Report on

Advanced Freshwater Aquaculture Training Course

Thailand, June 01 – July 19, 2008

Participant:

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1. Introduction

The culture of fish at an industrial level has a history of less than a century. As a relatively new area of farming compared to terrestrial animal production, aquaculture often resorts to rather primitive production methods. However, aquaculture is the fastest growing primary production sector in the world at present, having recorded an annual growth rate of 11% year-1 over the last decade (FAO, 2002). Of all aquatic products consumed currently, aquaculture accounts for 33%, and the global aquaculture production in 2002 was 51.4 million tones, valued at US$59.9 billion. Asia dominates aquaculture production of the world, and currently contributes 87% to the global cultured finfish production of 25.7 million tones (de Silva, 2006; alien finfish).

Fish is a vital component of food security, especially in developing countries where it contributes up to 80% of animal protein intake. Aquaculture is expected to bridge the widening gap between fish supply and demand and to contribute to the food and nutritional security of the poor in developing countries. If aquaculture is to fulfill this critical role of supplying the much needed protein in the diet of the poor, it will have to be through an expansion of the area under aquaculture, underpinned by sound management practices and the use of high quality seed from productive strains (Ponzoni, et al., 2006). On the other hand, there's a few technology achieved by research institution transferred to fisherfolk and limited government officer has a skill to applying the technology.

Department of Fisheries, Thailand, in cooperation with Japan International Cooperation Agency (JICA) and Thailand International Development Cooperation Agency (TICA) organized a training course titled Third Country Training Program on Advanced Freshwater Aquaculture. This training course designed to provide advanced knowledge and technique of freshwater aquaculture to be able applied in development country. I follow the training as invited by TICA after proposed by Directorate General of Aquaculture, Department of Marine Affairs and Fisheries, Republic of Indonesian. As my responsibility, this paper wrote as a report after my training completion. Some techniques might be applied on freshwater development in Indonesia fish farmer and others should be as comparative framework on aquaculture engineering and/or research.

2. Objectives

Objectives of this training course include:

- To provide advanced knowledge and technique of freshwater aquaculture;
- To build communicate and share of aquaculture technology among the participants.
- To be able to apply specific knowledge and practice techniques in their countries

3. Participants

➢ Ade Sunarma	Indonesia
➢ Alok Kumar Saha	Bangladesh
➢ Andriamaharo Ny Aina Tantely	Madagascar
➢ Benjamas Musikaew	Thailand
➢ Chananbaatar Ayushsuren	Mongolia
➢ Dorji Khandu	Buthan
➢ Gangaram Kharel	Buthan
➢ K.H.M. Gunarathna	Sri Lanka
➢ Koonchai Anan	Thailand
➢ Myint Theingi Soe	Myanmar
➢ Nguyen Viet Phuong	Viet Nam
➢ Nitikorn Piwpong	Thailand
➢ Phan Thi Le Anh	Viet Nam
➢ Pung Putseyha	Cambodia
➢ Purna Dhungana	Nepal
➢ R.M.S. Priyantha	Sri Lanka

- Rosa Bueno Delos Reyes — Philippines
- Than Zaw Win — Myanmar
- Un Chanthy — Cambodia

4. Lecture and Practical Work Subject

Many subjects on freshwater aquaculture lectured and practiced in this training and several object visited as study tour. These subjects comprised:

- Hatchery and farm management (lecture),
- Fish farm layout and geographic information system (lecture),
- Fisheries food safety and standard farm (lecture),
- Water and soil quality for aquaculture: water and soil in fish pond (lecture and practice),
- Fish pond dynamics and management (lecture),
- Sex reversal in tilapia: effect of androgens on sex reversal in tilapia (practice),
- Water recycle system and water treatment (lecture),
- Fish reproduction and fish breeding (lecture and practice)
- Egg incubation (lecture and practice),
- Fry nursing (lecture and practice),
- Fish nutrition: artificial and natural (lecture and practice),
- Fish genetic: selective breeding (lecture and practice),
- Fish genetic: genetic manipulation (lecture and practice),
- Fish diseases: fungal, parasitic, bacteria, viral and OIE (lecture and practice),
- Economic aquaculture (lecture),
- Statistic software, EpiData (lecture and practice),
- Study tour: Chachoengsao Coastal Fisheries Center (anemone fish culture), Chonburi Inland Fisheries Center, Seabass cage culture in Bang Pakhong River, Institute Marine Science, feed mill factory, Laem Phak Bia waste water treatment, Karnchanaburi Inland Fisheries Center (freshwater pearl mussel culture and freshwater turtle conservation) and Tilapia cage culture.

5. Result of Training Course

Only selected subjects presented in this report. These subjects summarized from both lecture and practice. Complete subjects available at lecture note and would be stored in library.

5.1. Hatchery & Farm Management

Selecting site and site analysis for aquaculture enterprise must consider a number factor, i.e.: ecological, biological, economic and social. Fundamental consideration, including: overall aspect (building, layout, water resources and light), facilities (space, material and environmental monitoring equipment) and operation (routine inspection, production stability and hatchery technique). However, all factors should be species-specific consideration. Hatchery operation should consider GAP aquaculture production, legal matter, environmental policy and technological development.

5.2. Fish Farm Layout and Geographic Information System

A large part of the world's fish culture production relies on the use of freshwater ponds which hold and exchange water, receive fertilizer or feed, and allow for holding, rearing and harvesting of fish. The size fish farm will vary according to the level of production that wishes to reach.

Application of GIS could be provide the updated information about extent and distribution of aquaculture production, such as: site suitability, aquaculture zoning, fish disease warning system, tools for sharing all stake holders and supporting traceability system.

5.3. Pond Dynamics & Management

"Understanding pond dynamics is basic to pond management and to achieve sustainable aquaculture" (Prof. C.K. Lin). There're several waters environment could be used for aquaculture production, i.e.:

- Natural water body: lake and watershed ponds,
- Artificial excavation: pond, quarry, pit and reservoir,
- Flow through: river, raceway, running water pond,
- Recirculation water

- Cage & pen.

Varying organism could be used in aquaculture production, including:

- Plants: micro & macro algae, aquarium plant,
- Invertebrate: plankton, benthos, macro-invertebrate (crustaceans and mollusks),
- Finfish,
- Other: amphibian, reptile and mammals.

Pond, as an aquaculture environment, comprises air, water and substrate which could be interacted to each others. The interactions lead to change in physical, chemical and biological features, either temporal (time) variation or spatial (horizontal and vertical) variation. Understanding its interaction, as pond dynamics, is basic to pond management and to achieve sustainable aquaculture.

Simple Soil Leakage Test

- Dig a hole as deep as your waist,
- Early in the morning, fill it with water to the top,
- By the evening, some of the water will have sunk into the soil,
- Fill the hole with water to the top again, and cover it with boards or leafy branches,
- If most of the water is still in the hole the next morning, the soil permeability is suitable to build a fish-pond here,
- Repeat this test in several other locations as many times as necessary, according to the soil quality.

Simple field tests for soil texture: Throw-the-ball test

- Take a handful of moist soil and squeeze it into a ball,
- Throw the ball into the air about 50 cm and then catch it,
- If the ball falls apart, it is poor soil with too much sand,
- If the ball sticks together, it is probably good soil with enough clay in it.

Simple lab tests for soil texture: The bottle test

- Put 5 cm of soil in a bottle and fill it with water,

- Mix water and soil well, and then let soil to settle in the bottle for an hour,
- At the end of an hour, the water becomes clear and soil settles at the bottom of the bottle in layers: clay at top, silt in the middle and sand at the bottom,
- If the water is still not clear, it is because some of the finest clay is still suspended in the water,
- On the surface of the water there may be bits of organic matter floating,
- Measure the depth of the sand, silt and clay and estimate the approximate proportion of each.

5.4. Hormone Residues after Application on Sex-Reversed Tilapia

Hormone contamination in fish meat:

- Around 80% hormone are deteriorated by metabolism and excretory system,
- Hormones are changed in structure and can be dissolved in the water,
- 90% of hormone will be excreted in 24 hours,
- Hormone still remains in fish meat less than 1% for 3 weeks after stopping hormone treatment,
- All hormones are excreted out before reach at the market sizes.

Hormone contamination in soil:

- Methyl testosterone increased 1.6 µg in 60 days and then reduced into normal,
- Methyl testosterone in soil increases 16 µg during 30 days and reduced to 1.2 - 3.2 µg during experiment period,
- Although sex revered has finished 3 months, but Methyl testosterone are found in soil,
- Methyl testosterone contaminated have effected to sex reversal ratio, and intersexes rate increased methyl testosterone accumulated at the bottom of ponds,
- The nests building heavier of Tilapia make methyl testosterone circulate in the water and soil methyl testosterone might leak and flow

into outside environment when having water exchange and slush draining,

- Methyl testosterone may effect on other aquatic animals,
- Methyl testosterone may effect on Human health in long term

Hormone sediment in soil (research conducted in non-ponds sex reversal of Tilapia):

- Methyl testosterone are found in the soil when treat with hormone at 17 days,
- High contamination are found under the cages which are treated with hormone feed,
- Sex reversal rate of three crops were increased as follows: Crop (1) 87.4%, Crop (2) 92.6% and Crop (3) 98.7%.

5.5. Water Recycle and Water Treatment System

The subject of waste management in aquaculture, and particularly the issue of effluent, has become an important issue in pond aquaculture. Regulating aquaculture waste correlated to maximum allowable concentrations or loads of potential pollutants in effluent. Therefore, methods to reduce the pollution potential are essential both to protect natural water and water supplies of the aquaculture. Water recycle and water treatment system are subjects corresponding to manage of effluent from aquaculture. Several reason associate to water recycle and treatment, including: availability of water supply, either quality and quantity, water quality control, reduce production cost to use of water source continuously, reduce environmental impact, an effort to energy conservation and global warming. Improving of water quality could be conducted using physical and biological treatment/filter or combined filter. Appropriate method should be selected base on nutrient loading from the effluent. Whereas, successful of water recycle/treatment depend on water volume, waste production and treatment process in system. Many scheme for improving effluents from pond have been advanced, including: hydroponics, irrigation, culture medium for other aquatic animal, wetland, settling basin, nutrient absorbing using floating macrophytes, fluidized-bed filter, and others.

5.6. Fish Reproduction

Broodstock Management

In hatchery operation, large number broodstocks are difficult to handle and require more facilities. Horvath, et al. suggested some guidelines to broodstock management in hatchery:

- Select healthy fish with good physical characteristics,
- Feed administration with good quality food of the appropriate dietary composition,
- Keep the broodstock at a low stocking density,
- Identify the sex of the broodstock and keep separately if possible, because mixed stocks are inclined to spawn naturally,
- Replace un-spawned broodstock because the broodstock should not only tolerate but actually respond positively to induced spawning,
- Keep spawned fish separately from other broodstock and feed with protein-rich feed at 2-5% body weight per day, in order to promote recrudescence of eggs and sperms,
- Produce natural feed by adding fertilizers regularly,
- Select deep ponds for keeping broodstock and supply with adequate water, in order to ensure favorable water quality and to stimulate gonadal development,
- Before each spawning season, add some trash fish into the feed, in order to promote gonadal development as well as recovery,
- Stock new spawners with old spawners, for replacement of broodstock

Gonad Maturation

Sexual maturity of teleost depends on many reasons. As a poikilothermic animal, temperature as an importance factor that affect sexual maturity. Under tropical condition, some fish become sexually mature within the first year, but others fish takes longer 2-4 years. Maturation of gonad is process where tiny incipient sex cell develops, together with accessory tissue, into large organ with mature sperm or eggs that can be spawning. Maturation may occur once in a fish's life or many time a year, depending to species and condition. Gonadothrophin (GtH) regulate the formation and maturation of gametes.

GtH I important in oocyte growth induces the theca cells to produce testosterone (T) which is converted to 17b-estradiol (E2) in the granulosa cells. E2 travels to the liver and stimulates production of vitellogenin (Vg). Vg return and sequestered by ovary as yolk protein. GtH II important in maturation of gonad, induces the theca cells to produce 17α-progesteron (17P) which is converted to 17 α,20β-dihydroxy-4-pregnen-3-one (17,20DHP) in granulosa cells.

In aquaculture, final maturation and ovulation are the stages of reproduction most commonly induced by hormonal therapy. Many species spawn immediately after ovulation as long as the needed environmental cues and social cues are present.

5.7. Fish Egg Incubations

Developing embryos and newly-hatched larva are most sensitive and delicate of the stages in the life history of a fish. Therefore, great care must be taken to provide them with the proper incubating and hatching environment. Water temperature, light, water quality, water flow, shock prevention, and type and size of the egg are very important considerations.

Wide variety devices are used for incubating fish eggs and closely correspond to egg type. Egg mats are primarily for adhesive eggs, e.g. catfish and common carp eggs. A tray-type incubator were originally designed to hatch of non-adhesive, lay in gravel bed of the eggs and can be injured by movement during incubation, e.g. trout and salmon eggs. Modified this type could be used to hatch of floating eggs, e.g. gouramy egg. Fish eggs that non-adhesive and require constant movement are commonly incubated in conical shaped tanks or jar where water flows into the bottom or top of the container, eggs gentrly suspended and constantly tumble in the lower portion of the jar, e.g. tilapia egg.

5.8. Fish Fry Nursing

Development of fish egg & larva can be mainly divided into 6 stages:

- Egg (incubation period),
- Prolarva (yolk sac period),
- Larval (absorbed yolksac but incomplete organ),
- Postlarva (complete organ),
- Juvenil (fry and fingerling),
- Adult.

Larva and fry have some different biological characteristics from adults especially in growth, feeding habit and habitat. During larval stages, the fish have fast growth. They require large amount of quality foods and good environmental conditions. It is very difficult to determine exactly that how many larvae should be stocked into nursery place. Stocking rate is related to many factors especially foods environmental condition and toleration of each species to the existing conditions. Primary nutrients are required for primary production (phytoplankton and then zooplankton) and maintain it availability in a nursery pond. Phytoplankton level could be corresponded to secchi disk visibility. About 35-45 cm secchi disk depth should be keep to maintain a level phytoplankton approximately 80 mg chlorophyl-a/m^3).

5.9. Using of Gonadotropins to Fish Induced Breeding

Hypophysation

- Injection with crude pituitary extracts (PG),
- Replacement therapy: GtH from another fish take over when the breeding fish is not producing enough of it own,
- Availability of pituitaries: powdered carp and salmon pituitaries or collected from mature fish, as fresh PG, and preserved in either alcohol or dried, after acetone extraction of fats,
- A lot of disadvantages: hard to standardization, extracts are highly impure, contain accessory hormones and other components that may stimulate some fish but inhibit others and action is unpredictable.

Mammalian GtH

- Human chorionic gonadotropin (HCG) is produced by the placenta and can be extract from urine of pregnant women,
- Has the advantages of purity and long storage life,
- However, its molecule is so unlike fish GtH, so high does is needed,
- Work well in some species (most marine fish) but some fish not respond at all,
- Usually use in combination with pituitary,
- May have an immune reaction in fish repeatedly injected with HCG

GnRH analogues

- Mammalian GnRH was purified in 1970,
- 10 amino acids joined together with an amine group (NH_2) attached to position 10,
- Glu-His-Trp-Ser-Tyr-Gly-Leu-Arg-Pro-Gly-NH_2,
- Salmon GnRH only different from mGnRH in amino acids at position 7 and 8,
- Because GnRH molecule are simple, they can be synthesizes and different amino acids can be inserted at any position to produce superactive analogues,
- More than 2000 analogues have been synthesized,
- In fish, the most potent analogues have 2 modifications: 1) Replace glycinamide (Gly-NH_2) at position 10 with ethylamide (NH-CH_2-CH_3) which increases the binding affinity; 2) Replace Gly at position 6 with D-form (mirror image form of the naturally occurring L-form) of hydrophobic or aromatic which been found to be important in either increasing receptor binding affinity and/or an increasing hydrophobicity and providing greater resistance to enzymatic degradation,
- 3 analogues useful in fish culture: 1) D-Ala6 mGnRHA (LHRHA); 2) D-Arg6 sGnRHA; 3) Buserelin,
- GnRH acts early in the hormonal chain and cause fish to produce its own GtH,

- GnRH is not highly species specific,
- GnRH is simple and easy to manufacture.

Combination of GnRHa with a dopamine antagonist

- Most cyprinids have a strong dopamine effect,
- Dopamine effect also varies according to the ripeness of fish,
- In carp, the combination is very effective,
- Repeated use of DOM in combination with BUS has no negative effect on the induction of spawning or gonadal development in the Thai carp

5.10. Tilapia in Thailand

Genetic improvement on Tilapia in Thailand has been carried out and produced at least 5 strains, i.e.:

- Thai-Chitrada 1: this species are from genetic improvement which grow faster than the original species,
- Thai-Chitrada 2: this species are from genetic modification which will produce only male,
- Chitrada 3 “GIFT” Strain (Genetically Improve Farm Tilapia): come from selected 25 group for base population using combined selection,
- Red Tilapian: hybrid between *Tilapia mossambica* and Nile Tilapia can spawn in freshwater, brackish and sea water,
- Tap Tim Tilapia: improved species was developed /produced by CP Company

Dominance of each species, including:

- Shape: Jirada1 has similar to normal tilapia, Jirada2 has small head and long body, and Jirada3 has Small head, thick and wide body,
- Production: Jirada1 higher than normal tilapia 22%, Jirada2 Higher than normal tilapia 45%, and Jirada3 higher than normal tilapia 40%,
- Survival rate: Jirada1 Higher than normal tilapia 10%, Jirada2 higher than normal tilapia 35%, and Jirada3 higher than normal tilapia 24%.

5.11. Role of Thailand's Fisheries on Aquafeed

Objective of the role is to ensure that the feed milling companies comply with feed quality control of THAI ACT (Animal Feed QC 1982 and additional 1999) and international standards. The same general principles of "Food Safety" have been applied to "Feed Safety" into Thai commercial feed milling companies. Department of Fisheries, Thailand, (DOF) has been taking charge of the law and regulations (only Aquafeed) since 1992. By this role, feed manufacturers must register and get the licenses.

At present, DOF control 8 Aquafeed:

- Catfish,
- Freshwater fish (Herbivorous),
- Freshwater prawn,
- Marine shrimp,
- Marine fish (Carnivorous),
- Freshwater fish (Carnivorous),
- Soft shell turtle,
- Frog.

DOF inspect and issue the certificates as follow:

- Certificate of free sale,
- Certificate formula,
- Certificate of analysis,
- Certificate of origin,
- Certificate of health,
- Certificate of feed milling / GMP / HACCP.

Regular checks and monitoring as follow:

- Proximate (protein, fat, fiber, moisture),
- Salmonella spp.,
- Aflatoxins,
- Antibiotics.

Screening Test for Antibiotics use test kits for detection of 8 drugs (colorimetric assay):

- Five of Nitrofurans group (Nitrofurazone, Furazolidone, Furaltadone, Nitrovin, Nitrofurantoin),

- Oxytetracycline, Chlortetracycline,
- Chloramphenicol.

However, confirmation method is needed for the positive result. (HPLC, LC-MS-MS).

5.12. Feed Formulation

Process is to select the ingredients and levels. Aim to combine to create a mixture that is:

- Pelletable,
- Palatable,
- Nutritious,
- Inexpensive,
- Easy to store / ship / use

Calculation methods

- Simultaneous equations: to solve simple feed formulations once ingredients have been chosen,
- Linear programming (least-cost feed): to solve complicated feed formulations, computer must have access to data on (nutrient content of each ingredient / price / levels allowed etc.),
- Excel / Spread-sheet
- DIY (Do It Yourself)

5.13. Feed Formulation for Air-Breathing Fish

Stage: Nursing 1 - 2 months in age; Protein requirement 24%, could be comprises:

- Fish meal (58% protein): 10%
- Soybean meal: 30%
- Rice bran: 23%
- Broken rice: 27%
- Binder (α-starch): 5%
- Vitamin & mineral: 0.2-0.5%,
- Soybean oil: 1%,

- Palm oil / lard oil: 2%,
- Dicalcium phosphate / bone oil: 1%

Stage: Nursing-grow out, fingerling-adult; Protein requirement 20%, could be comprises:

- Fish meal (58% protein): 8%
- Soybean meal: 18%
- Rice bran: 25%
- Broken rice: 39%
- Binder (α-starch): 5%
- Vitamin & mineral: 0.2-0.5%
- Soybean oil: 1%
- Palm oil / lard oil: 2%
- Dicalcium phosphate / bone oil: 1%

5.14. Tilapia Sex-Reversal Practiced in Thailand

- Method: Feed administration
- Fish: Tilapia fry 4-5 days old
- Hormone: 17α-methyl testosterone
- Hormone dosage: 50-70 mg/kg feed
- Treatment duration: 21 days
- Feed: combination of sieved-rice bran and fish meal at ratio 3:1
- Feeding rate: 20%, 15% and 10% bw/day in 1st, 2nd and 3rd week, respectively
- Feeding frequently: 5 times/day

5.15. Seabass Culture in Bang Pakhong River

- Owner: Mr. Rungsan (71 years old)
- Experience culture: 30 years
- System: cage culture
- Cage size: 4×2.5×2 m
- Number of cage: 40 cages
- Stocking density: 1.500 - 2.000 fish/cage
- Stocking size: 3 inches

- Rearing time: 8 months
- Grading interval: 2 months
- Harvest biomass: 700 kg/cage
- Harvest size: 500 - 600 grams/fish
- Seed price: 3 - 4 bath/fish
- Harvest price: 115 bath/kg
- Source: Mr. Rungsan (owner), Ms. Suree (worker), Mr. Jarun (officer at Coastal Research and Development Center, Chacongsao)

5.16. Selective Breeding in Practice

In aquaculture, selection is not commonly used probably because of poor extension of knowledge from researchers to farmer. However, selection is the efficient method in animal breeding programs because it can lead to the long term goals of genetic improvement. The objective of selection is to change the average performance of a population for the same specific trait by increasing the frequency of alleles that influence the trait in a desirable manner, that is, increase the frequency of the plus alleles. However, selection must be based on the observed performance of individuals. Therefore, our ability to identify genetically superior individuals depends on the heritability of the trait.

The heritability of a metric character is one of its most important properties. It is defined as the ratio of additive genetic variance to phenotypic variance. The heritability is estimated from the degree resemble between relative. Growth is an easy parameter for phenotypic measurement. It can be measured as change in length or weight which is defined as growth. Growth rate is perhaps the most important trait of interest in food fish culture. To describe the change of the genetic properties from one generation to the next we have to compare successive generations at the some point in the life-cycle of the individuals, and this point is fixed by the age at which the character under study is measured.

The change produced by selection that chiefly interests us is the change of population mean. This is the response to selection, which will be symbolized by R; it is the difference of means phenotypic value between the offspring of the selected. the measure of the selection applied is the average superiority of the selected parents, which is called the selection differential, S; it is mean phenotypic value of the individuals selected as parents expressed as a deviation from the population mean, that is from the mean phenotypic value of all the individuals in the parental generation before selection was made. In the selected population, the ratio of response to selection differential is equal to heritability. This parameter is called the realized heritability: h2 = R/S.

5.17. Fish Selective Breeding Method

Individual/mass selection

- At least 50 mating pairs in a same spawning time,
- Growing up in a same pond,
- Select the 50 best pairs for next generation spawning

Family selection

- At least 50 mating pairs in a same spawning time,
- Growing up each family separately,
- Select the 10 best families for next generation spawning

Within family selection

- At least 50 mating pairs, not necessary in a same spawning time,
- Growing up each family separately,
- Select the best pairs in each family for next crosses spawning.

Combined selection

- At least 50 mating pairs in a same spawning time,
- Growing up each family separately,
- Select the best pairs in 10 best families for next crosses spawning.

Tandem selection

- Different batch selected at different time

Independent culling level (ICL)

- Different batches selected at same time, require minimum standard of each trait

Index selection

- Different batches selected at same time, consider selection index of each trait including important parameters such as heritability, economic values, genetic correlation between traits etc.

5.18. Genetic Manipulation

Sex Ratio Manipulation

- For aquaculture or stocking, it may be desirable to use only one sex due to differences in growth rate or characteristics concerned with maturity and reproduction,
- Sex ratio can be manipulated either directly (using steroid hormones to alter the sex ratio in fry during sexual differentiation) or indirectly (manipulating the sex determination system of broodstock so that selected fish produce monosex offspring).

Chromosome Manipulation: Polyploidy

- Nearly all species of fish are diploid (2n),
- Triploidy (3n) fish exhibit good growth and condition over the spawning period comparing with 2n fish,
- Tetraploidy (4n) fish produce eggs and sperm which are 2n, thus a cross between a 4n fish and a 2n fish will produce 3n offspring without the need to use shocks to induce triploidy.

Gynogenesis and Androgenesis

- Gynogenesis is a tool for producing all-females where females are homogamety, has been used in the study of sex determination and gene recombination and as a tool for inbreeding and the production of clonal lines,

- Androgenesis is a tool for producing all-males where males are homogamety.

6. Possibilities for Training Result Application

Based on training result either lecture or practice and personal discussion to lecturer, as expert in their field study, many techniques might be applied on freshwater aquaculture development in Indonesian fish farmer and others should be as comparative framework on aquaculture engineering and/or research. These possibilities have been chosen based on correspond to aquaculture development in Indonesia include:

- Back to GnRH and/or dopamine antagonist to spawning induction instead using company based end-product (mixed product). Several human drugs have similar amino acid structure to GnRH (e.g. buserelin acetate) or as an active content (e.g. domperidone and metoclopramide). Its might be not quite cheaper (should be calculated financially) than mixed product but widely available in market, so easier to get by fish farmer.
- Adopting freshwater pearl mussel production technique than seawater. The technique has several weakness and excellence but its might be easier to adopt.
- Measurement of residues in fish meat, water and soil pond after hormones or antibiotics treatment.
- Pure culture of 'small' freshwater natural food, e.g. Moina sp.
- Applying simple test method for soil analysis rather than USDA's triangular diagram.

7. Award

Gladly, I wish to inform that I have successful to get award as BEST PARTICIPANT at this practice.

Acknowledgment

I would like to express my acknowledgment to Directorate General of Aquaculture, Republic of Indonesian, Department of Fisheries, Kingdom of

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Reference:

De Silva, S.S., T.T.T Nguyen, N.W. Abery, U.S. Amarasinghe. 2006. An evaluation of the role and impacts of alien finfish in Asian inland aquaculture. Aquaculture Research, 37:1-17

Ponzoni, R.W., B.O. Acosta, A.G. Ponniah. (eds). 2006. Development of aquatic animal genetic improvement and dissemination programs: current status and action plans, WorldFish Center Conference Proceedings 73, 120p.