank executed Study on International Fisheries Research in Paris in 1989; Aquaculture Specialist for the Danida funded Mekong River Commission Fishery Sector Policy Review of the Lower Mekong Basin in 1991/2; consultant to the FAO/APFIC Ad Hoc Working Group of Experts on Rural Aquaculture in Bangkok in 1999; review of research needs in feeds and feeding fish in Mekong River countries for ACIAR in 2001 and trash fish in Vietnam in 2003; Aquaculture Development Specialist for the ADB study 'An Evaluation of Small-scale Freshwater Rural Aquaculture Development for Poverty Reduction' in 2004; and member of the working group to revise the WHO Guidelines for the Safe Use of Wastewater and Excreta in Aquaculture in 2005.



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Dr Paul Ferrar is a graduate of Cambridge University, UK. He is currently the Director of the Master Class Program of the ATSE Crawford Fund. He retired from the Australian Centre for International Agricultural Research (ACIAR) in 2004, after a number of years as Research Program Manager for Crop Protection. In that role he acquired an interest in quarantine and biosecurity, including in relation to aquaculture and animal health as well as plant pests and diseases. However, he knows nothing else about aquaculture except as a keen consumer of its products. He is looking forward to learning more through this Master Class.

Before joining ACIAR he worked for the Australian research organization CSIRO on biological control of dung-breeding flies, and then on termites as recyclers of dead cellulose material in African savannas. He has written a number of entomological papers, including a two-volume reference work on fly larvae – all you ever wanted to know about maggots but didn't like to ask....



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Dr Brett Glencross has been employed by WA Department of Fisheries (WADF) for approximately 7 years. Prior to this he worked for the South Australian Research and Development Institute (SARDI). He was awarded his doctorate for studies on the essential fatty acid requirements of Black tiger prawns *Penaeus monodon* while working at the CSIRO. He has authored or co-authored approximately 40 manuscripts in peer reviewed journals and several extensive project reports on the nutrition of a range of fish, crustacean and mollusk species. His experience includes working with Prawns, Rocklobster, Abalone, Yellowtail kingfish, Asian seabass, Atlantic salmon, Rainbow trout, Red seabream, Silver perch, Tilapia, Pangasius catfish and Tuna among others. Prior to his PhD he also completed an MSc in Agricultural Biochemistry and he also has a BSc (Hons 1st Class) in Biochemistry. In recent years he has been the Program Manager for the Australian Aquaculture Feed Grains Program, which coordinates the national research on grain use in aquaculture feeds. In this role he has also been undertaking research projects on the application of lupin and canola products in aquaculture diets for the replacement of fishmeals and oils. He is also managing research projects examining the development of feeds and feeding management, nutritional models, flesh quality assessment and disease management for Asian seabass. He is presently also involved in research in Vietnam and Cambodia on ingredient assessment and diet development for Tilapia and Pangasius catfish. He has also conducted aquaculture research on Prawns, Asian seabass, Rainbow trout and Atlantic salmon for commercial feed companies. He has supervised the projects of several students studying for their honours or PhD qualifications on a range of topics including ingredient assessment, diet development, environmental impact assessment and utilization of carbohydrates. Brett is interested in all aspects of fish nutrition, particularly the nutritional and processing aspects of the use feed grain ingredients, bioenergetics and the development of models and molecular tools for use in nutrition research.



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After completing his BSc in Aquaculture in 1993 at the University of Fisheries, Tuan was appointed as a lecturer in the Department of Coastal Aquaculture specializing in seaweed cultivation. Between 1997 and 1998 he completed an MSc in aquaculture at the Asian Institute of Technology (AIT), Thailand. On returning to the university in 1998, Tuan led the Vietnamese components of several international aquaculture research projects including two DFID projects on marine cage aquaculture and on estimation and allocation of environmental capacity for aquaculture (Tropeca project), an AusAID CARD project on building aquafeed R&D capacity in Vietnam and the nutrition component of a Norad project. Currently, he leads the nutrition research being carried out by University of Fisheries in an ACIAR spiny rock aquaculture lobster project. Tuan has almost completed his PhD research on malabar grouper nutrition at the University of Fisheries under the supervision of Drs Kevin Williams (CSIRO) and Nguyen Huu Dung (UoF).



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Satya Nandlal is employed by Secretariat of the Pacific Community, Noumea, New Caledonia as the Aquaculture Officer. His main role is to advise and assist Pacific island government department and private sector operators in the establishment of environmentally and economically sustainable aquaculture. His other duties involve developing aquaculture extension services with a particular focus on the capacity of human resources, providing practical hands-on support to aquaculture ventures and also assisting Pacific island governments and private sector to assess aquaculture investment proposals and projects and draw up practical plans, policies or regulations governing aquaculture.

Prior to joining SPC in 2003, Satya worked for 2 years at the Institute of Marine Resources of the University of the South Pacific, Suva, Fiji as a Research Fellow, carrying out consultancies in aquaculture, training and some teaching.

Satya worked for Fisheries Division, Ministry of Fisheries and Forest of Fiji from 1981 to 2001 carrying out various activities, managing programs and projects in aquaculture research, extension, development and training.

Satya is presently studying part-time to finish his PhD studies too.



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Dr. Nguyen Thanh Phuong has been employed by Can Tho University in 1986 when he finished his Bsc. degree in aquaculture in this University. He started his career by teaching and doing researches on marine shrimp hatchery and farming. He then completed his Msc. in Aquaculture in Asian Institute of Technology in 1992. In 1995, Mr. Phuong began his Ph.D program and started new research subject on catfish nutrition, and he successfully defended his Ph.D thesis on the nutritional requirements and feed development for *Pangasius* catfish in 1998 in Institut Nationale Polytechnique de Toulouse, France. He is one of pioneer scientists working on nutrition and feeding of *Pangasius* catfish. Dr. Phuong is involving in several research projects on aquatic organism nutrition and feed development such as climbing perch (*Anabas testudineus*); giant freshwater prawn (*Macrobrachium rosenbergii*); snakehead (*Channa micropeltes*) and Tilapia (*Oreochromis niloticus*) in his College. He is recently leading an ACIAR-funded project studying on feeds and feeding for small scale aquaculture systems focusing on catfishes and Tilapia. Dr. Phuong is also leading and involving some research projects on biology, induced breeding and culture of marine finfish, shrimps and prawns. Dr. Phuong has authored and co-authored of more than 10 peer review papers and conference proceedings; and approximately 20 papers in Vietnamese journals and workshop proceedings. Dr. Nguyen Thanh Phuong is teaching courses on coastal aquaculture systems and scientific research methodologies for bachelor and master students; and supervising theses of bachelor, master and doctoral students.



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Igor commenced his PhD in March 2005 through James Cook University and is currently based at NSW Department of Primary Industries Fisheries at Port Stephens. His current research involves establishing the protein and energy requirements of mulloway, *Argyrosomus japonicus*, to develop quantitative models that predict optimal feed composition and waste output. Igor graduated with a BSc (Hons) from the University of Newcastle in 2004 researching the ecology of the abalone *Haliotis coccoradiata*. He also has a Diploma in Applied Science.

Prior to commencing his PhD studies, Igor was employed by NSW DPI in Aquaculture Research working with abalone, sea urchins and flat oysters. He has previously worked in Conservation Research for NSW DPI on introduced marine pests. Igor has also worked as a technician for the University of Newcastle in Medicine & Health Science, Geoscience and also for Sydney University in Veterinary Anatomy.



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David Smith has worked for CSIRO studying crustacean physiology and nutrition for 35 years, and has led the crustacean nutrition research at CSIRO Marine Research since 1991. He has been Principal Investigator of projects studying nutrient requirements, feeding strategies, developing new diets, and investigating replacement of fishmeal with terrestrial ingredients. This research has mainly involved working with prawns, particularly the brown tiger prawn (*Penaeus esculentus*) and the black tiger prawn (*P. monodon*). More recently he has been involved in research studying the nutrition of finfish – silver perch (*Bidyanus bidyanus*) and barramundi cod (*Cromileptes altivelis*), and larval and juvenile tropical rock lobsters (*Panulirus ornatus*).

He led the broodstock nutrition research in a 3-year, Fisheries Research and Development Corporation Project (Project 92/51) investigating factors affecting the reproductive performance of captive and wild broodstock prawns. Since 1993, David successfully initiated or co-led 15 aquaculture nutrition research projects which together have attracted external earnings of AUD\$4.9M. Seven of these projects involved multi-agency collaboration with the aquafeed industry, other Divisions of CSIRO, universities and state government agencies.

Over the last ten years, David has been senior author of 10 papers published in peer-reviewed scientific publications, co-author of an additional 24 papers and author of a further 20 technical reports of a significant nature. He has been part of and provided scientific support to trade missions to Indonesia, Thailand and Taiwan promoting the use of Australian-produced feed ingredients for use in aquaculture feeds.

David has a demonstrated commitment to collaboration with Universities, having supervised or co-supervised 2 PhD students, (Ausa Chandumpai, 1988-1990, University of New England, NSW; Brett Glencross, 1995-1998, University of Queensland), a Masters Student (Daniel King, 2004, University of Tasmania); and having contributed to the review of project proposals and guidance for many students over the last 10 years.



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Dr Robert van Barneveld has specialised in feed evaluation research for monogastrics for the past 15 years. He completed his PhD in 1992 on the effects of heating proteins on the digestibility, availability and utilisation of amino acids for pigs. Subsequently, he has studied the function of non-starch polysaccharides in pig nutrition in his role as a Senior Research Scientist with the South Australian Research and Development Institute.

Robert has operated as a Consultant Research Scientist with Barneveld Nutrition Pty Ltd and as a Consulting Partner with the BECAN Consulting Group since 1998. During that time he has developed many facets of these businesses with some of his current roles including:

- Specialist Director, Australian Pork Ltd
- Director, Pork CRC Ltd
- General Manager, CHM Alliance Pty Ltd (the CHM Alliance is a partnership representing more than 14,000 sows in Australia that also owns PIC Australia and PIC New Zealand);
- Manager, CHM Alliance Science and Technology Program;
- Leader, Fisheries Research and Development Corporation Aquaculture Nutrition Subprogram
- Leader, Fisheries Research and Development Corporation Rock Lobster Enhancement and Aquaculture Subprogram.

Apart from the Rock Lobster Enhancement and Aquaculture Subprogram and the Aquaculture Nutrition Subprogram, Robert has been actively involved with tuna nutrition research since 1994 and currently provides nutrition consultancy services to the abalone, barramundi, prawn, sea urchin and crocodile industries. He was also responsible for the development and construction of the Australasian Experimental Stockfeed Extrusion Centre.

Dr van Barneveld has secured research funding exceeding \$20 million since 1993 and recently led the bid to secure the \$81.4 million Cooperative Research Centre for an Internationally Competitive Pork Industry.

Robert received the Australian Society of Animal Production Young Scientist Award in 1992 and was recipient of the inaugural Batterham Memorial Award from the Australasian Pig Science Association in 1995 for his contributions to pig science. Robert was awarded the 1998 Nutrition Society of Australia Research Award for his research into feed evaluation for monogastrics.

Dr van Barneveld currently holds adjunct Associate Professor positions at the University of Queensland (Faculty of Natural Resources, Agriculture and Veterinary Science) and the University of New England (School of Rural Science and Agriculture).



DR KEVIN C WILLIAMS
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Dr Williams is a veterinary graduate of the University of Queensland and has a PhD from Melbourne University for studies on amino acid metabolism in pigs. For the first 25 years of his career, he was employed by the Queensland Department of Primary Industries where he conducted or managed nutritional research for the Australian intensive pig and poultry industries. This work entailed detailed nutrient requirement studies, particularly amino acid to energy relationships for all classes of pigs, assessment of the nutritive value of alternative protein and energy feed ingredients for pigs and poultry and mould and mycotoxin toxicity studies with pigs and poultry.

Since 1992, Kevin has applied the nutritional skills honed in the intensive pig and poultry industries to the rapidly expanding aquaculture industry. In 1995, he joined CSIRO's Division of Fisheries (now Marine & Atmospheric Research) to lead the aquaculture nutrition group with research management responsibilities for laboratories in Brisbane and Hobart. He has been the leader or co-leader of multi-organization national and international aquaculture research projects in Vietnam, Indonesia, Thailand and the Philippines. His current international research projects involve work with groupers (Indonesia and Vietnam) and spiny lobsters (Vietnam). He has presented his research results widely at international conferences and has been actively involved in the organization of national and international aquaculture conferences. He is a scientific advisor for several international research funding agencies and a regular reviewer of scientific papers submitted to journals such as *Aquaculture*, *Aquaculture Nutrition*, *Aquaculture Research* etc. His recent research interests include nutritional requirement determination and feed's development for farmed barramundi (Asian seabass, *Lates calcarifer*), groupers (*Cromileptes* and *Epinephelus*) marine shrimp (predominantly *Penaeus monodon*) and spiny lobsters (*Panulirus* and *Jasus*). He has authored more than 100 scientific publications in international journals and proceedings with 53 of these reporting the results of his research with aquaculture species.



DR THOMAS WILSON
THAI LUXE ENTERPRISES PUBLIC
COMPANY LIMITED,
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BANGKHANTA EK, A. MUANG,
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Email : thomas@thailuxe.com

Dr. Thomas Wilson has been employed by Thai Luxe Enterprises for 9 years out of the 14+ years he has lived in Thailand. Thai Luxe started shrimp feed production in 1987, and now has one shrimp feed factory and two fish feed factories in Thailand and a joint-venture shrimp feed factory in Vietnam. At the moment, in addition to being the nutritionist and formulator of both fish and shrimp feeds, he is also a Vice President, Chief Technical Officer, head of fish and shrimp feed production, QA/QC and R&D and a member of the Board of Directors.

Thomas grew up far away from the ocean in the Yukon Territory, Canada, but decided to pursue a career growing food in the ocean after watching Jacques Cousteau on television in the 1960's. After obtaining his B.Sc. in Marine Biology (1978) at the University of Victoria, British Columbia, Thomas worked for the Department of Fisheries and Oceans, Govt. of Canada, first as a technician in a marine geology laboratory, and later as a technologist in a Japanese-style chum salmon hatchery on Vancouver Island, British Columbia. In 1982, Thomas moved to attend the School of Fisheries, University of Washington, Seattle, USA, where he completed his MSc. in aquaculture related to Oregon salmon ranching (1986) and his Ph.D (1992) for research on the successful use of full fat soybean meal in diets for Chinook salmon (*Onchorynchus tshawstcha*), under the supervision of Dr. John E. Halver and Dr. Ronald Hardy, with funding and cooperation from Ewos Canada.

During his time at the UW, he served 9 years as teaching assistant for Dr. Halver, and was happiest when teaching the FAO-sponsored "Fish Feed Technology" classes for international students and researchers in 1984, 1986 and 1989. Thomas first came to Thailand to work in 1991 as an expert in feed technology for the FAO/UNDP on a project at the Department of Fisheries, teaching researchers how to make extruded feed. Being practically minded and service oriented, Thomas chose to seek employment in the feed industry, and opportunities were greater in Thailand than in Canada.



DR. AMARARATNE YAKUPITIYAGE
ASSOCIATE PROFESSOR & COORDINATOR
AQUACULTURE AND AQUATIC RESOURCES
MANAGEMENT FIELD OF STUDY
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Dr. Yakupitiyage obtained B.SC from Kelaniya University, Sri Lanka in 1979, M.Sc. from AIT in 1984 and Ph. D (Aquaculture) from University of Sterling, Scotland in 1989. Since then he has been teaching at the Asian Institute of Technology, Pathumthani, Thailand on aquaculture nutrition, aquatic resource management and research methods for aquaculture and aquatic resources management, and analytical techniques for Aquaculture research. He conducts research on aquaculture nutrition, aquaculture systems and sustainable management of wild aquatic resources. He closely works with AIT's Aqua Outreach Programme to conduct field research and engage in capacity building activities related to aquaculture and aquatic resource management. In his research and capacity building activities, he emphasizes on the role of aquaculture and wild aquatic resources as an entry point for community development and alleviating poverty. He has supervised over 95 Master's and 15 Doctoral students at the Asian Institute of Technology.

16.3 FULL PROGRAM

ASIAN INSTITUTE OF TECHNOLOGY KONG LUANG, PATHUMTHANI 12120 BANGKOK



7-20 AUGUST 2006



PROGRAM

Duties of Session Chairs

1. Decide on presenters for each module.
2. Collate/write workshop "notes" for each session (can get presenters of modules to help). Include key references (to be provided to students) and bibliography (not to be provided).
3. Prepare powerpoint presentations (using course template).
4. "Chair" session.
5. Lead discussion for revision/recap module.
6. All powerpoint presentations (or draft versions) to be forwarded to Geoff/Helena prior to Master Class.

N.B. Modules are now 40 minutes each with a break of 5 minutes. However, lecturers with consecutive modules may wish to reduce their modules further to 35 minutes with a break of 10 minutes. This is entirely a matter of personal preference.

MONDAY 7TH AUGUST

1. Introduction to Aquaculture Nutrition

Duration: #1: 6 x 45 min modules

Session coordinator: Kevin Williams

Trainers: Mali Boonyaratpalin, Brett Glencross, Mark Booth, Geoff Allan & Kevin Williams

TITLE	LECTURER	TIME
Welcome and introductions	GEOFF ALLAN & PAUL FERRAR	9:00-9:40
1.1 Type & function of nutrients: protein/amino acids; lipid/essential lipids	KEVIN WILLIAMS	9:45-10:25
MORNING TEA		
1.2 Type & function of nutrients: carbohydrate/fibre/macro & trace minerals; vitamins	MALI BOONYARATPALIN	11:00-11:40
1.3 Physiology of digestion: Structure of gastrointestinal tract and passage of digesta	MARK BOOTH	11:45-12:25
LUNCH		
1.4 Physiology of digestion: Enzymic digestion of carbohydrate, protein and lipid	GEOFF ALLAN	13:45-14:25
1.5 Nutritional biochemistry 1 (protein metabolism, lipid metabolism)	BRETT GLENCROSS	14:30-15:10
AFTERNOON TEA		
1.6 Nutritional biochemistry 2 (carbohydrate metabolism, energy metabolism)	BRETT GLENCROSS	15:45-16:30

TUESDAY 8TH AUGUST

2. Nutritional requirements of aquaculture species

Duration: #1: 1 x 45 min revision/recap
#2: 6 x 45 min modules

Session Coordinator: Kevin Williams
Trainers: Geoff Allan, Igor Birozzi, Brett Glencross, Phuong Thanh Nguyen, David Smith & Amara Yakupititige

TITLE	LECTURER	TIME
#1 Recap	KEVIN WILLIAMS	9:00-9:45
2.1 Nutritional requirements 1 (essential <i>vis a vis</i> non-essential nutrient; gross vs digestible nutrient; animal requirement <i>vis a vis</i> diet specification)	GEOFF ALLAN	9:45–10:25
MORNING TEA		
2.2 Nutritional requirements 2 (Nutritional requirements of Asian herbivorous and omnivorous finfish – carp, tilapia and milkfish)	AMARARATNE YAKUPITIYAGE	11:00–11:40
2.3 Nutritional requirements 3 (Nutritional requirements of carnivorous finfish – Asian seabass, trout and grouper)	BRETT GLENCROSS	11:45–12:25
LUNCH		
2.4 Nutritional requirements 4 (Nutritional requirements of Australian silver perch and snapper)	GEOFF ALLAN	14:15–14:55
2.5 Nutritional requirements 5 (Nutritional requirements of marine shrimp)	DAVID SMITH	15:00–15:40
AFTERNOON TEA		
2.6 Development of feeds & feeding systems for catfish culture in Vietnam	NGUYEN THANH PHUONG	16:15–16:55
2.7 Feeding aquaculture species in the Pacific	SATYA NANDLAL	17:00-17:30

Proposed Lab/Field work: Nil

WEDNESDAY 9TH AUGUST**3. Assessment of potential feed ingredients****4. Feeding strategies**

Duration: #2: 1 x 45 min revision/recap
#3: 4 x 45 min modules
#4: 2 x 45 min modules
#3 & #4: 1 x 45 min revision/recap

Session Coordinator: #3: Geoff Allan; #4 Brett Glencross

Trainers: Geoff Allan, Mark Booth, Brett Glencross, Le Anh Tuan, David Smith

TITLE	LECTURER	TIME
#2 Recap	KEVIN WILLIAMS	9:00-9:40
3.1 Status of use and efforts to reduce use of trash fish in aquaculture	LE ANH TUAN	9:45–10:25
MORNING TEA		
3.2 Nutritive value of feed ingredients (gross, digestible, utilizable; energy balance tree; compositional differences between ingredients; effects of processing)	MARK BOOTH	11:00–11:40
3.3 Feed ingredient restrictions (attractants, anti-nutritional/growth inhibitor factors)	BRETT GLENCROSS	11:45–12:25
LUNCH		
3.4 Fish meal replacement (need for; problems in interpreting reported work; impact on marketability/product quality; examples for fish and shellfish)	GEOFF ALLAN	13:45–14:25
4.1 Introduction to feeding strategies – why important (feeding preference of animal, rate of passage, leaching, improving FCR, timing of feeding)	BRETT GLENCROSS	14:30-15:10
AFTERNOON TEA		
4.2 Feeding practices for fish and shrimp	DAVID SMITH (shrimp) GEOFF ALLAN (fish)	15:45–16:25
#3 & #4 Recap	GEOFF ALLAN	16:30-17:15

Proposed Lab/Field work: Nil

THURSDAY 10TH AUGUST

Field Trip 1

Field trip to CP Feed Mill in Ban Pai; snakehead/catfish/giant catfish farm; macrobrachium farm: 9:00-17:00

FRIDAY 11TH AUGUST

Field Trip 2

Field trip to shrimp farms; DoF grouper hatchery: 9:00-17:00

SATURDAY 12TH AUGUST

5. Analytical techniques

Duration: #5: 6 x 45 min modules
#5: 1 x 45 min revision/recap
Session Coordinator: David Smith
Trainers: Mark Booth, Brett Glencross, David Smith

TITLE	LECTURER	TIME
5.1 Introduction to nutritional analysis (sample preparation, laboratory safe working, quality control; replication)	DAVID SMITH	9:00-9:40
5.2 Methods & interpretation (DM, ash & N)	MARK BOOTH	9:45–10:25
MORNING TEA		
5.3 Methods & interpretation (amino acids and other N forms)	DAVID SMITH	11:00–11:40
5.4 Methods & interpretation (crude fat, total lipid & neutral & polar lipids)	BRETT GLENCROSS	11:45–12:25
LUNCH		
5.5 Methods & interpretation (lipid class – fatty acids, cholesterol & phospholipids)	DAVID SMITH	13:45–14:25
5.6 Methods & interpretation (other common nutritional analyses – chromium, acid insoluble ash) incl. Carbohydrate & Starch.	DAVID SMITH	14:30–15:10
AFTERNOON TEA		
#5 Recap	DAVID SMITH	15:45–16:30
Proposed Lab/Field work: Tour of AIT laboratory facilities – Amara to lead.		

SUNDAY 13TH AUGUST

Free day – private study

MONDAY 14TH AUGUST

6. Natural feeds & integrated aquaculture

7. Diet formulation – introduction to feed formulation

Duration: #6: 3 x 45 min modules; **Plus** shared 1 x 45 min revision/recap; **Plus** Field trips previous Thursday & Friday

#7: 3 x 45 min modules; **Plus** shared 1 x 45 min revision/recap

Plus lab tutorial/practice on Tuesday 15th August

Session Coordinator:

#6: Peter Edwards; #7: David Smith

Trainers:

Peter Edwards, David Smith, Amaratne Yakupitiyage, Rob van Barneveld

TITLE	LECTURER	TIME
6.1 Nutrient dynamics in ponds (feeding the animal or the pond; nutrient pathways; stocking intensity; species selection; shrimp pond fertilization practices; minimizing environmental impacts)	PETER EDWARDS	9:00-9:40
6.2 Integrated livestock-fish farming (history; types of farming systems (livestock type and aqua species); rice-shrimp culture; nutrient value of animal manures; managing water quality; human health aspects)	PETER EDWARDS	9:45-10:25
MORNING TEA		
6.3 Economic and marketing aspects of integrated farming (polyculture (species feeding at different tropic levels); economics of alternative farm systems; marketing issues)	PETER EDWARDS	11:00-11:40
7.1 Science and art of diet formulation (matching animal's requirements to feed ingredient availability and nutrient supply; physical characteristics of feed; animal's acceptance; particle size and mixing uniformity), introduction to least-cost formulation	DAVID SMITH	11:45-12:25
LUNCH		
7.2 Methods of formulating diets (manual and software applications) 1	AMARARATNE YAKUPITIYAGE	13:45-14:25
7.3 Methods of formulating diets (manual and software applications) 2	ROB VAN BARNEVELD	14:30-15:10
AFTERNOON TEA		
#6, #7 Recap	PETER EDWARDS & DAVID SMITH	15:45-16:30

Proposed Lab/Field work: Field trip to be integrated with other field activities

TUESDAY 15TH AUGUST

7. Diet formulation – introduction to feed formulation Cont'd – Lab tutorial and practical session

Duration: #7: 8 x 45 min lab tutorial/practice

Trainers: Mark Booth, Igor Pirozzi, David Smith, Rob van Barneveld, Amaratne Yakupitiyage

Proposed Lab/Field work: Hands-on computer experience with formulating feeds for various template species from a selection of feed ingredients – 9:00-17:00.

Computer will be available from 7:30-17:30 in Room 107A, ground floor, AIT Extension.

WEDNESDAY 16TH AUGUST

- 8. Feed manufacture – Farm made & Laboratory feeds**
- 9. Commercial feeds – pelleting and extrusion**
- 10. Feed management – storage**

Duration: #8: 2 x 45 min modules **Plus** 8 x 45 min practical **Plus** Field trips previous Thursday & Friday
 #9: 4 x 45 min modules **Plus** Field trips previous Thursday & Friday
 #10: 2 x 45 min modules

Session Coordinator: #8: Mark Booth; #9: Rob van Barneveld; #10 Mark Booth
Trainers: Mark Booth, Kevin Williams, Rob van Barneveld, Thom Wilson, Mali Boonyaratpalin (or nominee), Igor Pirozzi

TITLE	LECTURER	TIME
8.1 Fundamentals of making pelleted dry diets (ingredient preparation; ingredient selection/suitability; binding procedures; post-manufacture handling & storage)	MARK BOOTH	9:00-9:40
8.2 Fundamentals of making moist diets (doughs/alginate bound driest, etc) (ingredient preparation, choice of binders; conditioning of mix; pelleting; physical characteristics/water stability; hot/cold set)	KEVIN WILLIAMS	9:45-10:25
MORNING TEA		
9.1 Industrial pelleting and extrusion (differences in formulation and end product; degree of gelatinization, end-product physical characteristics (sink rate, hydration/expansion, handling resilience); conditioning; fat content)	ROB VAN BARNEVELD	11:00-11:40
9.2 Industrial pelleting and extrusion continued	ROB VAN BARNEVELD	11:45-12:25
LUNCH		
9.3 Industry perspective - The real world of industrial fish nutrition	THOMAS WILSON	13:45-14:25
9.4 Regulatory perspective	THAI DOF	14:30-15:10

#10 Cont'd over page

AFTERNOON TEA		
10.1 Best practices for feed storage (cause of deterioration in storage; storage guidelines; rotation and shelf life; protecting nutrients; vermin control)	IGOR PIROZZI	15:45–16:25
10.2 Quality control – a commercial feed manufacturer’s perspective.	THOMAS WILSON	16:30–17:15

Proposed Lab/Field work: Field trip to see farm made feed in use previous Thursday & Friday plus practical session #8.

THURSDAY 17TH AUGUST

11. Farm made & Laboratory feeds – Practical session

Duration: #11: 8 x 45 min modules

Session Coordinator: Rob van Barneveld

Trainers: Rob van Barneveld, Thomas Wilson, Mark Booth, Kevin Williams

Proposed Lab/Field work: Hands-on experience with making laboratory feeds for various species from a selection of feed ingredients: 9:00-17:00.

Directions to find lab.

FRIDAY 18TH AUGUST**12. Research methods**

Duration: #8, #9, #10, #11: 1 x 45 min revision/recap
 #12: 7 x 45 min modules

Session Coordinator: Kevin Williams

Trainers: Brett Glencross, David Smith, Kevin Williams

TITLE	LECTURER	TIME
#8, #9, #10, #11 Recap	GEOFF ALLAN, ROB VAN BARNEVELD	9:00-9:40
12.1 Introduction to experimental design and statistical analysis (Research approach, assumptions of ANOVA, data transformation, statistical interpretation, pseudo-replication)	KEVIN WILLIAMS	9:45-10:25
MORNING TEA		
12.2 Statistical rigor and Power analysis	DAVID SMITH	11:00-11:40
12.3 Determining nutrient requirements using empirical methods (alternative experimental designs, 1-factor vs dose-response vs factorial vs kinetic saturation vs D-optimal)	KEVIN WILLIAMS	11:45-12:25
LUNCH		
12.4 Determining nutrient requirements using a factorial approach (nutrient/energy retention, efficiency of utilization, maintenance and growth requirements)	BRETT GLENCROSS	13:45-14:25
12.5 Experimental system (size and stocking of experimental unit; uniformity of animals; allocation to treatments; positional effects; monitoring/handling of animals; data collection, anaesthetics)	DAVID SMITH	14:30-15:10
AFTERNOON TEA		
12.6 Methods for ingredient evaluation (<i>in vitro</i> or <i>in vivo</i> ; apparent or true digestibility; gravimetric or marker; marker type; substitution procedures and calculation; fecal collection issues)	GEOFF ALLAN	15:45-16:25
12.7 Experimental protocol (need for and level of detail)	KEVIN WILLIAMS	16:30-17:15

Proposed Lab/Field work: Nil

SATURDAY 19TH AUGUST

13. Course Revision

Duration: #12: 1 x 45 min revision/recap
#13: 2 x 45 min modules

Trainers: All

TITLE	LECTURER	TIME
#12 Recap	KEVIN WILLIAMS	9:00-9:45
Review topics identified for further discussion during course	ALL	9:45-10:30
MORNING TEA		
Review topics identified for further discussion during course. Course assessment/questionnaire.	ALL	11:00-11:45
PRESENTATION OF CERTIFICATES WITH PHOTOS - OFFICIAL LUNCHEON 12:00-14:00		

16.4 NOTES ON FIELD TRIPS

Full Day Field Trip Thursday 10th August

Farm Visit 1

Mr Chamnien (head of Golden Carp Team – Co-op of >100 farmers)
Klong 13, Nong Sue District
Pathumthani

- Farmers used to use water from main irrigation canal to farm tangerines. This industry collapsed.
- Tilapia farming is replacement activity.
- >2000 cages (average ~6x6x2.5 m) in ~20 km stretch of canal.
- Producing sex-reversal red tilapia in 2-phase process; nursery from 45 d, growout phase 120 d. Fingerlings cost 60 Baht for 100 fingerlings @ 0.6 g/fish.
- Produce fish from 300 g – 1 kg/fish @ 50 Baht/kg for fish >550 g/fish and 30-50 Baht/kg for <550 g/fish.
- Feed with FCR of around 1.2:1. Two types small pellets @ 400 Baht/20 kg bag (20 Baht/kg); large pellets @ 380 Baht/20 kg bag (19 Baht/kg). (For both types minimum crude protein was 30%, large pellets had maximum crude fibre 8%, lipid 3%, smaller pellets had maximum crude fibre 6%, lipid 5%.
- Fed to satiation
- Average production ~3 tonnes fish/cage @ 1000 cages ~ 3,000 t.
- Feed cost = 24 Baht/kg return 30-50 Baht/kg.



Mr Chamnien hand feeding tilapia

Farm Visit 2

Mr Thana
Klong 12
Nong Sue District
Pathumthani

- Hybrid walking catfish *C. macrolephalus* female; *C. gariepinus* male.
- 20 ponds @ 0.32 ha (=2 rai) each.
- ~ 15 tonnes fish/pond/6 months = ~45 tonnes/ha production; total fish ~ 600 tonnes/year.
- 28-30 Baht/kg for fish ~ 140-160 g/fish (preferred size).
- Fed chicken waste: entrails give FCR ~ 3:1; skeleton ~ 7:1; bones ~ 8:1 @ cost of 6 Baht/kg entrails; 4 Baht/kg skeleton; 2 Baht/kg bones.
- Fed 400-800 kg/day/pond (depending on fish size) for 5 months.
- Purchase 4 tonnes chicken processing waste/day from factory type of material (entrails/bones & skeleton) depends on factory.
- Fingerlings from hatchery cost 2 Baht for 100 fish (0.02 Baht/fish) very small <5 cm/fish.
- Must get >30% survival to break even: last year had 50%.
- White egrets are predators – string lines and hooks across ponds.



Poultry waste is used to feed walking catfish at this farm

Farm Visit 3

Mrs Maew
Testhong Farm (Catfish hatchery)
Klong 13
Nong Sue District
Pathumthani

- Hatchery produces 2×10^6 fingerlings/day over 8 months of production period from March to October ($\sim 500 \times 10^6$ fingerlings/year).
- Fingerlings sell for 0.015 Baht each – 15 Baht/ 10^6
- Farm had 28 tanks, 10 x 5 x 0.5 m for production of *Chlorella* (green algae), *Moina* (live feed) and larval rearing.
- Fertilizers used included inorganics, monosodium glutamate (MSG) plus lime.
- Fish are sold 3 days after hatch.
- Hybrids are female *Clarias macrocephalus* and male *Clarias gariepinus*. Females are native to Thailand and taste good but are slow growing. Males are native to Africa, not popular for the taste but very fast growing. Male broodstock just over a year old weight $\sim 3\text{-}5$ kg/fish while female broodstock weigh ~ 250 g/fish.
- Males are killed to recover milt; females induced to spawn using carp pituitary extract.
- 40 kg of female fish used to produce 1×10^6 fingerlings.



Left: Egg baskets. Right: Male broodstock catfish *Clarias gariepinus*

Farm Visit 4

Mr Chairwut
Suanprikthai Muang District
Pathumthani

- Catfish farm – mixed hybrid and giant catfish
- Ponds are leased. 3 “family” groups lease a total of 30 rai of ponds (1 rai = 0.15 ha).
- Keeps pigs as well as fish. Effluent from pigs washed into pond to keep water green. No significant source of food for fish.
- Has contract with canteen from factory – feeds all kitchen wastes to fish. Some he ferments (by leaving overnight) and this is preferable.
- In 2 large ponds (~ 1-2 ha each) he produced 100 tonnes fish/year. (Takes ~ 1 year to reach market size).
- Stocks 200-300 x 10³ fingerlings.
- Sale price fish 19-20 Baht/kg depending on size and demand. Giant catfish prices more stable than hybrid catfish.
- Pigs – 4- Baht/kg to farmer; middleman gets 80 Baht/kg; retails butchered at ~ 120 Baht/kg.



Left: Pigs housed above catfish ponds. Right: Fermenting kitchen/restaurant waste used to feed catfish

Full Day Field Trip Friday 11th August

Farm Visit 1

Amon Luengnaruemitchai
Managing Director
Manit Farm, Mono-sex tilapia hatchery
No Official Host at this site.

- Mono-sex tilapia hatchery facility. Extremely neat and tidy with staff of 10-15 persons.
- Technology for sex reversal and hatchery production learned at AIT (ex student of Dr Amaratne).
- Combined hatchery production of approximately 200 million pieces in 2005.
- Each piece (fingerling) is sold for about 0.3 baht.
- Hatchery for 5-7 days and fry are sold when reach about 3 weeks old.
- Approximately 99% of hatchery production is sold to other tilapia farmers. The remaining is kept for stocking into Manit export tilapia farm.
- Sex reversal using hormone (female to male tilapia) although this hatchery is investigating ways to induce sex reversal without using hormone.
- Management is also investigating improvement of offspring through a brood-stock breeding program (e.g. monthly rotation of brood-stock, selection for growth, shape and fertility). Brood-stock usually about 150-170 g each.
- Male tilapia is produced because they grow faster and are 20% larger at harvest.

*Top: Amon Luengnaruemitchai, Managing Director of Manit Farm with his former teacher Dr Amaratne.
Below: In the lecture theatre at Manit Farm*



Farm Visit 2

Amon Luengnaruemitchai
Managing Director
Manit Farm, export tilapia farm

- All vehicles passed through an infection control dip located at the entrance to the farm.
- A very warm welcome, with all participants etc. offered cold bottled water and a toilet stop. Lunch also provided with compliments of Manit Farm.
- The group was ushered into an air-conditioned training facility adjacent to the main house for introductions followed by a comprehensive 10-15 minute power point presentation on the Manit Farm Operation by the farms Managing Director, Mr Amon Luengnaruemitchai.
- Topics of his presentation included the historical importance of “Gift” tilapia to Thailand (The King of Thailand decreed that the “Gift” should be propagated and an industry be developed in Thailand) and the role of AIT in the development of the technology used on their farm (sex reversal, higher meet recovery of small headed strain etc.).
- Farm was originally used to grow shrimp (*P. vanamai*) but shifted to tilapia culture some 20 years ago by the current owner’s father. Remains a family owned business.
- Staff of 110 people including 10 technicians.
- Farm approximately 250ha. Predominantly used for tilapia culture although some hybrid catfish are being grown. Farm producing about 700 tonnes of tilapia per year in brackish water ponds. Automated feeding and aeration returning FCR’s between 1.2 to 1.5. Tilapia grown for approximately 10 months to reach 1.2.kg. Harvest by seine.
- Farm has an exclusive arrangement with a feed company for the supply of manufactured feeds (25-31 baht kg feed) and a processing plant for the export of tilapia products. Processor demands tilapia of 500-1.2kg with no off-flavour, no antibiotic residue and free from pathogenic bacteria. Fish transported on ice to processing plant.
- Major problems include streptococcal infection (survival some times < 40%), proximity to coast causes increases in salinity of rearing ponds > 15 ppt, off-flavour problems associated with pond dynamics, high summer water temperatures.
- Conclude with group photograph and presentation of gifts.



Tilapia and walking catfish are grown at Manit Farm

Thailuxe Feed Plant

Mr Thomas Wilson

69/5 Moo 5, Rama 2 Road, T. Bangkhantaek

A. Muang, Samutsongkhram, Thailand 75000

- Group was offered refreshments on arrival. No photographs inside mills permitted.
- Power point presentation by Tom Wilson covering background and structure of Thailuxe operation. Shrimp mill commissioned in 1987, fish mill in 2004.
- First company in Thailand to obtain ISO 9000 for shrimp feed.
- Thailuxe now has AJA01# + HACCP DLD-TISI + GMP-DLD certification.
- All participants then signed in, dressed in overcoats and hair nets and taken on tour of shrimp and fish feed mills (bulk storage, ingredient preparation and receipt, manufacturing and warehousing).
- Producing about 35,000 tonnes of shrimp feed per year (much smaller than CP). Shrimp mill used exclusively for the production of shrimp feeds.
- Manufacturing feeds for catfish and tilapia (catfish formula). Formulate to gross nutrient values rather than digestible nutrient values.
- Thailuxe deal directly with the farmer and do not use “middle men”.
- Tour of laboratory facility (Leco analyzer, halogen moisture analyzer, Buchi fat analyzer, muffle furnaces, drying ovens etc.). Feed stability tests demonstrated.
- Conclude with presentation of gifts and group photograph.
- Return to AIT.



Group photo outside Thailuxe Feed Plant

16.5 RESOURCE AND REFERENCE MATERIAL

List of Resource Material and References from ATSE Crawford Fund Aquaculture Nutrition Master Class, AIT, Bangkok, 7-19 August 2006.

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16.6 QUESTIONNAIRE (OVERLEAF)

AQUACULTURE NUTRITION MASTERCLASS QUESTIONNAIRE

This questionnaire is anonymous - you do not have to sign your name if you do not wish to. Your answers will assist in improving future Master Classes.

1. Please indicate how useful you felt the various components of the Master Class were by ticking the relevant boxes below:

▪ Lectures

very helpful good fair not helpful

▪ Computer tutorial (Winfeed)

very helpful good fair not helpful

▪ Feed formulation practical session

very helpful good fair not helpful

▪ Field trips

very helpful good fair not helpful

2. Please indicate how useful you found the individual sessions by ticking the relevant boxes below:

▪ Introduction to Aquaculture Nutrition

very helpful good fair not helpful

▪ Nutritional Requirements of Aquaculture Species

very helpful good fair not helpful

▪ Assessment of Potential Feed Ingredients

very helpful good fair not helpful

▪ Analytical Techniques

very helpful good fair not helpful

▪ Natural Feeds & Integrated Aquaculture

very helpful good fair not helpful

▪ Diet Formulation - Introduction to Feed Formulation

very helpful good fair not helpful

▪ Feed Manufacture

very helpful good fair not helpful

▪ Commercial Feeds - Pelleting & Extrusion

very helpful good fair not helpful

▪ Feed Management - Storage

very helpful good fair not helpful

▪ Farm Made & Laboratory Feeds

very helpful good fair not helpful

▪ Research Methods

very helpful good fair not helpful

▪ Course Revision

very helpful good fair not helpful

3. What was your opinion of the Class materials (e.g. books, CDs, presentations etc.)?

4. Did you have any language problems? If so, please give details.

5. How has your view of aquaculture nutrition changed as a result of the Class?

**6. Has the range of your professional contacts changed as a result of this Class?
If so, please describe what has happened.**

**7. Were the accommodation, meals and general arrangements appropriate?
If not, could you provide details?**

8. What should be done now to reinforce the activities of this Class?

MANY THANKS FOR YOUR TIME.