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Japan International Cooperation Agency
Nibancho Center Building 5-25,
Niban-cho, Chiyoda-ku
Tokyo 102-8012
JAPAN

Network of Aquaculture Centres in Asia-Pacific
Suraswadi Building, Kasetsart
University Campus, Ladyao,
Jatujak, Bangkok 10900
THAILAND

Royal Thailand Department of Fisheries
Kasetsart University Campus
Ladyao, Jatujak
Bangkok 10900
THAILAND

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International Symposium on Small-Scale Freshwater Aquaculture Extension
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Foreword

Makoto KITANAKA
Director General
Rural Development Department
Japan International Cooperation Agency

It is my great pleasure that Japan International Cooperation Agency (JICA), together with Network of Aquaculture Centers in Asia-Pacific (NACA) and Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand, has conducted successfully an international symposium from December 2 - 5, 2013 in Bangkok. It dealt with small-scale aquaculture extension based on experiences accumulated over years in Asia and Africa. There were representatives from different countries including Cambodia, Myanmar, Lao PDR, Madagascar and Benin where JICA has been assisting in the implementation of technical cooperation project. In those projects, so-called farmer to farmer extension approach is adapted to maximize the outputs and effects of project activities. Such outstanding achievements on extension efforts were presented to the symposium by project managers, extension officers and farmers. In this manner, the sharing of good practices is ensured among participants from different international organizations and other countries, hoping small-scale aquaculture will be further developed in many areas in the world. These proceedings are expected to be a right reference for such endeavor. For JICA, it will be a part of knowledge management to improve future technical cooperation projects.

Aside from the above copartners and countries, we had important representation from different organizations such as South-East Fisheries Development Center (SEAFDEC), FAO Regional Office for Asia and the Pacific, Asian Institute of Technology (AIT) and Thailand International Cooperation Agency (TICA). Country representatives came from Cote d'Ivoire Indonesia, Japan, Malawi, Nepal, Philippines, Zambia and Bangladesh.

I am very grateful to those speakers from partner organizations and countries for their contributions, and those moderators and participants in the workshops. Special thanks should be extended to NACA and DOF Thailand for their devotion to this event. I sincerely hope to deepen the relations between JICA and them in order to achieve our common global goals; poverty alleviation, food security and livelihood improvement of rural farmers in the world.

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INTRODUCTION

The world population is projected to increase drastically in the coming decades which might bring about shortage of food. It is therefore necessary to properly manage resources and to put more effort in the food production sectors. Among the different sources of animal protein, freshwater fish is considered as one of the most promising commodities that can contribute in increasing food production. Moreover, small-scale aquaculture which is common in the Asia-Pacific region, provides diverse benefits to rural farmers including income generation, nutrition improvement, and sustainable aquaculture practices through integrated farming system. The Japan International Cooperation Agency (JICA) has been involved in the development of small-scale aquaculture through technical cooperation projects (TCPs) in Southeast Asia and Sub-Saharan Africa, which evidently demonstrate the effectiveness of “farmer-to-farmer extension” approach among rural aquafarmers. In these TCPs, core-farmers who produce fingerlings are motivated to teach grow-out farmers simple aquaculture techniques so that they can acquire patronage of clients and expand market outlets among fish farmers. It is noteworthy that such system not only provides economic benefit to the core-farmers but also enhance their social role as local leaders and/or extension workers. This approach is not totally new especially in the agriculture sector, thus the experiences, lessons learned and findings from these TCPs on small-scale aquaculture are worth sharing to other stakeholders, as reference for good management practices.

In this context, this international symposium was organized for stakeholders involved in the JICA-assisted projects in Cambodia, Lao PDR, Myanmar, Benin and Madagascar. The symposium was also attended by representatives from other countries in the region including Cote d’ Ivoire, Indonesia, Malaysia, Nepal, Philippines and Zambia. JICA, NACA and DOF-Thailand co-organized this symposium, with support from key partner institutions including Food and Agriculture Organization of the United Nation – Regional Office for Asia and the Pacific (FAO-RAP), Southeast Asian Fisheries Development Center (SEAFDEC), Thailand International Cooperation Agency (TICA) and Asian Institute of Technology (AIT). Complete list of participants is presented in Annex B.

The main objective of this symposium is to provide a venue for information sharing on extension of small-scale aquaculture, specifically targeted to those individuals and relevant organizations involved in various aquaculture development projects. The symposium will also assess and present the effectiveness of “farmer-to-farmer extension” approach in the implementation of relevant aquaculture development projects in the region.

KEYNOTE LECTURES

JICA AND SMALL-SCALE AQUACULTURE DEVELOPMENT

Satoshi CHIKAMI
Senior Adviser in Rural Development and Fisheries Development
Japan International Cooperation Agency (JICA)

Japan International Cooperation Agency or JICA is an incorporated administrative agency in the Japanese government structure, mandated to be an implementing body of bilateral official development assistance including technical cooperation, ODA loan and grant aid. Its organizational vision is "Inclusive and Dynamic Development". JICA is highly committed and contributing to achieving Millennium Development Goals (MDGs) set by the United Nation toward 2015.

JICA has been extending its international cooperation in the field of fisheries for several decades. Looking at the historical transition, some important changes in direction of JICA Technical Cooperation Project (TCP) can be observed on aquaculture development assistance. For instance, in 1980's and 1990's, implemetned TCPs tended to concentrate onto establishment of aquaculture centers as well as capacity development of staff involved with research and development activity. The main target of TCP for technology transfer were researchers and technicians who worked in the aquaculture center, while fish farmers were seen as not direct but indirect or eventual beneficiary as a result of hypothetical trickle-down effect. Sometime in early 2000's, there was an increasing demand for ODA to implement rural development projects that should benefit directly rural farmers in order to address poverty issues. In this context, JICA put emphasis on formulating TCP to generate tangible effects on those needy people. Among diverse farming activities practiced by rural farmers, small-scale aquaculture is on focus because it can be undertaken by small holders and it is a part of integrated farming system that ordinary farmers can easily adapt in their farms. Thus, priority of technical cooperation in aquaculture has been shifted from research and development to delivery of extension services to farmers, resulting in formulation of a number of TCPs dealing with small-scale aquaculture extension activities. These TCPs may be considered as rural development projects rather than aquaculture development projects.

It should be noted that almost all aquaculture centers assisted by JICA had function of extension or outreach on technology developed in the center. It could be called on-farm verification trial conducted by the center involving a limited number of beneficiaries. In many cases, successful technology transfer from the center to farmer was reported. However, for the center, replication or expansion of the effect afterwards was not found easy since the center was usually not responsible for nationwide extension services. TCP aimed chiefly at aquaculture extension, on the other hand, have been so designed that an administrative unit or office, in place of an aquaculture center, should be the implementing body of extension services with appropriate technology package. With this project formation, not only delivery of extension services in wider areas could be ensured but also sustainability of the project could be highly expected.

However, some common constraints were observed in government extension system among a number of developing countries such as inadequate budget allocation, lack of mobility for extension works and lack of trained personnel. Scarcity of fish seed in target area has also been a bottleneck problem for aquaculture development. In order to supplement the government extension works, farmer to farmer extension approach has been proposed in order to totally or partially overcome those problems. There is a self-sustaining mechanism in the farmer to farmer approach to ensure sustainable aquaculture development without government interventions. There are successful stories and lessons accumulated from TCP of JICA that should be shared to other developing partners.

Further development of inland aquaculture: towards poverty alleviation and food security in rural areas

Masahiro YAMAO
Professor
Hiroshima University, Hiroshima, Japan

Objectives of inland aquaculture development in poor rural areas are diverse. Rural aquaculture provides job opportunities, income and nutrition, even if its production scale is small. Particularly in monsoon Asia, a small scale aquaculture could effectively integrated into agrarian economy, with the support of appropriate technologies and the provision of seeds. Freshwater fish farming supplies animal protein to poor farmers, for household consumption, and markets the volume left over to earn additional income. Through the development of integrated fish farming system, farmers effectively use their agricultural and natural resources including water. This increasingly creates job opportunities both inside and outside household economy. With a high productivity of fish farming, the poor may purchase fish at cheaper prices in local market and eliminate malnutrition. Vulnerability of rural people and community will be reduced by achieving food security. The integration of inland aquaculture into rural development is an effective method to raise social stability.

Many attempts to extend small-scale inland aquaculture have been made so far in many parts of Asia and some parts of Africa. According to lessons learnt from these experiences, stable seed production is the most decisive factor to develop freshwater fish farming in poor rural areas. Seed production technology, with ensuring the supply of good quality brood stock, should firmly be built. Along with an increasing number of grow-out farmers, seed production will be highly commercialized, contributing to a growth of local economy. Yet another important factor is to introduce and extend grow-out technology fitted into with the local conditions of production. Indigenous technology of fish farming can be improved by adequate extension services which train farmers to grow out economic species in less-intensive and cost-effective ways. In cases where a conventional extension service hardly works, small-scale seed farmers transfer grow-out technology to their customers while selling fingerings. Fostering such a practical and market-oriented relationship between seed and grow-out farmers is defined **"farmer-to-farmer approach,"** which is flexibly put into practice in many parts of poor rural areas. The presentation focuses the theoretical and workable framework of this approach, by referring to the past and present experiences learnt from JICA's development projects in small-scale inland aquaculture.

General Discussion

Participants noted the importance of the concept of a network of core farmers, who in turn teach others.

The training of core farmers was a priority activity for extension staff, in order to improve the reach of extension services via the core farmers who act as additional extension agents by sharing their experience with other farmers. Participants indicated that a strong network needed to be maintained between the core farmers so that they could continue to develop their skills and learn from each other.

Prof. Yamao indicated that the core farmers network concept was based on experience with projects in Cambodia and other countries, and there was a need to clearly differentiate between core and non-core farmers in planning activities.

Partner Institutes' Presentations

FAO support to small aquaculture farmers in Asia and the Pacific

Weimin MIAO
Fisheries Officer
Food and Agriculture Organization of the United Nations – Regional Office in Asia and the Pacific
Bangkok, Thailand

Fish and other aquatic animals have become an important source of animal food for the world population after rapid development of aquaculture and fisheries for 3 decades, which currently compose about 30% of total animal production globally. In 2011, the world per capita food fish supply reached 18.8 kg, increased by 40% over the level of 1990, with 21 kg/capita for Asia. Fish and other aquatic animals provide 20% animal protein intake for 4 billion people and 15% animal protein intake for 3 billion people in 2011. The significantly increased per capita fish supply is largely attributed to the rapid development of aquaculture. Aquaculture has become an main source of fish and other aquatic animals, which was used to be dominated by capture fisheries. In 2011, aquaculture supplied 47.6% of the total food fish in comparison to 9% in 1980.

Asia is where contributes the major production of aquaculture products, accounting for nearly 90% of the world total culture fish and other aquatic animals. Aquaculture in Asia is dominated by small-scale farmer (80% of 12 million farmers). With the continuing increase of the world population and economic growth, it is anticipated that the demand for fish by the world population will increase by 30-50 million tonnes by 2030 from the current level. Considering the exploitation to the wild fisheries resource and trend of aquaculture development across the different regions of the world, whether the increasing demand for fish can be met will be largely determined by the sustainable development of small-scale aquaculture in Asia.

Small aquaculture farm holders are experiencing some drastic changes, the shift from household consumption focused subsistent production to market oriented commercial production and external environment changes such as tightening governance on environment impacts control and resource allocation and increasingly stringent standard for food safety and quality. To adapt to the changes, the small-scale farmers need to intensify, diversify and commercialize the production, which require better management and often lead to increased reliance on external input supplier and marketing channel and greater economic risk and financial vulnerability when encountering disasters.

In order to support the small-scale aquaculture farmer to effectively cope with the challenges for building up resilience and achieving sustainable growth, FAO has been supporting the member governments in the region to bridge the small-scale aquaculture holders with the market for both sourcing inputs and selling products, to empower small farmers in market negotiation and compliance with changing governance and standards of food safety and quality and to reduce the economic vulnerability of small-scale farmers.

FAO's support to small-scale aquaculture farmers is provided through both field projects and normative works, which focus on helping the farmers to improve production efficiency through improved inputs supply, introduction of new technologies, cultured species and management practices; to improve the market accessibility of small farmers through improved quality and safety of products, facilitation of certification (group approach) and empowerment of farmer community and to increase resilience of small farmers through disaster risk reduction and management, climate change impact adaptation and social safety-net.

The presentation introduced some examples of FAO's activities in supporting the small-scale aquaculture farmers, which include various FAO TCP projects for

- improving supply of quality aquaculture seed—"Improving National Carp Seed Production System in Nepal" and "Developing a national shrimp seed certification system in Bangladesh"
- improving aquaculture feed and feeding management --"Enhancing aquaculture production for food security and rural development though better seed and feed production and management with special focus on Public Private Partnership in Bangladesh" and "Improvement of feeding and feed management efficiency in aquaculture production in the Philippines" and "Regional TCP on reducing dependence of marine fish culture on trash-fish as direct food"
- improving aquaculture food safety through promoting BMP—"Improvement Aquaculture food safety in Hubei Province, China"
- improving market access of small-scale farmer--"Certification of small aquaculture farmers in Thailand" and "Capacity building to improve market access for fish and fishery products in Myanmar
- reducing the risk of small farmer--"Strengthening Capacities for Climate Risk Management and Disaster Preparedness in Selected Provinces of the Philippines", "Development of preventive aquatic animal health protection plan and enhancing emergency response capacities to shrimp disease outbreaks in Indonesia" and "Emergency assistance to control the spread of an unknown disease affecting shrimps in Viet Nam"
- and introduction of new species and culture technologies-- "Capacity building in fingerling production and farming of selected marine finfish species in DPR Korea", "Capacity building in seed production and juvenile rearing of ark shell and sea urchin species in DPR Korea", "Technical support to trout breeding and farming in Sri Lanka", "Sustainable Development of Community-based Mullet Culture in Loniu, Manus Province, Papua New Guinea" and "Assistance for development of Community based Milkfish farming in Nomuka Isl and Tongatapu"
- The presentation also briefly introduced some FAO normative work supporting small-scale aquaculture farmers, such as development of various aquaculture related technical guidelines under the framework of "Code of Conduct for Responsible Fisheries" and various regional consultations and workshop addressing the priority issues related to sustainable development of aquaculture in the region.

IMPLEMENTATION OF BETTER MANAGEMENT PRACTICES (BMPS) THROUGH CLUSTER MANAGEMENT

CV MOHAN
Manager of Research and Development, Network of Aquaculture Centres in Asia-Pacific
Bangkok, Thailand

Practices and people can be considered as two key ingredients to responsible aquaculture. Practices that are; in conformity with national and international standards and requirements, ensure sustainability of the sector, ensure environment protection and integrity, enable social equity and respect ethical values and standards, consider human food safety concerns seriously and People who; are well informed, willing to change and ready to embrace practices for public good.

Most aquaculture in Asia is undertaken by large numbers of relatively small scale farmers. These farmers face a variety of constraints that increasingly center around questions of how best to develop more sustainable production practices as a longer term outcome. Sustainability (the process) is really about changing behaviors; in this case the behaviors of these large numbers of small scale aquaculture farmers. Small farmers are too big to ignore. They should be part of the solution to many of today's problems (e.g. food safety, environmental integrity, social equity, food and nutritional security, societal harmony). This is only achievable through their involvement and empowerment.

BMPs in the aquaculture context outline norms for responsible farming of aquatic animals. These are management interventions developed to address the identified risk factors while its implementation is generally voluntary; they are not a standard for certification. Implementation of the BMPs by small scale farmers will help translate principles of responsible farming into reality and ensure the flow of benefits to the farmers, environment and society. Cluster/group management in simple terms can be defined as collective planning, decision making and implementation of crop activities by a group of farmers in a cluster through participatory approach in order to accomplish their common goal (e.g. reduce risks and maximize returns, achieve economy of scale). Attempts at empowering groups of small farmers have been more effective compared to individuals. The concept of collective and participatory decision making process while pursuing the primary livelihood (in our case fish farming) appears to have more positive impacts.

Aquaculture BMP and cluster management programs (with the support of MPEDA/NACA/NaCSA) are ongoing in India since the early 2000. Indian experience and lessons learned especially on BMPs and cluster approach were used in Aceh, Indonesia by various donors and partners (ADB, NACA, IFC, FAO, ARC, OISCA, WFC) after the 2004 tsunami to support aquaculture rehabilitation programs. In parallel, there have been several programs in Thailand supporting implementation of GAP and BMP programs in shrimp aquaculture since early 2000, including group certification programs supported under various national (DOF) and international programs (e.g. WWF/Aquastar/NACA, FAO TCP project). NACA has been involved in all these 3 countries directly and indirectly in project implementation and monitoring.

The presentation provided some insight on the risk management approach (adoption of BMPs through cluster/group approach) promoted by NACA over the last ten years in some of its member states. This approach supports building capacity and awareness of farmers and involves them in the (a) process of identification of risk factors to the sustainability of their operations, (b) development of interventions in the form of BMPs, (c) promoting adoption of BMPs through a cluster/group management approach and (d) ensuring market access through participation in group certification programs.

In summary, BMP adoption by such farmers is increasing, aquaculture management practices are improving and overall these cases illustrate that successful changes are possible even for very small scale farmers. Such change has been possible by using clusters, associations and other group based approaches supported by action based research and training/extension. Overall, we conclude that even very small scale farmers can, and will change, when provided with appropriate incentives and support. A fundamental shift in the attitude of producers, traders, consumers, policy makers, governments and international development agencies is necessary. Bringing about such a change is a very slow process. When these attitudinal shifts take place we will see responsibly caught wild fish, sustainably produced farmed fish, healthier aquatic ecosystems and important of all more empowered small farmers.

General Discussion

Participants sought NACA's views on the Aquaculture Stewardship Council's plans to certify aquaculture products. Dr Mohan advised that NACA does not formulate or evaluate standards, but rather encourages all parties to adopt the International Guidelines on Aquaculture Certification Standards. The proliferation of third-party standards and the inconsistencies and lack of mutual recognition between them were problematic for farmers. The guidelines provide approaches to establish equivalence between different certification standards and benchmarking of standards, which would reduce these problems.

Small-scale freshwater aquaculture development: experiences from the Philippines on giant freshwater prawn, milkfish and tilapia

Frolan AYA
Binangonan Freshwater Station
Aquaculture Department, Southeast Asian Fisheries Development Center
Bingangonan, Rizal, Philippines

Introduction

The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD) has been promoting a number of programs towards effective dissemination and adoption of science-based aquaculture technologies for rural aquaculture development. This is in line with the national government development program on sustainable aquaculture, which is implemented in agreement with the country's Fisheries Code of 1998 and Local Government Code of 1991.

SEAFDEC AQD, thru its Binangonan Freshwater Station (BFS), offers extension services and training courses on freshwater aquaculture. Also, AQD has been providing technical support to other countries through a series of regional trainings on freshwater aquaculture to facilitate the dissemination of aquaculture technologies and to capacitate the various stakeholders on this aspect. Aside from training activities, AQD established the Agree-Build-Operate-Transfer (ABOT) AquaNegosyo program which caters to private investors. In this program, AQD assists fish farmers from site selection, design and construction of facilities and monitoring of production run until harvest. Another program is called the Institutional Capacity Development for Sustainable Aquaculture (ICDSA) which aims to establish partnerships and build the capacities of local government units (LGUs), community-based organization and non-government organizations (NGOs), fishery schools and other local institutions. This is through training and information dissemination, on-farm demonstration and on-site consultations on fish culture.

AQD continues to carry out research and development (R&D) activities on various commodities and disciplines. One of the R&D programs developed by AQD is the "Meeting Social and Economic Challenges in Aquaculture Program" or MSECAP. This program aims to develop and implement social and economic strategies in aquaculture and resource management for food security and poverty alleviation in rural communities (Salayo et al. 2012). The five-year targets (2012-2016) of the MSECAP are directed on the implementation of R&D activities which include the (1) promotion of aquaculture technologies in inland and coastal communities through verification and on-site demonstration activities and (2) the development of appropriate technology adoption pathways for aquaculture technologies, among others (Salayo et al., 2012).

Success stories

AQD has implemented various initiatives aimed to accelerate the successful promotion and adoption of freshwater aquaculture technologies in the Philippines and in other countries. These activities were carried out in response to the needs of the community, that is, to provide them with the basic knowledge and training on culture of commercially-important species. In these studies, AQD identified several modalities in accepting technology in different areas or communities where various techno-demo activities were implemented. The types of modality for technology adoption include people organizations (POs), fisheries cooperatives and fish farmer cooperators. The modalities of the technology demonstration project on three important commodities (i.e. giant freshwater prawn, milkfish and tilapia) were briefly discussed.

Giant freshwater prawn

The BFS in Binangonan, Rizal, Philippines started its pioneering work on the grow-out culture of giant freshwater prawn (GFP; *Macrobrachium rosenbergii*) in lake-based cages (Cuvin-Aralar et al., 2007). This species can also be used in polyculture with other freshwater species such as tilapia (SEAFDEC 2009). Locally known as ulang, it is considered a promising alternative to lobster and tiger prawn due to its high market value and export potential. The world production of this species rose from 17,000 T in 1993 to more than 200,000 T in 2002, and the Philippines has successfully made it to the top 15 producers in 2008 (FAO 2004-2014).

Farming of GFP in cages could be a sustainable option for the growth of aquaculture in lake-shore fish farming communities, similar to other well-known species such as bighead carp, milkfish and tilapia. In 2011, AQD thru BFS has assisted the Lunsad Multi-purpose Cooperative (LMPC) of Binangonan, Rizal for GFP cage culture. Convinced with the potentials on the grow-out farming of GFP, this cooperative tapped AQD's technical expertise for the conduct of a pilot project on grow-out culture. The project was implemented with a grant from the Microfinance Council of the Philippines through its Financial Product Innovations Fund (FPIF). Prior to the inception of the project, a two-day training course on the culture of GFP was held at BFS and attended by the farmer members of LMPC. AQD also provided technical assistance to LMPC farmers during site selection and stocking of prawn juveniles in cage modules, and on monthly monitoring of stocks and water quality. Partial harvest of marketable-sized prawns was done jointly by the LMPC farmers and the BFS staff after four months of culture and sold in the nearby market. The cooperative was enticed by the promising results of the partial harvest. However, the activities were discontinued as LMPC farmer members needed to resolve some internal problems.

In addition, verification and demonstration studies that will lead to the adoption of cage culture of giant freshwater prawn among smallholder fishfarmer in Laguna de Bay, Philippines are currently underway as part of AQD's effort to provide the fish farmers with a high value commodity. Verification trials were conducted and fish farmer cooperators who will later be involved in the project were invited to participate and observe during sampling of the stocks. After five months of culture, production ranged from 0.12 to 0.15 kg/m2. About 40 fish farmers from adjacent fishing communities were invited for a series of preliminary meeting to discuss the project and its objectives. Nonetheless, only two fish farmer cooperators were involved in the demonstration activities. The fish farmer cooperators provided the cage and facilities, and expenses for GFP grow-out operation and maintenance. AQD, on the other hand, trained and provided the fish farmer cooperators with GFP postlarvae (PL) for its first year of operation and monitored the progress of grow-out activities. Scoping for potential partners to finance such demonstration activities was also done in consultation with the national government agencies like the Bureau of Fisheries and Aquatic Resources (BFAR) and Laguna Lake Development Authority (LLDA).

Milkfish

Milkfish (*Chanos chanos*) is considered one of the commercially-important species for aquaculture in the Philippines, Indonesia and Taiwan. Of the world aquaculture production of milkfish of nearly 595,000 T in 2005, about 49% was contributed by the Philippines, followed by 43% and 8% from Indonesia and Taiwan, respectively. This species is now cultured intensively in ponds, cages and pens.

In 2006, AQD provided technical assistance on milkfish cage culture to a fisherfolk organization that was severely affected by an oil-spill event in one of the municipalities of Guimaras Island in central Philippines. AQD trained the affected fishers in two fishing villages on milkfish cage culture. The project was supported by the municipal and provincial government of Guimaras with funds from Citi-Petron, and managed by Taytay sa Kauswagan, Inc. (TSKI), a non-government micro-finance institution. The project was successful as the organization gained income from milkfish harvest.

Tilapia

Tilapia ranks third, after seaweeds and milkfish, in terms of the major species produced in the aquaculture and fisheries (BFAR Philippine Fisheries Profile, 2010). In 2010, the tilapia industry contributed about 258,800 T or 10.17% of the total fisheries production. Tilapia production has been progressively increasing over the last 30 years. It rose from 26,800 T in 1981 to 303,169 T in 2011 (34.37% growth) with highest production obtained in 2009 at 304,303 T. About 95% of tilapia was produced from freshwater culture (BAS 2012).

Farming of tilapia helped the fisheries sector in generating income and employment. For the past 30 years, the value of tilapia production jumped from PhP102,000 to PhP19.07 million (BAS 2012). In 2011, BAS conducted a Costs and Returns Survey of Tilapia Production which covered the six major tilapia producing provinces (i.e. Pampanga, Batangas, Camarines Sur, Iloilo, South Cotabato, and Sultan Kudarat) in the Philippines. Results showed that tilapia farming is the main occupation of 60.97% of farm operators surveyed (BAS 2011).

AQD focused its early research efforts in 1980s towards improving growth and survival of tilapia in the nursery and grow-out cages, ponds and pens (Carlos and Santiago 1988). AQD's early studies on cage farming of tilapia started the proliferation of tilapia cage culture in Laguna Lake which was followed by the private sector. In response to the recurring problem on fish kills in freshwater lakes in the Philippines, AQD took the lead role in doing ecological or limnological studies, focusing on the impact of tilapia aquaculture practices on the natural productivity and carrying capacity of these waters for aquaculture. AQD, in collaboration with BFAR, verified and demonstrated more efficient feeding management schemes to reduce the cost of feeds and increase in yield of tilapia grown in cages (Cuvin-Aralar et al. 2012). This helped in the promotion of better aquaculture management practices in areas where culture of tilapia is being intensified.

To help the displaced farmers who were affected by typhoon, AQD thru its ICDSA program introduced the tilapia grow-out culture to cooperative members who owned the submerged agricultural lands in municipality of Dumarao, Capiz, in Western Visayas in 2007. The cooperative was not able to sustain the farm operations due to its inactiveness. The individual coop members ended up operating their own farms through backyard culture of tilapia and practice of alternative day feeding as a strategy to reduce operation costs.

With funding support from the Australian Centre for International Agricultural Research (ACIAR), AQD partnered with BFAR on tilapia cage culture in Bicol Region, Philippines (Cuvin-Aralar et al., 2011; 2012). The two-year project aims to improve cage culture management by fish farmers to improve economic returns as well as to reduce the environmental impact of aquaculture in Lakes Buhi and Bato, which are among the major lakes in Rinconada area. The areas were chosen as project sites as they ranked second in terms of poverty incidence in the Philippines (Cuvin-Aralar et al. 2011). The fish farmer cooperators in the two lakes were involved in the project implementation.

Overstocking of tilapia in cages has been identified as the poor farmer's practice that has to be modified for sustainable usage of the lakes. With this, stocking density trials and different feeding management schemes were tested in the two lakes. Verification trials were also conducted in Laguna Lake, Philippines. Results showed that stocking density of 10 pcs/m2 and skip feeding are recommended for a more profitable production of tilapia in cages (Cuvin-Aralar et al. 2011). Thus, the study on the lake was very timely and necessary for the benefits of the fish-farmers as well as other stakeholders.

Training programs on freshwater aquaculture

From 2011-2013, AQD thru its BFS conducted several training programs to about 171 government officers from SEAFDEC member countries (Malaysia, Thailand, Cambodia, Lao PDR, Singapore, Myanmar, Vietnam, Indonesia, Philippines), fish farmers, technicians, researchers, extension workers, entrepreneurs, teachers, local government officers and personnel, and other private workers from within and outside the country. The training programs were focused on the hatchery and grow-out operations of tilapia, bighead carp, native catfish and giant freshwater prawn.

In response to the need to promote freshwater aquaculture especially for rural aquaculture, the Government of Japan – Trust Fund (GOJ-TF) project provided financial support in the conduct of two international training courses: (a) Giant Freshwater Prawn Training Program; and, (b) Community-Based Freshwater Aquaculture for Rural Areas in Southeast Asia (CBFWA). The GFP training program was held for two consecutive years (2011-2012). Since 2004, the GOJ-TF supports GFP research in Thailand, Indonesia and the Philippines. The training is expected to provide the participants with the technical knowledge and skills on the breeding, propagation and culture of the GFP to (1) enable them to start a freshwater hatchery of the species mentioned, (2) update their knowledge in recent developments in freshwater prawn breeding and seedstock production, and (3) learn verified methods in farming freshwater prawns particularly in cages and ponds. The training was an opportune time for exchange of knowledge and experiences in prawn breeding and farming between the participants and the AQD resource persons. Considerable progress has been made ever since and now science-based technologies in prawn aquaculture are available and are ready for dissemination to the other countries in the region.

The CBFWA training courses, in collaboration with AQD, were attended by representatives from SEAFDEC member countries. To recognize the need to promote and transfer rural freshwater aquaculture technologies in remote rural areas of Southeast Asia for rural development, SEAFDEC initiated a project on the "Promotion of Sustainable Freshwater Aquaculture for Rural Communities" under the GOJ-TF Program with Lao PDR as the main beneficiary country. In line with the project goal, the training aims to (1) capacitate aquaculture extension officers on community organizing through participatory approach; (2) enhance their knowledge and skills on freshwater aquaculture technologies from broodstock development to seed production, nursery and grow-out phase; and (3) enhance their skills in the transfer and extension services of freshwater aquaculture technologies.

In collaboration with SEAFDEC partners, the training sessions were held in Lao PDR from 2007 to 2009 with government extension officers from SEAFDEC member countries as participants. Resource persons came from DOF-Thailand as well as experts from SEAFDEC and partner organizations, namely: Mekong River Commission (MRC) and the World Wide Fund for Nature (WWF). From 2010, this training program has been entrusted to AQD in recognition for its extensive R&D projects on freshwater aquaculture as well as its track record in information and training activities.

Conclusion

AQD's research and training efforts on many aspects of freshwater fish breeding and culture paved the way for the development of the small-scale freshwater aquaculture sector in the Philippines. AQD has developed various technologies for freshwater commodities such as giant freshwater prawn, milkfish and tilapia culture which have already been adopted by the small-scale fish-farmers in the country. However, AQD will continue to package and disseminate all the generated research information and technologies on freshwater aquaculture through information materials, training and seminars to target end-users. Through the use of appropriate culture and feeding management strategies, AQD shall educate and train the fish farmers on environment-friendly aquaculture practices. All of these will translate to improved fish production, increased income for lake-shore farming communities, and sustainability of inland water resources for aquaculture.

Acknowledgments

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GENERAL DISCUSSION

There was some concern expressed about the environmental risks of tilapia escaping to the environment. However, in general only monosex tilapia are cultivated and escapees are subject to heavy fishing pressure from local fishers, largely just providing an additional catch.

Madagascar participants indicated that paddy field culture of tilapia fed with rice bran had not been successful there (commercial feeds were unavailable). Dr Aya advised that SEAFDEC AQD was successfully polyculturing tilapia and *Macrobrachium* using a SEAFDEC-formulated diet, which had proved to be more successful than commercial feeds. SEAFDEC was mainly farming in cages rather than in paddy fields and recommended to use monosex tilapia in order to avoid uncontrolled reproduction and possible stunting. This could be achieved either through hormone manipulation or certain hybrids which produce 95% male tilapia (eg. *O. niloticus* x *O. aurea*) but it was important to make sure the parent strains were pure.

SEAFDEC AQD had achieved three crops per year and high stocking density (10 fish / square metre) with fish reaching market size in three months. FCR was now less than 2.0 using low feeding rates and mixed feeding schedules. Harvest size was approximately 350 g. One farm usually managed 3-4 cages. Prawns were fed at 10% biomass daily in first month, reducing as the prawns grew. SEAFDEC AQD had not yet developed a targeted feed for prawns yet.

EXPERIENCE ON INTEGRATED COASTAL RESOURCES MANAGEMENT IN PATHEW DISTRICT, CHUMPHON PROVINCE, THAILAND

Sumitra RUANGSIVAKUL

Training Department, Southeast Asian Fisheries Development Center
Bangkok, Thailand

Introduction

In 2001, the Southeast Asian Fisheries Development Center (SEAFDEC) and the Department of Fisheries (DOF) in Thailand conducted the collaborative pilot project on coastal fishery resources management with the cooperation of local fishing communities and other stakeholders, community groups and local administrative authorities in Pathew District, Chumphon Province under the auspice of Japanese Trust Fund – 1(JTF-1). The Chumphon Marine Fisheries Research and Development Center (CMDEC) served as the core implementing counterpart and Chumphon Provincial and Pathew District Offices of Fisheries as the collaborating agencies. The purpose of the project was to establish a practical framework for locally-based coastal resource management by encouraging fishermen's participation supported by the creation of alternative job opportunities in coastal fishing communities.

The collaborative pilot project was initially named "Locally Based Coastal Resources Management in Pathew District (LBCRM-PD)" which was implemented from 2001 to 2006. The name of the project was changed to Integrated Coastal Resources Management in Pathew District (ICRM-PD) in 2004. The project site covered an area of approximately 117 km^2 in Pakklong Sub-district, Pathew District, Chumphon Province. There are seven villages, composed 879 households with total population of 4,152, which are engaged in capture fisheries, coastal aquaculture and agriculture. The various fishing gears are Indo-pacific mackerel gill net, squid cast nets with light luring, blue swimming crab gill nets, shrimp trammel net, mullet gill nets, anchovy falling net with light luring, collapsible crab trap and cuttlefish traps and various kinds of small-scale fishing gear. For aquaculture, cage culture of fish and pond culture of shrimps are practiced. Rubber, coconut and palm oil are the major income sources for agriculture.

Overall Objectives of the Project

1. Establishment of sustainable resource management at local level;
2. Rehabilitation of coastal resources;
3. Poverty alleviation in coastal fishing communities;

Activities

There are six main activities under this project:

1. Baseline Survey

1.1 Biological

The survey was done to monitor performances of fishermen regarding catch per unit effort (CPUE) and identification of species composition, among others. Local people collected the data daily then handed it over to CMDEC for their monthly analysis.

1.2 Oceanographic and coastal

This activity was initiated by SEAFDEC/TD, CMDEC and Chumphon Marine Coastal Resource Research center. They were involved in the survey, analysis and presentation of results of coral reefs, sea grasses and water quality in the project site.

1.3 Fishing ground and gear survey

The activities are to monitor the fishing ground of each type of fishing gear and their seasonal changes as used by Pakklong fishermen. The survey was conducted between January 2002 and September 2006 by SEAFDEC.

1.4 Socio-economic survey.

This survey developed a community database of the seven villages that can be utilized to develop an extension program and community development plans. The community database was also used to assess the changes in the community considering the number of households, population and occupation. The survey was conducted between 2002 and 2005 by SEAFDEC and CMDEC.

1. Community-Based Resource Management

The project promoted responsible fishing and aquaculture activities and community participation in monitoring, surveillance and control programme of the demarcated coastal zones. These enhanced community capacity to manage fisheries by themselves. The following activities were undertaken:

2.1 Zoning arrangements

The project staff, fishermen, Pakklong Sub-district Administrative Organization (Ao.Bo.To) and other stakeholders agreed to establish maritime territory of the project site. This was ratified in October 4, 2002 by provincial mandate on the "Prohibition of some fishing gear to operate in zoned area of Chumphon waters". This mandate banned the use of trawls, push nets and dredges in the project area. Moreover, the aquaculture area in Tung Maha bay was divided into 4 zones: the cruise track for fishing boats; fish cage culture area; shellfish culture area; and monsoon-avoidance area.

2.2 Crab bank and mesh-size control on crab traps

Crab bank is the scheme developed and used to conserve the crab resource. The fishers were obliged to stock gravid blue swimming crab in the cage of crab bank for spawning, after which they were sold to the local market. The profit from the sales of crabs was divided to four parts: 50 % for loan in the group; 30 % for cage maintenance; 10 % for feeds; and 10% for operating expenses. The fishermen changed the mesh size (from 1.25 inches to be 2.5 inches) of the crab traps which was found more effective as scientifically monitored by CMDEC for one year. The result showed an increasing trend in terms of carapace size as well as total catch volume even if the data was yet marginal. Therefore, the enlarged mesh size resulted in higher benefits in terms of exploitation, thus the rule on mesh size control was used for fishers in this group. Under this program, the fishers' motivation and morale have been significantly boosted. At present, there are two crab bank system at project site: crab bank in cage; and Japanese system. Crab bank in cage operates from March to September while the Japanese system operates from October to February (monsoon season).

2.3 Pakklong Fishermen Group (PFG)

The PFG with 108 fishers as members was registered to the Provincial Cooperative Promotion Office. It represent the fishermen in raising problems and discussions on how to solve fisheries problems with the government, find ways in promoting fisheries resource management and conservation, and patrol illegal fisheries in the project site.

2. <u>Promotion of Local Business</u>

To reduce over-dependence on coastal resources, the project encourages and enhances local businesses outside capture fisheries at the project site. The project assisted people to increase household income in two ways as summarized below:

3.1 Improving the technologies of handling, marketing and processing fisheries products

The Project assisted the fishers to increase their income by improving technologies of handling, marketing and processing of fishery products. All endeavours under this activity supported the "One Tambol One Product" (OTOP) scheme that the Thai government has stimulated so far. In collaboration with Pakklong Sub-district Administrative Organization (Ao.Bo.To) and other local agencies, the project extended necessary technology and marketing information to the targeted sectors, including:

- Fish processing
- Local snack and dried flower making
- Batik painting

3.2 Creation alternative job opportunities inside and outside the fishing communities.

Some of the income-generating projects that were implemented include: babylonia shell culture; fish cage culture using artificial feed; and, swimming crab culture.

3. Enhancement of Human Resources Capability and Participation

Participatory training and educational course were planned, prepared and implemented for Activities 2 and 3. The training programs were arranged to suit the needs of the target groups of trainees, including project staffs, community leaders, fishers' group leaders, women's group leaders, and Ao.Bo.To council members. Since 2002 until now, the training courses on sustainable use of the coastal resources were offered for around 150 students from 5 schools in the project site every year.

4. Development of Extension Methodologies and Strengthening of Extension System

Extension services are required for the developed technology and methodologies. Text, manual and any visual methods for extension and training activities were prepared and developed. Leaflets, posters, newsletters and calendars were distributed to schools and communities. Overall, the project produced 49 published documents containing the results of the project's various activities.

5. Rehabilitation and Enhancement of Coastal Resources

This activity is planned and implemented by the DOF which has allocated funds for installation of artificial reefs (ARs) around the demarcated coastal zones. Setting up sustainable management and utilization of resources around the areas of deployed ARs will be target activity grouped into Activity 2. Releasing fingerings is also planned.

- Installation of artificial reefs (ARs) and Fish Enhancement Devices (FEDs)
- Release of fingerings and evaluation by tagging technique
- Mangrove Rehabilitation

Final Project Evaluation from Coastal Resources Institute

The activities for this project were well planned that every aspect of the issues were resolved. The baseline survey provided all the important details needed to identify and prioritize the different issues in the study area. The CBRM activities were very significant in the understanding and learning process of the local community regarding the protection and conservation of the environment and the coastal resources. The local businesses of the villages provided them with alternative and/or additional sources of income to sustain their daily needs. More importantly, the dissemination of information material to local people is a great way to keep them updated with and informed about recent developments, and enables them to identify ways where they can participate and extend assistance. Lastly, the resource enhancement activities were very important in engaging the interest and participation of the local people, rather than just giving them theoretical knowledge which is difficult for them to visualize and understand. However, the weak point is the lack of collaboration between the Ao.Bo.To and other agencies involved in this project.

Follow-up of the On-going Project

After end of the ICRM-PD, the DOF by CMDEC ran the project up to now by supporting the different activities in the project site including:

- Activity of PFG;
- Support materials for maintenance crab bank;

- Releasing of fingerlings;
- Conduct of training courses on sustainable use of coastal resources for 150 students from 5 schools in the project site every year;
- Green mussel culture

General Discussion

Participants commented that finding appropriate leaders for local co-management teams was a key factor for success. Dr Ruangsivakul advised that this was a difficult but essential process, and often took a couple of years to find people who had the right combinations of skills and recognition within the target communities to carry out the role effectively.

The group discussed the minimum size of a farmers group or collective to be effective. Dr Ruangsivakul indicated that in this case the farmer groups were quite large, but they were also divided into smaller sub-groups for day to day operations.

Participants enquired if the project was supported by regulations on zonation and carrying capacity. Dr Ruangsivakul indicated that there were no formal regulations on zoning for the mussel project but the project had assessed carrying capacity and advised the farmers on suitable stocking densities for farms.

AIT experience on small-scale aquaculture development

Aquaculture Outreach Program Team (Peter Edwards, David Little, Nick-Innes Taylor, Harvey Demaine, Amara Yakupitiyage and AIT + DOF staff members)
Asian Institute of Technology
Pathumthani, Thailand

Extended summary not provided.

General Discussion

Some participants noted that off-flavour could impede consumer acceptance of tilapia in emerging markets. Dr Yakupityage indicated that muddy taste was often caused by blue-green algae in ponds. This could be reduced by adding lemon in the cooking. However, it was better to address the issue by improving water quality in the ponds.

It was important to control the amount of organic matter going into the water, with a maximum of 100kg / ha / day. If this amount was exceeded biological oxygen demand would become a problem after a few months and fish growth would be affected. If organic fertilisation was used it was advisable to reduce the culture period.

Controlling tilapia reproduction in ponds was very important to avoid overpopulation and stunting. It was best to use hormone treated fish, otherwise the sexes would have to be segregated manually.

Feed is a major constraint in many countries, as few resources are available to small-scale farmers. Participants asked if tilapia feed could be produced without fishmeal using protein sources such as hydrolysed feather meal or soybean meal. Dr Yakupityage advised that while these materials are deficient in certain amino acids the feed could be supplemented with artificial amino acids as necessary. However, fishmeal still played an important role as an attractant. Research had shown that different species were attracted to different amino acids, and it was important to find out which.

SMALL-SCALE AQUACULTURE DEVELOPMENT AND EXTENSION IN THAILAND

Thavee VIPUTHANUMAS
Inland Fisheries Research and Development Bureau, Department of Fisheries
Bangkok, Thailand

Extended summary not provided.

GENERAL DISCUSSION

DOF advised that it produced a large quantity of seed for the benefit of farmers, a side-effect of which was that the overall market price of seed was somewhat reduced, due to the improved supply (in the past, the shrimp farming industry had faced severe shortages of seed). DOF also played an important role in controlling seed quality, both internally and through regulatory influence on private hatcheries. While the private sector was quite capable with respect to most aspects of seed production there were increasing concerns about the genetic quality of such.

It was noted that pond liners were not a substitute for good pond construction in poor rural areas, where farmers may not be able to afford them. Generally speaking, small ponds were easier to manage for small-scale farmers and required lower investment for supporting infrastructure such as pumps etc.

In Nepal, lowland (tropical) ponds were difficult to drain as they were typically constructed in floodplains and require mechanical drainage. However, a community-based approach helped small-scale farmers to afford infrastructure.

Country Presentations

Project for extension of inland aquaculture in Benin

Arsene D'ALMEIDA[1], Justin GANDONOU[2], Yaovi Guy KOUCOU[3] , Nezaki GORO[4]

[1]Project Manager/Coordinator, Provac Republique de Benin

[2]Extension Officer, Communal Sector for Agricultural Development, Adjohoun Commune, Ouémé Department, 02 BP 413 Porto-Novo Benin

[3]Core Fish Farmer, Adjarra Commune, Ouémé Department Representative of Fish Farmer Cooperative. 02BP413 Port-Novo, Benin

[4]JICA Expert, Benin Provac

In order to develop aquaculture in Benin, a master planning study namely "the Project for Study of the Promotion of Inland Aquaculture for the Rural Development in Republic of Benin (PACODER)" was conducted from 2007 to 2009. As a result, a total of 15 action plans were proposed and "the Project for Extension of Inland Aquaculture in Republic of Benin (PROVAC)" was identified to be implemented from June 2010 as a priority project.

PROVAC aims to increase fish farmers in the target seven provinces of the Southern Benin by using the extension approach so-called "farmer-to-farmer" training. In this approach, the Project supports establishment of core farmers who can produce seeds and homemade feeds. The core farmers then offer technical training for ordinary farmers in cooperation with extension officers at the facilities of core farmers. PROVAC has achieved various technical improvements including the seed production technique of mono sex male tilapia (*Oreochromis niloticus*) using hormone treated feed, which was the first attempt in Benin.

After the trainings, the ordinary farmers who can prepare adequate aquaculture facilities are provided from the core farmers assisted by the Project with input assistance in terms of fish seeds and feed for their new cycle of aquaculture. Through the 3.5 years of project activities, we have trained more than 2200 ordinary farmers. Among those, 1704 farmers were benefited with the input assistance and started pond culture or "box culture", which is a mobile type of aquaculture usually carried out in wooden box coated inside with vinyl sheet. The box culture is developing rapidly in peri-urban area for African catfish (*Clarias gariepinus*) in Benin.

Thus, the farmer-to-farmer extension approach is proven to be an effective tool to train new fish farmers as well as existing fish farmers. The number of candidates who want to attend the training is still many or rather increasing. Through the PROVAC activities, the inland aquaculture in the Southern Benin has been received strong interest and now developing rapidly, although the production statistics has yet been compiled well.

Through the Project, we have learnt many lessons and also understood current problems and issues. The most crucial one is the selection criteria of the candidate ordinary fish farmers, which affect directly on the continuation rate of aquaculture thereafter. In the early stage of the Project, significant percentage of participants could not start aquaculture because of lacking of money to prepare facilities. Some opportunist people attended the trainings in order to benefit from the free input assistance of seeds and feed. In general provincial extension officers are supportive to the project activities but their capacities are often insufficient and there are cases that the relation with core farmers is found not good.

SMALL-SCALE AQUACULTURE EXTENSION IMPLEMENTED BY THE FRESHWATER AQUACULTURE IMPROVEMENT AND EXTENSION PROJECT PHASE 2 (FAIEX-2) IN CAMBODIA

Hav VISETH[1], Chin DA[2] and Yukiyasu NIWA[3]

[1] Project manager of FAIEX-2, Department of Aquaculture Development, Fisheries Administration, Kingdom of Cambodia

[2] Deputy Project Manager of FAIEX-2, Department of Aquaculture Development, Fisheries Administration, Kingdom of Cambodia

[3]Project chief advisor of FAIEX-2, INTEM Consulting Co. Tokyo, Japan

1. Background of the project

Cambodia has abundant freshwater fisheries resources produced by Tonle-Sap Lake and the Mekong River. Freshwater fish are the source of animal protein, which local people can most easily obtain. In fact, fish products account for about 75% of the animal protein consumed by the people of Cambodia. Annual consumption of fish products per capita is estimated at 52.4 kg. However, the main fishing grounds are limited to Tonle-Sap Lake and the basin of the Mekong River, moreover the distribution infrastructure is not well developed. As a result, the supply of freshwater fish is always low in other rural areas.

It is considered that aquaculture could be a solution to increase the nutrition available as well as to provide additional income source to local farmers, as it is known that the potential demand for small-scale aquaculture using paddy fields, canals and ponds is very high. However, many rural communities have little experience with fish culture. There exists a lack of awareness of the benefits of this food source. In addition, there are local shortages of the required raw materials (fish eggs, fish fry and juvenile fish etc.) for farmers to practice fish culture.

The Freshwater Aquaculture Improvement and Extension Project (FAIEX) started to improve above mentioned situations and activate fish culture activities.

2. Phase 2 descended from Phase I

FAIEX phase I (hereinafter “FAIEX-1”) implemented from 2005 to 2010 targeting aquaculture potential provinces such as Takeo, Kampot, Kampong Speu and PreyVeng, has conducted training on fish culture to more than 9,000 farmer households in 5 years. Number of seed farmers increased from 21 households to 69 households thus amount of fingering supply in target area is raised. FAIEX-2 started in April 2011 after successful implementation of FAIEX-1.

FAIEX-2 takes same method and same strategy for aquaculture extension to small-scale farmers but targeting more difficult area, less potential 3 northern provinces such as Pursat, Battambang and Siem Reap.

3. Implementation

<u>3.1 Method of aquaculture extension</u>

The project pursues aquaculture extension by making use of Farmer-to-Farmer (FTF) approach in which seed producers instruct aquaculture techniques to small-scale farmers and provide them with seeds. The three steps of technical transfer were executed in Phase 1, namely 1) from experts to extension officers, 2) from extension officers to seed producers, and 3) from seed producers to small-scale farmers. Phase 2 builds on and expands this approach and made a plan of implementation to bring up 45 core seed producing farmers (CSPF) and the project aims for more than 3,000 grow-out fish farmers to be trained by CSPFs in 4 years from 2011 to 2014.

3.2 Implementations

3.2.1 Bringing up seed producing farmer

At first, the project evaluated seed farmer candidate by rating on the basis of the 5 criteria, such as (1) Skills / Experience, (2) Facility / Equipment, (3) Water Availability, (4) Economic Status, (5) Willingness / Extension Experience. Consequently 41 seed-producing farmers were selected so far. Secondly, the project conducted the training on seed production technique, and also provided necessary materials and equipment for hatchery operation and on-farm guidance regularly. Afterwards, the project conducted TOT (Training of Trainers) for the seed farmers to learn teaching technique to other fish famer beginners.

3.2.2 Training for Grow-out farmer

The project selects new target communes every year and let the seed farmers take responsibility to train grow-out farmers as well as to provide fingerlings in target communes. The project so far selected 92 communes in three years (from 2011 to 2013) based on the set selection criteria. The project has provided the training to 505 grow-out farmer households in 19 communes in 2011, to 897 grow-out farmer households in 34 communes in 2012 and to 1,091 grow-out farmer households in 39 communes in 2013.

3.2.3 Follow-up of grow-out farmer

After the training, the project conducted follow-up support for trained grow-out farmers to practice and continue aquaculture activities such as providing fingerling at first year's trial and fish-net (hapa net, screen net). In addition, the project held the evaluation workshop for all trained farmers after harvesting fish from 1st year's aquaculture trial in order to share lessons learned and to encourage them to continue fish culture. Consequently more than 95% of trained farmers have been continuing aquaculture after 2nd year.

4. Lessons learned (Key issues of farmer-to-farmer extension)

Implementation and outputs of FAIEX-2 generate the following lessons learned.

4.1. Technology transfer by 3 steps works efficiently.

The technology transfer by project was progressed in three phases: 1) expert to counterpart → 2) counterparts to SPFs (fingerling producers) → 3) SPFs to grow-out farmer. The target group shifted successively from one phase to the next phase.

4.2. Farmer-to-farmer extension could be sustainable approach for technical transfer

Core seed producers not only extend their activities but also disseminate fish culture technologies after termination of the project. They can get more customers who would buy fingering continuously if they disseminate fish culture to the beginner farmer. In other words, core farmer get more business chance and it is directly related to the incentive for dissemination.

4.3. Farmer's selection is a crucial issue

Selection of both core seed farmers and grow-out farmer candidate is a key issue for successful implementation of farmer-to-farmer extension. Candidate farmer should be carefully evaluated. Selection work needs to follow criteria through interview as well as field survey.

4.4. Monitoring and evaluation is essential condition to encourage the farmers to continue fish culture

After implementing farmer-to-farmer training, follow up activities are needed at appropriate time and frequency: 1) Monitoring their activity from stocking fish until harvest; and, 2) Workshops to evaluate and to share experiences of first fish culture trial among farmers are recommendable to make the farmers continue fish culture.

SMALL-SCALE AQUACULTURE IN LAO PDR

VannapharTAMMAJEDY[1], Khamlay PHOMVICHIT[2], Vorasack INTHALAPHET[3], Lane BOUMYCHIT[2], Khouangchai NYUTHTHABUD[3]

[1]Project counterpart of LIPS & Deputy Director of Namxouang Aquaculture Development Center, P.O Box 6644, Lao PDR

[2]Core farmer

[3]Provincial counterpart

Lao PDR as an inland country is located at the center of Indochina. Inland capture fisheries and aquaculture in Lao PDR are based mainly on water ecosystems consisting of rivers and their basins, hydropower and irrigation reservoirs, temporary or permanent derivation weirs, gates and dykes, small water bodies, flood plains and wet season-rice fields. The aquaculture production in 2011 was 88,000 T while capture fisheries production was 30,900 T (FAO). Whereas the capture fisheries production is in stagnant situation in recent years, the aquaculture production is dramatically increasing. One of the reasons for that is the number of fish ponds which is drastically increasing due to the necessity of soil for infrastructure building.
Supply of animal protein for the people is still insufficient in most rural areas in Lao PDR. Fish is the most important source of animal protein. Lao government has set a target to increase fish supply to 24 kg/year/person by 2020. Promotion of aquaculture is the most promising way to increase fish supply to the rural people.

The farmers in the rural area are engaged in various agriculture activities in the village. Their inputs of cost and time for fish culture are quite limited. They prefer to use extensive method in fish culture and most of the fish ponds are small. The problems in aquaculture extension include lack of fish fingerlings for stocking into ponds and lack of basic aquaculture techniques such as on feeding and stocking.

The core farmers are the ones producing fingerlings and providing training on basic aquaculture techniques, and these activities are expected to be extended to small scale aquaculture in the rural area. The farmer-to-farmer approach by core farmers was demonstrated by Aquaculture Improvement and Extension Project Phase 2 (AQIP2; 2005-2010) in several provinces. Some core farmers were successfully fostered by the project. The effectiveness of the aquaculture extension in the rural area was verified. Currently Lao government is also conducting to foster core farmers in the national development policy. It is expected that the farmer-to-farmer approach will contribute in the extension of aquaculture in wide area.

In most cases of aquaculture extension, exotic species have been used as target species. In view of biodiversity, establishment of habitat and hybridizations with indigenous species in the natural water body, this practice may cause deterioration of the natural biodiversity. Therefore, to protect the diversifications, aquaculture extension using indigenous species should be promoted. The development of aquaculture technique for indigenous fish should be enhanced for the aquaculture extension.

Case Study 1: Experience of Mr. Khamlay PHOMVICHIT, Laongam District, Salawan Province

He used to be a fish grow-out farmer to produce table fish from a few ponds. Through provision of technical training and on-farm guidance by a JICA-assisted technical cooperation project, AQIP2, he has acquired seed production technology. He received in-kind assistance from the same project for facility construction and aquaculture equipment. He was also trained as a core farmer who was expected to transfer grow-out techniques to ordinary fish farmers.

As a result of AQIP2 assistance and his self-help efforts, he has successfully expanded his fish production, i.e. over 200,000 fingerlings of common carp, tilapia, silver barb and *Clarias* catfish and 3,000 kg of table fish. He now has 18 ponds and 2 concrete tanks. The proceeds of fish sales have become a main source of his income. He has market outlets not only in his district but in other neighboring provinces as well. He practices farmer-to-farmer extension by teaching other fish farmers grow-out techniques such as pond preparation, seed stocking and feed preparation. He often receives visitors and study tour groups and international donor-assisted project people. As such, he has been recognized by the Lao government and donor agencies as a model farmer.

He has a future plan for expansion of fishponds in order to produce 500,000 fingerlings a year. He is also interested in *Moina* culture for stable larval rearing and production of indigenous species and ornamental fish such as arowana.

Case Study 2: Experience of Mrs.Lane BOUNMYCHIT, Laman District, Sekong Province

She used to be merely a grow-out farmer with 2 small backyard ponds before the project intervention. After she has been provided with technical assistance by a JICA-assisted project called LIPS (Livelihood Improvement Project for Southern Mountainous and Plateau Areas: implemented 2010-2015), she has been trained as a core farmer to produce and sell fingerlings. She was motivated to invest in the expansion of production area and now she owns 6 ponds and 18 concrete tanks for seed and table fish production. When she sells fingerlings to farmers in her district and neighboring districts, she teaches them grow-out techniques including pond preparation, seed stocking and feed preparation. Her fish production in 2012 reached 100,000 fingerlings and 350 kg of table-size fish. Thus, fish has become her main source of income. Government recognizes her endeavour as a model case. As a matter of fact, the Agriculture Minister visited and recognized her and a local magazine wrote an article about her success. She plans to increase annual fingerling production up to 500,000 and to challenge seed production of silver carp and mrigal, species new to her.

SMALL-SCALE FISH FARMING FOR SMALL-SCALE FISH FARMERS IN THE NORTHWEST REGION OF MADAGASCAR UNDER THE PROJECT PATIMA (PROJET D'AQUACULTURE DE TILAPIA À MAHAJANGA)

Raboanari Jaona Harilalao ZOELYS[1], Miaretsoa LONGONDRAZA[2], Tondalh Jo MANA[3], and Oomizo HIROSHI[4]

[1]Director of Aquaculture, Ministry of Fisheries and Halieutic Resources, Madagascar

[2]Extension Officer, [3]Core Farmer and [4]Expert on Rural Development Project, PATIMA

Introduction

A program/project of FAO ignited a first practice of freshwater carp aquaculture in highlands near the capital of Madagascar in the late 1980's. Since then, carp culture has been practiced in the area but the number of farms at present are only few. In terms of tilapia culture, the Rural Development Support Project in Madagascar (PSDR: abbreviation in French) financed by the World Bank promoted the tilapia culture for small-scale farmers in the district of Marovoay, northwest of Madagascar, from 2002 to 2004. Because the assistance of PSDR is only limited to supplies of fingerlings and some pumps, almost all the fish farmers gave up the fish farming in the end.

The Marovoay district is one of target districts of PATIMA. There were few farmers operating fishponds in the district when PATIMA started its activities in April 2011. It is, therefore, no exaggeration to say that PATIMA is the first project of tilapia farming with practical techniques for the sustainable rural development.

Practical techniques suitable for small-scale fish farming

The region had had almost no background on freshwater aquaculture, aside from the practice of primitive fish farming, when the project started two and a half years ago. The project, therefore, started with site surveys and feasibility studies, which were followed by pond construction. Generally, the soil texture of the target area is basically sandy that a water-holding capacity is low and leads to a heavy seepage. The process of constructing a deep pond with good water-holding capacity was therefore explained to the fish farmers.

Both domestic and exotic tilapia species, which were from Japan, are being reared in farmers' ponds. Mono-sex and mixed-sex culture are being practiced, with manual sexing method used for mono-sex culture. The reproductive behaviours of both domestic and exotic tilapias have been studied in farmers' ponds. Core fish farmers produce fry/fingerlings of both tilapias. Integrated farming with common domestic livestock (duck, cow, goat) is being practiced where cultured tilapia relies mostly on natural foods produced from dung-fertilized ponds. Polyculture of tilapia and carp is also practiced. Home-made compound feed is currently being tested for higher productivity.

Extension work and farm-to-farmer network

The project has selected 25 core fish farmers, 19 of whom are producers and suppliers of fry/fingerling of tilapia. The candidate core fish farmers, first of all, received an aquaculture training of trainers (TOT) and training on seed production. Besides these two trainings, the extension team of our project gave on-the-job training to the farmers in their own production site/pond for around one year to make them polish up more practical skills in seed production and grow-out pond operation.

Trained core farmers also started giving a farmer-to-farmer (F-to-F) training to ordinary fish farmers including newcomers whom the core fish farmer intended to sell fry/fingerling. The F-to-F training covers techniques for grow-out pond operation. There are many farmers in the target region who grow rice and vegetable with primitive livestock raising such as wide-range duck, chicken and goat. They had no history/experience on aquaculture when the project started in April 2011. The total number of F-to-F training participant is 955 as of October 2013. Through this F-to-F trainings and extension service, the number of fish farmers now increased to 286.

Agriculture alone cannot be a stable source of income so that many farmers seek for other reliable cash-making source. Most of those who participate in F-to-F training expect the fish farming to become the stable cash crop. But most cannot afford to invest anything due to poverty. It is, therefore, necessary to develop techniques of the tilapia culture with low input, which is extensive or semi-intensive method, with integration of livestock raising (integrated fish farming system).

We are still at the early stage of aquaculture development in the country. There are only few core fish farmers who sell fry/fingerling to ordinary farmers and sell fish reared in grow-out pond. There are still a lot of problems, to which we have to find solutions. In socio-economic aspect, these problems are distribution channel including means of transportation, sales and marketing of produced fish. In technical aspect, technique for low-cost or zero-cost fish farming should be developed to produce fish at affordable price for consumers whose income is low. We are going to establish Farmer-to-Farmer Network for the fish farmers to exchange information and idea to overcome the socio-economic and technical difficulty. It seems that it will take more years to see a lot of pond-raised tilapia being sold in the local markets.

General Discussion

It was noted that cow dung and duck manure were used separately, as cow dung was not available in some areas. In addition, the project sought for farmers to make a profit on their ducks as well; in some cases ducks were the main business rather than fish farming.

Small-scale Aquaculture Extension for Promotion of Livelihood of Rural Communities in Myanmar Project – SAEP

Aung Khine SOE[1], Aung Soe MIN[1], Kyaw SOE[2], Win KHINE[3], Saw Maung Maung AYE[3], Shingo TAKAHASHI[4]

[1]Fisheries Officer, Department of Fisheries, Ministry of Livestock, Fisheries and Rural Development, Myanmar

[2]Fisheries Officer, Department of Fisheries, Aquaculture Department, Head Office, Nay Pyi Taw, Myanmar

[3]Core farmer

[4]Chief Advisor, SAEP

In Myanmar, the agriculture and fisheries sector plays a crucial role in contributing to the social and economic development where the people are traditionally great consumer of rice and fish. Fish is regarded as one of the most important diets for the Myanmar people since more than 70% of animal protein is taken from fishery products.

It has been reported, however, that people in the rural areas, particularly those who live far from the main river systems suffer from a deficiency of animal protein due to insufficient supply of fish. The majority of those are needy farmers and they depend only on crop cultivation for their livelihood. In this situation, development of small-scale aquaculture is considered as a potential measure to address these problems. Small-scale aquaculture in low investment and in easy techniques is expected to provide opportunities for rural poor population to improve their livelihood through generating additional income sources as well as raising their nutritional condition. However, due to various constraints such as insufficient number and knowledge of extension staff, undeveloped rural extension system and limited budget from the government, the extension services on small-scale aquaculture are not well delivered in Myanmar.

In this context, the Department of Fisheries, Myanmar, in cooperation with JICA implemented the Project (Small-scale Aquaculture Extension for Promotion of Livelihood of Rural Communities in Myanmar Project - SAEP) from 2009 to 2013. The main objective of the project was to improve livelihood of rural communities through extending appropriate small-scale aquaculture practices, such as small pond culture, paddy-cum fish culture, small-scale fish seed production and fry nursery, among others. The project targeted three (3) State/Regions (Ayeyarwaddy, Bago Region and Kayin State) wherein the selected farmers/communities were experimentally carrying out small-scale aquaculture under the supervisions of the Project. The Project also tried to establish a system, what so called “Farmer-to-Farmer (FTF)” extension, which was expected to make sure that farmers are able to start aquaculture autonomously without much dependence on extension service by government. For “FTF”, the project selected well-motivated farmers and trained them not only on aquaculture and seed production techniques, but also on extension methodologies, so that they became core farmers. They are expected to supply healthy fish seeds produced by themselves as well as disseminate technical information to other farmers in the area.

General Discussion

A question was raised on how is the management by the community of the small-scale aquaculture conducted, and on how is the revenue distributed amongst the community. Farmer groups formed are composed of 5-10 people with a chief and secretary, who work together. After the harvest, the expenses are paid and profit is distributed to all members.

The lands used for fish farming under the project are all private lands.

INVITED COUNTRY PRESENTATIONS

SMALL-SCALE FRESHWATER AQUACULTURE IN CÔTE D'IVOIRE

Vakaramoko BAMBA
Aquaculture Technical Advisor, Department of Animal and Fishery Resources
Republic of Côte d'Ivoire

Summary
Promoting SSFW-FF[1] in Côte d'Ivoire was done in two stages. First was awareness and establishment stage (1974-1990) implemented by dense and diverse state support. The second was the professional stage (1992-2002) executed by specific regional projects. Activities targeted small-scale fish farming including: i) promotion of quality amenities, reproducible by the promoters; ii) marketing – taking into account the demand of the target market; iii) training of professional stakeholders capable of ensuring support animation of the sector in all its components; and, iv) the promotion of research and development focused on the needs of stakeholders.

Actions of regional projects, combined with the advent of some lagoon farms, had a significant positive impact on the development of national fish production which has increased at a rate of 6.8% /year and reached production level of 1200 tons in 2002. In 2013, the national fish production is estimated at 4,500 tons, obtained from 1300 farms with a total of 750 hectares of water. The contribution of small farmers, estimated at 3,010 tons, represents 66.9% of total production.

The production consists essentially of tilapia *(Oreochromis niloticus),* raised in monoculture, polyculture, or monosex male, and contributes 90% of the total production since 1998, despite the significant investments made toward other species including catfishes *(Chrysischtys nigrodigitatus*, *Heterobranchus longifilis and Clarias spp.)*.

The model of rural fish farming, extensive to semi-intensive, developed and popularized, from participatory approaches of the Midwest regional fish Project (PPCO), is now the basis for the development of the SSFW-FF in Côte d'Ivoire. This development is mainly driven by the relay stakeholders (topographers, builders of ponds, fish farmers) trained and installed by the regional projects. This process can be amplified and the SSFW-FF production can be increased if the constraints, i) of sexing and the slow growth of the local strain of tilapia and ii) on low control of conditions for the marketing of inputs and outputs, were lifted. Overall production could also be doubled, considering all other things remain equal, if the capacity of the channels were reinforced by implementation of i) professional organizations capable of providing the primary collection of inputs and outputs, and ii) subsequent harvest storage equipment.

Finally, government appropriate regulations and the creation of one agency for aquaculture development will meet the many challenges streamlining support/consulting and extension systems and valuing all resources.

[1] SSFW-FF : Small Scale Fresh Water - Fish Farming

Introduction

With 550 km of coastline, Ivory Coast covers an area of 322,462 km^2, along the Gulf of Guinea in West Africa. The country is located in the tropics and receives relatively high annual precipitation that feeds a dense river network consisting of lagoons (1200 km^2), lakes (reservoirs and hydroelectric and irrigation dams covering 1760 km^2), rivers, relief, little rough, consists of plates of 100 and 400 meters, covering 80% of the territory. The highly diversified agricultural production include food crops such as rice, corn and soybeans and cash crops such as cocoa, coffee, oil palm, rubber, cashew, cotton, fruits and citrus.

In economic terms, the fish is the primary source of animal protein with about 70% of total meat consumption, representing per caput of 13 to 15 kg/person/year for an estimated 20.8 million people in 2008. Domestic consumption of fish products was estimated at more than 339,000 T in 2009, against a domestic production of 44 199 T. The deficit, nearly 80%, is covered by imports amounting to about US$2 billion per year. The distribution of fishery products by source and destination is presented in **ANNEX C.** Given the low domestic production of capture fisheries due to the narrowness of the continental shelf of Côte d'Ivoire and, conversely, the population growth of 3.0% per year, it is clear that the deficit of fishery products trade balance will only get worse, if the aquaculture production does not record a significant departure.

Taken together the climate, topographic, agricultural, and market condition offer great potential for aquaculture development in Côte d'Ivoire. Today, only small-scale fish farming is experiencing an autonomous expansion across the country, thanks to the undeniable plasticity and resilience at all events, of extensive technical models to semi-intensive and participatory extension approaches implemented by regional projects during the decade 1992 -2002.

Current situation of aquaculture in Côte d'Ivoire

Definition of Small Scale Fresh Water fish farming (SSFW-FF)

In this paper, we adopt the definitions of FAO (FAO, 2008[2]) to describe the situation of small-scale aquaculture in Côte d'Ivoire. Communication therefore focuses on fish farms whose production does not exceed 10 T/year. Management is done by family or community members, input use is low to moderate, and there is little external labor. Almost everywhere in Côte d'Ivoire, it is about commercial fish farms that actively participate in markets by buying inputs (including capital and labor) and selling their products off the farm.

SSFW-FF place in Côte d'Ivoire

The importance of SSFW-FF is both economic and strategic order in an agricultural country like Côte d'Ivoire. For the Government, as well as for fish farmers, the activity is primarily driven by objectives of diversification, job and income creation to which one must add household supply of fresh fish, generally not available on rural markets: the scarcity of game makes the SSFW-FF preferred source of quality protein.

Nevertheless, the development of SSFW-FF in Côte d'Ivoire, as elsewhere in sub-Saharan Africa has been made by jerks and jumps at the rate of authorities support capabilities and regulating aided by technical and financial partners, face repeatedly to the same constraints that are identified: access to quality inputs, extension services and credit.

[2] http://www.fao.org/fi/glossary/aquaculture/

The willingness of the government to promote fish farming has been manifested since the 1950s. It resulted with the installation of research and seed production stations for private farms in 1954. The first extension activities are carried out through the precursor UNDP/FAO project from 1978 to 1990; there aimed primarily the development of small-scale and semi-intensive fish farming in rural zones. In 1992, 1730 fish farmers were installed across the country, on 3787 ponds with a total area of 149 ha. However, less than 50% of farms were still operating in 1993 with an estimated total production equal to 351 T.

From 1992 to 2002, the policy of aquaculture development was carried out throughout regional projects, which was implemented by specialized structures on the basis of specific agreements with the Government and exclusivity mandates on their response zone. The aim was to build upon the achievements of the UNDP/FAO project and harmonize messages and support initiatives for the sub-sector. Activities targeting small-scale fish farming and were structured around: i) the promotion of quality amenities, reproducible by promoters, ii) taking into account the demand of the target market, iii) training of professional stakeholders able to support the industry animation in all of its components and iv) the promotion of Research / Development focuses on the needs of stakeholders.

This new approach, combined with the advent of some lagoon farms, has had a significant positive impact on the development of production, both in terms of volume and quality of the product being marketed. Domestic production has increased at a rate of 6.8%/year in 2002 to reach the level of 1200 T, and was obtained from 48% of the farms under large-scale operations (in lagoon with technical intensive floating cages and semi-intensive earthen ponds) and 52% from small-scale farms using intensive or extensive techniques in earthen ponds (Table 1).

Table 1: Contribution of the different systems to domestic production in 2002

	Production	Contribution
Technical production system	*(Tonnes)*	*(%)*
Large-scale production	***578***	***48.1***
Intensive lagoon (floating cages)	400	33.3
Continental semi-intensive (ponds)	178	14.8
Small-scale production	***622***	***51.9***
Continental intensive (ponds)	138	11.5
Continental semi-intensive (ponds)	484	40.4
Domestic production	***1200***	***100***

<u>Specific composition of aquaculture production</u>

A. Tilapia

The specific composition of aquaculture production is not diversified because it essentially concerns four species: *Oreochromis niloticus, Chrysischtys nigrodigitatus* and catfish *(Heterobranchus longifilis and Clarias spp.).* Most of the production consists of tilapia, particularly *O. niloticus,* farmed in monoculture or polyculture and monosex male for inland aquaculture, and *Sarotherodon melanotheron heudelotii* and *O. aureus* strain *Manzala* for lagoon aquaculture. Tilapia contributes about 90% of the total production since 1998, despite the significant investments made by the public and private sectors in other fish species.

B. Catfish

The catfish *(C. nigrodigitatus* and *C. maurus)* is very popular with consumers and thereby has a very high value. Controlled breeding of this species had raised great hopes for the Ivorian aquaculture in 1986, but it has not kept its promises. Production fell from 300 T in 1994 (Hem and Numez Rodriguez, 1995) to 20 T in 2002, before almost disappeared in production structures, due to imperfect mastery of reproduction and slow growth of the Ivorian strain. These constraints result in low availability of fry and high production costs. As for the catfish *(Heterobranchus longifilis, H. isopterus* and *Clarias anguillaris, Cl gariepinus Parachanna obscura),* production has stagnated at around 10%, mainly because of cultural taboos that restrict consumption.

C. Algae and crustaceans

Spirulina *Arthrospira platensis* (*Oscillatoria platensis, Spirulina maxima* and *Spirulina platensis),* is currently produced in tank at a large scale by one unit. Finally, the development experiences of raising penaeid shrimp *(Penaeus duorarum, P.monodon, P. indicus, P. vannamei)* initiated in the 1980s, have not been successful in large-scale projects because of their shortfalls in design.

Plasticity of the technical SSFW-FF models

The growth momentum was interrupted by the military-political crisis that has affected Côte d'Ivoire since 2002. Production in Central, North and West regions have stopped because of the destruction of production facilities and massive population displacement during the war. Domestic production fell below the symbolic threshold of 1,000 T in 2003. The generalization of the crisis in 2011 and other phenomena, such as pollution of the lagoon waters, led to the closure of almost all operations including:

- out-of-town artisanal farms, semi-intensive (one cycle/year);
- Small and Medium Enterprises (SMEs) that had semi-intensive or intensive regular production[3] ;
- big farms with intensive production in lagoon in the region of Abidjan[4].

In contrast, and despite the war, the development of fish farming on a small scale continued independently and vigorously, particularly in the southern part of the country, thanks to the relay stakeholders (managers, builders of ponds, fish farmers) trained during the regional projects implementation. Figure 1 shows the establishment of fish farms in six regions[5].

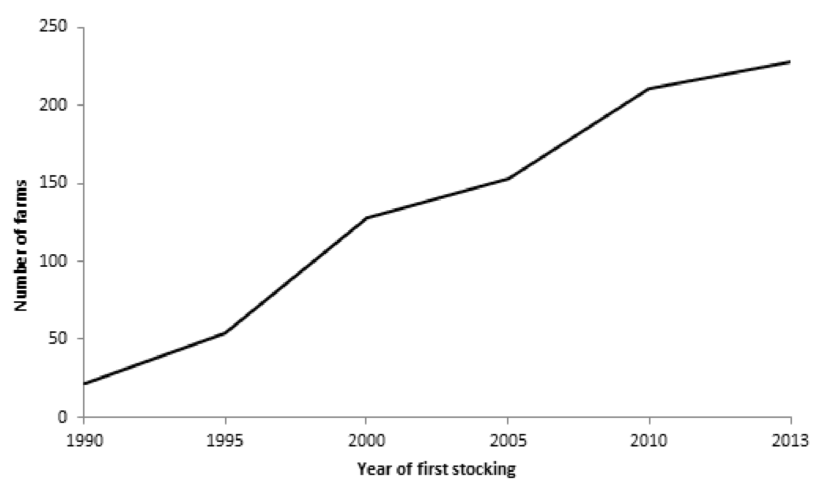

Figure 1. Pace of establishment of SSFW-FF in six regions.

[3] Farms in western ADB-West project, CAPMR of Brobo, etc.
[4] N'CARP, SOAP, CARPIVOIRE
[5] San Pedro (SE), Gagnoa (CO), Bouaké et Yamoussoukro (Centre), Abengourou (Est), Odienné et Touba (NO).

The appointed technical systems are naturally those who have been popularized by the regional projects: extensive to semi-intensive culture of monosex *O. niloticus*, with or without a predators *(Hemichromis fasciatus, Heterobranchus longifilis, H. isopterus)* or even *Clarias spp.* and *Heterotis niloticus* in earthen ponds. The production facilities consist of one or more dam ponds from 0.3 to more than 10 hectares, accompanied each by ponds from 400 to more than 1,000 sqm.

The ponds are used for breeding, rearing, the pre-fattening or growing, while ponds dam, closed in most cases, are used for both dams and pond culture. The fish are fed with rice flour, in addition to pond fertilization, and are harvested at an average weight of 350 g after a breeding (8 to 12 months) cycle. Yields are 0.5 to > 3 T/ha/cycle in ponds dam.

Table 2 below shows the standards and the expected performance of production systems in SSFW-FF popularized by the Midwest Fish Culture Project (PPCO).

Table 2: Standards and technical performance of the SSFW-FF

		Extensive	Semi-intensive
Fertilizer	kg of DM/are/day	0	0.3 to 1
Tilapia	Density (D)	< 0.2 p / m²	0.25 to 0.7 p / m²
	ADG (g/Day)	1.5 to 2	1 to 1.5
	Yield (T/ha /year)	**0.5 to 1**	**1-3**
Heterotis	Density	1/are	1 to 2/are
	ADG	5-15	5-20
	Yield (T/ha/year)	**0.2 to 0.5**	**0.5 to 1.5**
Catfish	Density		5-10/are
	ADG		2-3
	Yield (T/ha/year)		**0.5 to 1.0**
Predator	Density	At least one predator for 10 tilapia	

Technical standards and management systems applied by the SSFW-FF are finally those in the economic and institutional context of aquaculture development in Côte d'Ivoire, which correspond at best capabilities of small fish farmers, in terms of resources available and provide the best answers to the constraints of market factors and products.

In 2013, the national fish production is estimated at 4,500 T, obtained from 1300 farms with a total of 750 ha of water[6]. The contribution of small producers can now be estimated at 66.9% (or 3,010 T), against 24.3% (1,095 T) for intensive closed-loop production and 8.8% (395 T) for other large-scale production in earthen ponds and floating cages in freshwater.

Issues and problems on small-scale aquaculture development

Seed supply quality remains a major problem.

Regarding *O. niloticus,* only one intensive and large-scale production firm solved the problem by importing super male genotype YY broodstock, in order to avoid sexing work. Besides the high cost of production ($ 0.08 /fry), growth performance and the interest of no-sexing fry from spawning super males are not yet established for ponds, both for extensive or semi-intensive technical systems.

[6] Sources: National Association of Farmers in Côte d'Ivoire (ANAQUACI); not officially validated data.

Elsewhere, local strains of tilapia failed to grow to the size of 300 g after 6 months of culture using ordinary densities and rations. This issue was formally raised by fish farmers since 2007. The traditional reasons known to farmers (overcrowding in ponds, excessive sexing errors, precocity and prolificacy of the species) failed to explain the observed slow growth. In addition to that, another phenomenon was noted: the fall in the ratio of males to only 30 to 35%, implying low yields after sexing and therefore an increase in work time and fish stress related to this mandatory activity. In general, there seems to be a problem on genetic purity of biological materials, resulting in a degeneration or genetic regression of *O. niloticus* strains used throughout the country for more than 50 years.

For other species, such as catfish, reproduction cannot be done without often sophisticated artificial technologies – hormonal injection by qualified personnel, imported hormone, larval feeding with imported *Artemia salina* – resulting to higher total cost of production. The question arises even more difficult when it comes to terms to justify the creation of a hatchery or maintenance of such state units. Funding problems and operating budgets of such companies and their privatization in favor of the fish farmers have never been resolved. In the current state of technology, contexts of production and marketing of fish products, the fry from hatcheries can be accessed only if it is heavily subsidized. *C. nigrodigitatus,* for example, the on-station cost of getting the fry was estimated at US$0.2 in 1999, while the sale price to fish farmers was US$ 0.14.

For species which reproduction occurs naturally in the local farming conditions, the production of fry is hampered by the lack of organization of the sector. Attempts to specialize some farms in this activity have failed for three reasons, which are not yet rigorously evaluated:

- low profitability of activities ;
- high investment costs (oxygen, container, vehicle, etc.), poor organization of the orders that makes fry/fingerling price unacceptable to the client;
- propensity of fish farmers for self-supply as soon as their needs for establishing a broodstock are satisfied.

Fry of catfish *(H. isopterus* and *Parachanna obscura)* and Heterotis are still sometimes collected from the natural environment.

<u>Feed supply</u>

The evolution of the market and the availability of agro-industrial by-products (fish meal, rice bran, cottonseed meal, etc.) can be locally unfavorable for intensive and semi-intensive fish farming models when using composite feed 3A: 70% of rice bran, 20% cottonseed meal and 10% fish meal. Because of strong demand from other sectors, often better structured (including poultry and other livestock), even small-scale mills increased prices and tightened the conditions of assignment in the Midwest region, one of the area of large rice production. In 2013, rice bran prices increased to US$0.06/kg from US$0.04/kg in 2000 and US$0.032 /kg in 1996, and sometimes with an obligation to buy in cash with minimum quantity of one ton. Fish meal and cottonseed meal again became almost inaccessible since 1997.

Regarding industrial feed, import of certain raw materials such as wheat flour and vitamin increased production costs and sale prices[7]. Moreover, besides the random availability, these feeds can be of poor quality or simply unsuitable for cultured fish. Finally, for feeds import plan,

[7] USD 0.48 /kg for start pre-fattening and 0.62 USD /kg for finishing /growing out.

imported feeds become more and more competitive as local distribution entails additional cost incurred by the atomicity of fish farmers demand, coupled with difficulty in accessing certain areas for delivery or the disorganization of customers in forecasting their needs[8]. Responses from a SSFW-FF to these problems were of three types:

- buy the feed available in the market, then increase the selling price of harvested fish, therefore confronted with declining sales;
- produces the feed on farm in varied forms in the course of same cycle, depending on ingredient availability. The production timing is disturbed in this case by longer culture period;
- practice extensive culture system: lower density, longer cycles, family-run management. This is the case that became widespread.

Marketing constraints

For the vast majority of consumers, farmed fish and fish from lake of the same species are perfect substitutes and the market is globally competitive. Until 2002, the market structure was such that farmed fish are often sold to consumers of middle to higher incomes. The current market of fishery products is characterized by a growing deficit due to combined effects of continuing decline in supply from fisheries and the rapid increase in consumer demand. Given this trend, which is intensifying, the competitiveness of farmed fish is growing rapidly, due to its quality and improving availability on the market in terms of quantity and regularity of supply.

However, atomicity supply of SSFW-FF requires professional relays to provide primary collection and marketing. The positive development of aquaculture has naturally led capture fishers to become interested in the farmed fish industry. However, the board farm prices they offer to fish farmers do not allow them to increase their production taking into account the current situation of marketing factors.

The analysis of the structure of consumer prices indicates that the share that goes to the producer is only about 36-42% against 58-64% for fishmongers. In comparison, the combined share of wholesalers and retailers are only 48% of the consumer price of frozen tilapia imported heavily from China since 2002. The challenges of readjustment of the price structure for the fish farmers are very important. Indeed, the fish production could be doubled by an intensification to make two production cycles per year, if the fish farmers were receiving at least 50% of the price to the consumers.

For this purpose, fish farmers should strengthen their negotiation skills by acquiring both: i) professional organizations capable of providing primary collection of inputs and outputs; and ii) subsequent harvest storage equipment. Attempts in this field, since the implementation of regional projects for autonomous initiatives in the sector, gave no result so far. The solution could come from a single major player in the industry, capable of uniting all the supply and marketing of inputs and outputs for the benefit of all stakeholders.

Training and Research / Development

Over the years of promoting fish farming, the Government of Côte d'Ivoire has made significant efforts in research, education and extension that allowed the country to have a diversified national and quality expertise, and to be a reference point for fish farming in West Africa and Central Africa. Since the late 1990s, efforts were undertaken under the combined effects of

[8] Food is altered two to six months after the machining time.

military-political crisis and the government disengagement from extension activities. Skills and infrastructure acquired in the aquaculture projects are all in decline or are inadequate. Therefore, the creation of a national agency for aquaculture development and strengthening of national capacities, in all their components, are priorities for the post-crisis Côte d'Ivoire, facing the new challenges of aquaculture development.

Extension systems and its challenges

During the years 1970-2000, extension efforts in Côte d'Ivoire have been worn by a dense system of supervision that gave way later to a more flexible and less costly support and advice, empowering the beneficiary farmer for meaningful participation. In their evolution, these systems were designed for the promotion, implementation and the professionalization of SSWF-FF. Since the government disengagement from extension activities and the end of regional projects in 2002, there is no longer extension system in Côte d'Ivoire strictly speaking.

Fish farmers are being advised by a multiplicity of actors operating independently, with no coordination at all, for specific actions advisory support and training: administration officials for fisheries (Government fish Stations, PAGRH[9], etc.), research structures (CNRA[10] , CRO[11], AISA[12]), consulting firms and training mandated by the FDFP[13], support structures (ANADER[14]), national and international NGOs, national parks and reserves, and individual services sellers (Liberian refugees, former agents and former managers of regional projects, independent consultants). There is little information on the quality and results of these isolated initiatives that are also, to this day, the only recourse for entrepreneurs in aquaculture in all categories. Benefits being paid in most cases, the situation is a reflection of a social demand for extension, far from satisfied.

The challenges in this area are to regulate and coordinate all interventions. The establishment of formal regulation and the creation of an agency for aquaculture development will permit to meet these challenges by streamlining support/advice and extension systems and valuing all resources.

Good practices and successful cases in SSFW-FF extension

Among the different approaches implemented for extension, that of the Midwest Fish Culture Project (PPCO; 1996-2000) was the most successful. This success is still reflected to this day by the autonomous dynamic model of rural aquaculture that expanded across the country.

The strategy of this regional project was to only involve interested fish farmer volunteers, identified at the level of a home called "training group". The home is a place with at least three candidates. In this context, candidates for fish farming are aware of the value of lifelong learning, the interest to initiate their professional organization from a core structuring, and increase the efficiency of advisory support service. The structure of the core aims for candidate’s profit, to reduce the cost of construction, supply and marketing through the establishment of effective local services: transfer of knowledge; picketing and building production facilities (ponds and dams); joint purchase of construction materials (wheelbarrow, mussels and other works of monks drain), of fish equipment (nets); production and sales of fingerlings from fish farms or homes.

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[9] Support Program for the Sustainable Management of Fisheries Resources
[10] National Agricultural Research Center
[11] Oceanographic Research Center
[12] Ivorian Association of Agricultural Sciences
[13] Development Fund and Vocational Training
[14] National Support Agency for Rural Development

As can be seen, the approach is not only limited to the technical aspects of the activity; it also includes all the constraints and socio-economic potential of the industrial environment, starting from the first contacts with prospective fish farmers. Through a participatory approach, fish farmers are prepared for their future roles: to support eventual autonomous operation of the industry in a technical, economic and institutional controlled environment. The specialization of actors on different farming activities (ponds construction planners, builders of ponds, feeds and fry suppliers, training and sharing of technical knowledge, etc.) gradually emerges according to the needs.

The results of PPCO project was very positive, and still the basis for the expansion of the SSFW-FF for the entire national territory up to the present time.

- **In terms of the extension approach**: the Pilot Project PPCO has developed and validated a support board approach and is based on the principles of local development, but it is adapted to the specific requirements of fish farming, rather up close conventional management systems (see Annex D).
- **On the technical side**: the Pilot Project PPCO has demonstrated the feasibility and the interest of rural fish farming system. It developed and popularized an alternative production system adapted to conditions in rural areas; the model is made at least of a pond dam (for water retention and grow-out ponds) and two ponds service (for breeding and rearing). Both facilities are used extensively or semi-intensively, with a high degree of autonomy. This model is a successful model to face out-of-town semi-intensive small ponds; the "small pond" model is inaccessible for rural populations because of its operating constraints: firm dependency vis-a-vis specialized players and consequently requiring an efficient work environment.
- **In terms of methodology**: the Pilot Project PPCO has established a business environment run by local relays[15]; these relays are able to capture and disseminate technologies of good quality. Synergies between the different stakeholders and their activities[16] are identified and encouraged in the value chain to stimulate and maintain the dynamics of the production focus zone.

The results of the Pilot Project PPCO have been the subject of some criticism. They are summarized in Annex E.

Conclusion

The model of rural fish farming in earthen ponds, extensive to semi-intensive, developed and popularized by the PPCO project is an undeniable success for promotion of fish farming activities; it is the basis of dynamic and autonomous development of the SSFW-FF in Côte d'Ivoire.

This development, mainly driven by the relay stakeholders (pond construction planners, builders of ponds, fish farmers) trained and made operational by regional projects can be amplified. In addition, the SSFW-FF can increase its contribution (now at 67%) to national fish production, if the constraints related to the low quality of inputs (seed and feed) and less controlled marketing conditions are lifted. This situation will definitely lead in doubling the current production, considering all other things equal and if the capacity of the value chain are enhanced by adopting both: i) professional organizations capable of providing the primary collection of inputs and outputs; and ii) of subsequent harvest storage equipment.

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[15] Fish ponds Planners, jobbers, net and molds makers, oxygen suppliers, etc

[16] Exchange of knowledge, arbitration of disputes, Production, sexing and selling fry, organized fish marketing, price fixing, reception and installation of candidates fish farmers, etc..

Finally, the establishment of formal regulation and the creation of an agency for aquaculture development will meet the many challenges in streamlining support and advice and extension systems and valuing all resources.

SMALL-SCALE FRESHWATER AQUACULTURE EXTENSION DEVELOPMENT IN INDONESIA

Maskur MASKUR[1], Rina RINA[2], Mimid Abdul HAMID[3]
[1]Director of Fish Health and Environment, Directorate General of Aquaculture, Jakarta, Indonesia
[2]Director of Center for Fisheries and Aquaculture Extension, AMFHRD
[3]Head of Jambi Freshwater Aquaculture Developmet Center, Directorate General of Aquaculture

Indonesia is a large country, with high population estimated at 236.331 million people in 2011. Fisheries sector in 2011 produced 13.6 million tons, consisting of 5.7 million tons from capture fisheries and 7.9 million tons from aquaculture (Fisheries and Aquaculture statistic book, 2013). Fish consumption reached 31 kg/cap/year in 2011, so aquaculture subsector has a good opportunity for domestic and export market. Indeed aquaculture is becoming a very important activity in order to generate job and income and provide nutritious food for the people.

Aquaculture production achieved 9.67 million tons in 2012 (Aquaculture Statistic Book, 2013), consisting of 10 major commodities which are seaweed, tilapia, milkfish, shrimp, catfish (African catfish), common carp, gouramy, pangasius, sea bass and others. This production was dominated by seaweed, followed by tilapia, milkfish, and catfish. Since 2010 aquaculture production topped the production from capture fisheries. Aquaculture in Indonesia is becoming a leading sector of fisheries production for providing aquatic protein food, generating income, creating jobs and improving livelihood.

Freshwater aquaculture production in Indonesia has significant contribution to the total aquaculture production. In 2012 freshwater aquaculture production was 2.15 million tons or 68% of the total aquaculture production of 3.16 million tons (excluding seaweed). This production came from pond culture, floating net, floating cage, and rice field culture. The fish production is dominated by pond culture (1.43 million tons), followed by floating net (455 thousand tons), floating cage culture (178 thousand tons) and rice field (81 818 tons). The major commodities cultured are common carp, tilpia, pangasius, giant gouramy, African catfish, java carp, and freshwater prawn. Criteria for business scale on aquaculture sector have been stipulated by the Ministry Decree no 05 series of 2009. Because of insufficient data, it is very difficult to calculate the accurate number of small-scale farmers. However, by using total areas calculation approach for the fish farmers ownership and neglecting the capital, the number of small-scale fish farmers can be estimated. In the Ministry Regulation, for micro and small scale ownership is defined as those farms with less than 1000 m2 (pond culture), less than 30 unit (cage culture), less than 2 unit (floating net), and less than 2 ha (rice field). So freshwater aquaculture fish farmers in Indonesia are mostly grouped into micro and small-scale level (estimated > 90%).

Small-scale freshwater aquaculture extension is very important to assist the fish farmers in the region in order to produce more fish in good quality, get more income and improve their life. However, the number of extension officer is very limited with 4,800 government officers and 5,500 voluntary officers. Meanwhile, to support extension activities covering the 33 Provinces, a total of 15 500 officers are needed. There are three types of extension methods which have been developed: 1) Individual method, 2) Group method, and 3) Mass method. Among these three methods, the individual method and the group method are commonly implemented for small-scale aquaculture, while the mass method is mostly implemented for large-scale aquaculture.

Success story for small-scale freshwater aquaculture extension has been seen under the JICA Project in Jambi Province, Sumatra Island during the 2000-2007. JICA collaborated with Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries in the form of Project Type Technical Cooperation (PTTC). The PTTC project located at Jambi Freshwater Aquaculture Development Center initially implemented from 2000 to 2005, was extended for two years up to 2007. The aim of the project was to develop freshwater aquaculture in Jambi Province and Sumatra Island. The outputs of the project were: 1) High quality broodstock (common carp, tilapia, and pangasius) was produced; 2) Quality of seed (common carp, tilapia, and pangasius) was improved; 3) Effective extension model area was established; and 4) Technology for indigenous species was developed.

Three extension model areas were developed, namely: Padang Jaya District, Bengkulu Province; Muara Bungo District, Jambi Province; and Kuantan Singing District, Riau Province. Pond and floating cage culture management and high quality broodstock were disseminated to the fish farmers in the three model areas. Training on freshwater aquaculture to improve their knowledge and skill was carried out for fish farmers in the Jambi Centre. During the project period, freshwater aquaculture developed very well and successfully. The eight new areas of freshwater aquaculture were then developed: 2 Districts (MuaroJmbi and Kota Jambi Districts) in Jambi Province; 2 Districts (Musi Rawas and Banyuasin) in South Sumatera; 2 Districts (Blume and Seginem) in Bengkulu Province; 1 District (Kampar) in Riau Province; and 1 District (Sawahlunto Sijunjung) in West Sumatera.

Minarti et al. (2006) reported that income of fish farmers from 5 Districts (Bungo, BatangHari, North Bengkulu, Kuantan Singingi, and Sawahlunto Sijunjung) increased significantly and the aquaculture activities contributed more to their main income, compared to the situation before the JICA project activities where the income of fish farmers was less than IDR 500,000 (80%) and less than IDR 1,000,000 (20%). Small-scale freshwater aquaculture extension development by means of proper concept, approach, methodology, and implementation based on uniqueness, characteristic of fish farmers and availability of resources could successfully increase their income, create job, and improve their livelihood of small scale fish farmer.

AQUACULTURE DEVELOPMENT IN MALAWI

Hastings ZIDANA
Fisheries Department, National AquacultureCenter
Box 44, Domasi, Malawi

Fisheries resources play a very important role in Malawi's national economy, in terms of food and nutritional security of the population. It contributes about 60-70% of annual animal protein supply of the nation. In fact, fish is the readily available source of animal proteins consumed in small amounts among Malawian daily meals, thereby nutritionally supplementing essential amino acids in their diet. Fisheries sector provides source of employment to over 300,000 people through fishing and its associated activities. The sector contributes about 4% to the nation's Gross Domestic Product (GDP) with a beach value of about US$15 million on an annual basis. In addition, fisheries resources provide a source of livelihood to about 1 million people (about 10% of nation's population) in the lakeshore districts.

Although the first introductions of rainbow trout (*Onchorhynchus mykiss*) into the cold water of the Mulunguzi Stream on the Zomba Plateau took place in 1906, colonial Nyasaland received relatively little development on aquaculture during the first half of the 20th century. Indeed, throughout Malawi's history, the majority of fish consumed has come from capture fisheries, and even prior to the arrival of colonialism, there are records of some inland communities maintaining close trading relationships with lakeshore communities to exchange staple foods and labour for fish. The main species currently farmed in both small-holder and commercial aquaculture operations in Malawi are the three tilapia species - *Tilapia rendalli*, *Oreochromis shiranus*, *O. karongae* - and the catfish *Clarias gariepinus*. The three tilapia species account for 93% of the production, catfish for 5%, and exotic species such as common carp, black bass (*Micropterus* sp.) and trout 2%. Extension services have promoted a fingerling stocking density of 2-3 fish per m^2 to accommodate the inferior nutritional content of the commonly used farm by-products in Malawi, principally maize bran and green manure. In 2002, NAC estimated total aquaculture activity in the country to produce 800 T of fish, with varying yields, depending on the level of intensification, from around 500 kg/ha/year to 2,316 kg/ha/year. The most recent government statistics report the existence of 7,000-8,000 fishponds covering an estimated total area of 208 ha.

STATUS AND PROSPECTS OF SMALL -SCALE FRESHWATER AQUACULTURE IN NEPAL

Jay Dev BISTA
Senior Scientist, Nepal Agricultural Research Council (NARC), Fisheries Research Centre
Pokhara, Kaski, Nepal

Introduction

Modern aquaculture practices in Nepal started around the 1950s (Rajbanshi, 1979). Since then, aquaculture has contributed about 1% of the Gross Domestic Product (GDP) in the country. The national average production from pond aquaculture is about 3.6 million tons/ha (DoFD, 2007) however, the range of fish production varies from about few hundred kilograms to 7.0 million tons/hectare depending upon different farming and management system.

In general, the aquatic habitats and fish species can be viewed as prospects for fisheries and aquaculture development in the country. This also implies that aquatic resources located at different altitude and climatic zones can offer potential for different fisheries and aquaculture activities in Nepal.

The major economic activities of the country heavily depended on agriculture. Since last so many years, the country has been ranked as one of the poorest in the world due to increasing population, inadequate and irrational improvement in agricultural technology and other infrastructures. Recently, among the most prioritized agricultural sector of GoN, aquaculture sector has been considered as one of the potential areas through which substantial improvements in the income of farmers are expected. Fish culture has a short history in Nepal, while capture fishery in rivers, lakes, reservoirs, wet lands and flood plain has been practiced for long. Fisheries is a small but important subsector of agriculture contributing about 2.61 % of agricultural gross domestic product (AGDP) which amount to nearly 1.0 % of the national GDP (DoFD, 2005).

Despite its auspicious character and significant dietary contribution, the per capita consumption of fish is rather low. The per capita animal protein consumption in Nepal was 1.97 kg/year in 2010/11 (DoFD, 2011) and fish contributed only about 10.0 %. Fisheries development represents a largely untapped resource in Nepal and there is ample opportunity with regard to land areas for increased production by improved technology and management. Therefore, to improve the agricultural productivity, the Fisheries Prospective Plan of Nepal (FPP/N) has envisioned the national fish production to reach 75,000 T by 2015, from the 56,000 T in year 2011/12.

Aquatic natural resources

Being landlocked, Nepal is deprived of any oceanic resources and overwhelmed by mountains, which comprise about 83% of the total area of 147,181 km^2. Approximately, 5% of the total area of the country is known to be occupied by different freshwater aquatic habitats (Bhandari, 1992) where some 230 fish species are reported to thrive (Rajbanshi, 2012).

The economic development of the country depends on careful utilization of natural resources and water resources is the most natural resource of the country. Nepal is the second richest country in the world possessing about 2.27% of the world water resources (CBS, 2003). Altogether 6000 rivers including rivulets and tributaries flow in the country making about 45,000 kms length Koshi, Gandaki and Karnali are the main river systems, which play major part for supplying water from snow, glaciers and small tributaries and fish species are diversified richly in the river systems. Rivers in Nepal cover an estimated area of 395,000 hectare. Similarly, a number of small to medium sized lakes in various parts of the country cover 5,000 hectare and about 1,500 hectare of small reservoirs have been constructed in the country.

Table 1. Estimated water surface area in Nepal (Country profile-Nepal 2010/2011)

Resource details	Estimated Area (ha)	Percent coverage (%)	Potential area (ha)
Natural water	401,500	49.0	-
Rivers	395,000	48.21	-
Lakes	5,000	0.61	-
Reservoirs	1,500	0.012	78,000
Village ponds	7,300	0.89	14,000
Marginal swamps	12,500	1.52	-
Irrigated rice fields	398,000	48.57	-
Total	**819,300**	**100**	**92,000**

There is a considerable amount of surface area present in village ponds (6,000 ha) and irrigated paddy field covering about 398,000 ha. Furthermore, growth in hydroelectric and irrigation project would add more water surface area in the future. It is estimated that about 4-5% of the irrigated area in Terai region are low lying, generally unsuitable for agricultural crops cultivation, but can suitably be developed into fish ponds (NFC, 1994). The existing water resources of the country and their future potential reveal that there is tremendous scope for expansion and intensification of fish production in the country.

Table 2. Estimated fish production in Nepal (Country profile-Nepal 2011/2012)

S.N.	Aquaculture/fisheries practices	Area (ha)	Production (mt.)
1	Ponds fish culture	6735	31649
2	Gholes and swaps	1670	2096
3	Rice-fish culture	300	135
4	Cage fish culture	80,000 m^3	480
5	Enclosure culture	100	140
6	Capture fisheries	Open water	21,500
	Total		56000

Fish resources of Nepal

A total of 230 indigenous fish species are distributed in the different water bodies of Nepal (Rajbanshi, 2012). Indigenous fish with potential for mass production under commercial conditions may be categorized into cold water fish of the high hill region and warm water fish of the Terai.

Asla (*Shizothorax progastomus* and *S. richardsoni*), Sahar (*Tor putitora* and *T. tor*) and Katle (*Neolissochielus hexagonolepis*) have been identified as high value fish and common in the high hill water bodies that need to be conserved. The indigenous fish in the warm water regions of the country are more numerous. Three warm water fish species (*Labeo rohita*, *Cirrhinus mrigala* and *Catla catla*) from the region popular for commercial cultivation have been evaluated. Fish species belong to families Siluridae, Ophiocephalidae and Heteropnestidae have the potential to be included in the list of cultivable species. Besides the air breathing fish, there are number of other varieties of indigenous fish (*Mystus oar*, *Wallago attu* and *Ompak bimaculatus*) if produced in a large scale that may be greater economic benefits derived from aquaculture.

Altogether 12 exotic fish species including crustacean (freshwater prawn) and tilapia have been introduced for culture and some of them are under research in the country. These includes three species of Chinese carps (*Hypophthalmichthys molitrix*, *Aristichthys nobilis* and *Ctenopharyngodon idella*), two species of tilapia (*Oreochromis niloticus* and *O. mossambicus*), three strains of common carp (German, Israeli and Yugoslavian), three species of salmonid (*Oncorhynchus nerka*, *O. mykiss* and *Salmo salar*) and one species of each of the African catfish (*Clarias gariepinus*), silver barb (*Puntius gonionotus*) and freshwater prawn (*Macrobrachium rosenbergii*). These are some of the most popular cultivable fish species found in fresh water fish culture enterprises in most of the countries. .

Small-scale aquaculture practices in Nepal

Presently seven species of commercially valuable carps are being cultured in Nepal. Major aquaculture systems adopted are carp polyculture in ponds, lakes and enclosures. Cage culture of herbivorous carp species and common carp in rice-fish culture are common practices. A change from extensive systems to semi-intensive/intensive-farming methods is currently practiced in aquaculture system in the country. At present, technology of subsistence carp farming in ponds has been widely disseminated in the southern part of the country because warm climatic conditions in these areas.

In the 1960s, trout was introduced in the country but failed due to inadequate technical knowhow, but later in 1989, rainbow trout (*O. mykiss*) was reintroduced from Japan. After several years of study, a complete technology for breeding, culture as well as feed preparation has been developed successfully and the farming practices are slowly disseminated among the farmers in the hilly region. JICA Nepal supported for breeding activity to establish the self-sustain seed production facilities for rainbow trout farming in Nuwakot. Inspite of having enormous potential, the fish production has not been enhanced due to non-utilization and adoption of the techniques.

By tradition, Nepalese society has distinctly identified ethnic communities for fishing, which, entirely depend upon fishing and water related occupations such as boating and fishing net mending as a family profession. However, with few exceptions, such traditional occupations are not financially rewarding enough for sustaining a family. There are 17 ethnic communities involved in traditional fishing. Among which, prominent groups are Pode or Jalari, Suneha, Mallah, Bote or Majhis, Mushahar, Mukhiya, Danuwars, Darai, Kumal and Tharu. They live in villages near the water resource. All communities in the country accept fish as delicious food and considered auspicious among many communities.

Present status of small-scale aquaculture in Nepal

Nepal represents most of the climatic conditions of the world - from tropics to alpine within a narrow range – providing opportunities to develop different forms of small-scale aquaculture. Nepalese aquaculture is predominantly small-scale, which is mostly family-owned and managed by family.

The majority of rural farmers of Nepal are small land holders and subsistence in nature. Increasing food and nutrition security, augmenting cash income for household expenses, and utilization of family labor are the major issues of the rural poor. The role of small-scale aquaculture in household food and nutrition security, income generation and empowerment of women and marginalized communities has been increasingly appreciated in recent years.

Small-scale cage fish farming

In Nepal cage fish farming was introduced in 1972 by JOCV using floating cages in Phewa lake of Pokhara Valley. During 1975, Integrated Fishery & Fish Culture Project assisted by UNDP/FAO successfully demonstrated cage fish culture in the Lakes of Pokhara valley. In 1980, FAO through Australian FFHC (Food for Hunger Campaign) further assisted cage fish culture program in Pokhara. The target group was an ethnic deprived, landless and so-called untouchable community known as Jalari or Pode living around lakes in Pokhara valley, which was entirely dependent on capture fishery. Due to the unavailability of fish seed cage fish culture activities were lacking behind. Therefore, in 1991 JICA donated a Natural Water Fisheries Development Project (NWFDP) to develop the model farm with complete set of facilities for fish seed production, research and support services. During this period (1991-98) JICA assisted to strengthen fish seed supply and granted cage materials in Pokhara valley and human resources development in fisheries research in Nepal. Letter on cage fish farming technology was disseminated in Kulekhani reservoir.

Cage fish culture in Nepal is of extensive type where fish are fed on naturally available plankton and no supplementary feed is supplied. In such system, fish are stocked in low densities. Mainly two species of carps are popular for cage culture: bighead carp (*A. nobilis*) and silver carp (*H. molitrix*). Occasionally, other species are also stocked with bighead carp and silver carp such as rohu (*L. rohita*) as a biological cleaning agent of fouling in cages. Recently, cage fish culture with grass carp (*C. idella*) in macrophyte dominated area of Phewa Lake has become a promising enterprise among its fisher community and yielded 1-1.5 times more production than planktivore species. An initial trial of growing rainbow trout in cages in lakes and reservoirs has been started in Nepal. Studies have shown that trout farming in lakes and reservoirs of the mid-hills in winter could be one of the alternative opportunities for cage farmers to increase their income.

Cage fish culture has been substantial to improve women empowerment. Women of Jalari and displaced community actively take part in all activities concerning to cage fish culture from attending meeting, workshop to fingerling transportation, fish stocking, boating, harvesting and marketing aspects. This provide alternative livelihood to nearly 45% families of displaced communities in Kulekhani reservoir. Contribute about 75% of the annual income of Jalari community of Pokhara. With the adoption of cage aquaculture the living standard of Jalari community has improved considerably over past three decades.

The cage fish culture initiated in lakes of Pokhara is one of the most successful activities. Following this, it was later developed in Kulekhani focusing on the resettlement of the displaced community during the construction of the Kulekhani hydropower reservoir. The cage fish culture developed in Pokhara and Kulekhani is one of the most successful practices in alleviating poverty (Table 3).

Table 3. Present status of private sector cage fish culture in Lakes of Pokhara valley and Kulekhani Reservoir, 2008.

Location	No. of farmer	No. of cages	Volume (m^3)	Production (mt)
Phewa lake	120	700	24000	103.2
Begnas lake	37	120	6000	19.2
Rupa lake	53	117	5850	14.0
Reservoir	239	1630	81500	114.2
Total	419	2467	117350	250.6

<u>Pond aquaculture (Carp polyculture)</u>

Presently seven species of commercially valuable carps are being cultured in Nepal mostly using polyculture in ponds, lakes and enclosures. A change from extensive systems to semi-intensive/intensive farming systems is currently practiced. Technology of subsistence carp farming in ponds has been widely disseminated in the southern part of the country because of warm climatic conditions in these areas.

Over the years, aquaculture has developed as one of the fastest growing food production sectors in Nepal. However, local fish supplies have been extremely inadequate to meet the ever increasing demand in the country. Nepal imports substantial quantities of fish and fish products from India, Bangladesh, Thailand, and elsewhere. Integration of pond aquaculture in existing crop-livestock-based farming system is believed to be effective in increasing local fish supply and diversifying livelihood options of a large number of small-holder farmers in southern plains and mid-hill valleys, thereby also increasing resilience of rural livelihoods. There is growing appreciation of the role of small-scale aquaculture in household food and nutrition security, income generation, and empowerment of women and marginalized communities.

<u>Homestead catfish culture</u>

Similarly, African catfish farming rapidly expanded in recent years mainly because it can be cultured in small ditches and even in dirty water with high density. Since it could be cultivated in "nano-pond" to support the livelihood of "ultra poor" communities, farming of this fish has been extensively promoted in various hilly districts on farmers-to-farmers basis. However, its further expansion is questionable. As it is carnivorous in nature, it can be a big threat to local indigenous species and farmers face feeding problem as well. Some are using chicken and livestock viscera, while others are struggling to collect snails, tadpoles and other aquatic organisms from the wild. The government has not given priority to this fish because of possible impact on ecology.

Tilapia fish culture

Nile tilapia (*O. niloticus*) was introduced in Nepal around 1985. However, it has not been promoted adequately fearing that this species also affects natural habitats of indigenous species and compete for food. Biodiversity and environmental concerns have presently received overriding attention compared to the rampant malnutrition and food insecurity. Although this is a never-ending debate, in a country where the majority of people are suffering from malnutrition and low income, biodiversity conservation and environmental issues should get low priority (Stewart and Bhujel, 2007).

Besides, the cultivation of tilapia and African catfish, striped catfish (*Pangasius hypophthalmus*) from the southern tropics to the mid-hills is also increasing.

Integrated small-scale rice-fish culture

Integrated fish farming with rice, livestock and horticulture is commonly practiced by small-scale farmers. The basic advantage of integrated farming systems is that through the application of the waste products from one system as supplementary feed to boost the production in another system, as in the application of vegetable waste as feed in a fish pond. A major socio-economic benefit of integrated fish farming is that inputs to the various sub-systems, which comprise the farming system, tend to come from within the farm. Moreover, fish efficiently convert low-grade feed into high quality animal protein and can be kept alive on sustenance diets. Through integrated farming systems, high-value and nutritious source of food can be obtained with a minimum effort and external inputs.

Fish culture in the rice fields has been reported in various parts of the country but with little success. It requires at least one year of culture cycle, whereas rice is harvested in 3-4 months. Various reports have shown that nursing of fingerlings is more suitable for this short period. Another option is to culture fast- growing fish such as tilapia. Social factors affecting rice farming are overlooked by many organizations. Use of insecticide and pesticide in rice-field is a common problem which could be overcome by adopting integrated peat management (IPM) technique. Poaching is another unavoidable problem if fish are stocked in the fields that are far away from home. Therefore, rice-fish farming in group approach might be suitable for fish farming.

Fish farming in seasonal water bodies

Gholes/swamps are shallow seasonal water-logged areas in marginal lowlands, grossly overlooked for their utility. The area of gholes in Nepal is estimated to be about 12,700 ha, which constitutes about 1.6% of the total water area. There is a great prospect of fish production in gholes. The overall utility of the fisheries sector is to support food security, enhance livelihood opportunities, and conserve and manage natural resources to achieve the goal of sustainable national development. One of the national policy objectives is to develop extensive natural productivity-based carp polyculture techniques in gholes through mobilization of local communities for increased fish production and livelihood improvement. Currently, about 1,612 ha of gholes have been utilized for fish culture and the average yield is reported to be 1.3 T/ha.

Livelihood based open water fisheries

The freshwater fisheries are widely scattered and artisanal in Nepal. Natural water provides hunting ground for human since the early age. Present livelihood activities in these bodies are:

fisheries, aquaculture, eco-tourism/nature tourism, recreations, swimming, boating, yachting and transport. Among them, traditional fishing is prominent and conventional gears are used for subsistence production.

The rivers and few natural water bodies have not yet been managed in such a way and mostly remain a "free-for-all". The Lakes of Pokhara valley have been using cultivable carp to increase production, as strategies to reduce the fishing pressure on low populated native species without losing the fisher's employment and income generation.

As a consequence of ongoing practices, fisheries yield per hectare is relatively low but important for local rural communities. In view of the significant dietary, socio-cultural and economic contribution of native fisheries in localized rural communities, there is need for a long-term research and development strategy for managing the natural water resources of the country.
In Nepal, it has been estimated that about 85500 peoples are engaged in aquaculture activities and about 425,000 people have been estimated to be actively involved in fisheries management (DoFD, 2008). The total number of direct and indirect beneficiaries of the fishery sector is 728000 (3.1% of total population).

<u>Ornamental fish keeping</u>
Decorative fish keeping is becoming popular as an easy and stress reliving hobby in the world. Today fascinating houses, offices, hotel, restaurants, hospital etc. are decorated with ornamental fish worldwide because they provide hours of joy, entertainment and mental healing. From religious point of view fish keeping in houses is considered a symbol of good luck. From medicinal aspect it is believed that daily observation of different types of color fish help to slow down blood pressure, headache and other types of tension. Decorative fishery has gained popularity among the people of all classes in Nepal. Decorative fish enterprising in the country initiated with the establishment of the first aquarium shop during 1973 and in recent years ornamental shops increased to over 40 in major urban areas. Survey revealed that about 39 genera of exotic decorative fishes are commonly used in aquarium industry of the country. It has been estimated that about more than 25 million rupees are spent annually to import aquarium fish seed, feed, aquatic plant, medicines and other electronics accessories. Inadequate technological package for the production of ornamental fish including native species in the country has been the major problem constraining the promotion of aquarium fish industry in the country. Visualizing the demand for ornamental fishery, Nepal Agricultural Research Council (NARC) has placed concerted efforts on the development of breeding and aquarium fish management technology of several exotic species. Successful breeding and rearing of Fancy carp (Koi carp), Platy, Sward tail, Guppy, Moli and Gold fish have been encouraging for aquarium entrepreneurs to adopt the technologies and extend the industry. Research efforts are also being placed on identification native fish species having ornamental characters and their and domestication for enhancing decorative fish diversity and for the sustainability of aquarium industry. Identification of more than 40 genera of native fish suitable as decorative fish could support the increasing demand for pet fish with the rapid growth of urbanization, if the technology package of ornamental fish is delivered in private sector through establishment of hatchery, enhancing capacity of farmers and promotion of market value chain.

<u>Cold water small-scale aquaculture</u>
Promotion of indigenous fish species has been one of the main agenda of the government. Basic principle is that indigenous species are assumed to have had better adaptation to local environment. Breeding programs for three of such species - sahar (*T. putitora*), gardi (*Labeo dero*)

and asala (*Shizothorax* sp.) - have been carried out. Although they are highly preferred fish, their slow growth hinders farmers to adopt them for commercial purpose.

<u>Rainbow trout Raceway culture</u>

Rainbow trout is one of the world's renounced fish for commercial cultivation in cold water regions (Rai et al., 2005). Considering its popularity and importance for the prosperous aquaculture development in the hills, NARC had initiated research on this species. Earlier studies have shown that Rainbow trout is now successfully grown in hill and mountain terraces of Nepal using cold and clean stream waters. Recently, Government of Nepal has given priority to expand in mid hill. JICA Nepal supported to private farms for breeding facilities to make self-sustainable seed production in mid hill. Trout culture in private sector started since 1998, now there are 85 private farms in 16 districts covering an area of 13161 m^2 producing about 180 T trout in 2012 (Fig. 1). Mostly the trout raceways are constructed in sloppy land where in general other agricultural crops are not grown. Besides, that fallow land close to rivers and streams banks is also useful for raceways construction for trout production. But, care should be taken to that flood and landslides would not harm fish farm.

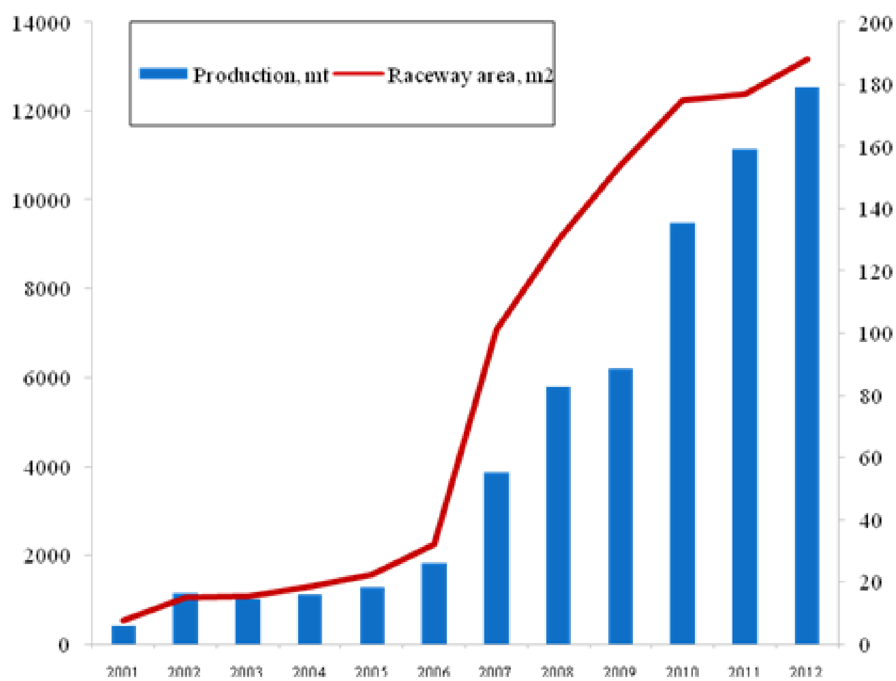

Figure 1: Raceway area and trout production.

At present the raceways are constructed by cement structures due to available landscape for trout cultivation. This has increased the capital cost investment in trout farming. Further research is needed to find out cheaper ways for trout farm infrastructure development to reduce the capital cost in trout farming in Nepal Himalaya. Rainbow trout can be cultivated in earthen ponds; however, the only requirement of water flow should be maintained. Major parts of Nepal are hills and mountains therefore it is expected that the rainbow trout farming technology would be further expanded in other areas soon.

Extension policy for Small-scale aquaculture in Nepal

Based on local feasibility, comparative advantage, and specific opportunities, suitable technologies will be developed, scaled up and extended to increase fish production and productivity. In addition, commercialization and diversification of aquaculture production will be promoted for income and employment opportunities.

The unproductive land for other crops in hills will be used for increasing fish production through developing cold water aquaculture technologies. In the mid and high hills, high-valued fish production will be prioritized. Based on the local need, specific fisheries programs will be implemented and subsidized. For the extension of food and nutritional technologies, farmers' group will also be mobilized, through government extension services and Institute for Agriculture and Animal Science. Similarly, for effective fisheries extension, media will be used to provide information services to the stakeholders.

Fisheries and aquaculture research that is compatible to specific location will be promoted through competitive grant system. National and international collaboration on fisheries research and extension will be promoted through exchange of technologies and experts. International and private investment will be encouraged to enhance fisheries and aquaculture sub-sector. Supply of the main production material such as fingerlings will be monitored and guaranteed. Bank loan will be made available for the promotion of aquaculture. An insurance system for commercial aquaculture development will be promoted. For capability enhancement of the farmers, various training programs will be organized.

For sustainable human resource development, agricultural university will produce specialized human resources in the country. There will also be a provision of expert exchange among academic institutions, research and extension related institutions. Women's participation in all sectors will be encouraged. Common water bodies, such as community ponds, lakes, rivers, reservoirs and swamps, will be leased for fisheries and aquaculture activities to the deprived, marginalized and poor.

Various institutions, such as academic and research organizations, government line agencies, civil society organizations and private sector, should coordinate and collaborate for small-scale fish farming, extension and marketing in Nepal.

Institution involved in aquaculture research and extension in Nepal

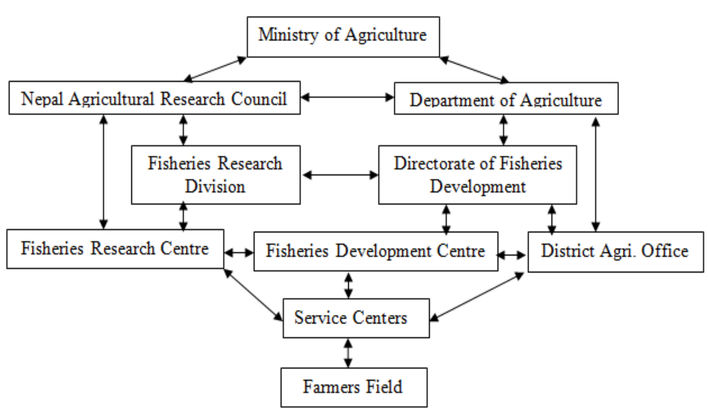

Figure 2: Diagrammatic presentation of Fisheries/Aquaculture R&D linkages among organizations

A. Education sector

Government as well as private academic institutions are directly and indirectly involved in fisheries research and extension activities in the country. Fisheries Department of Tribhuvan University is working for education and scientific research. Nepal Academy for Science and Technology (NAST) has well facilitated laboratory and highly qualified human resources for high tech-scientific research and provide small grant for specific research activities in and abroad. Similarly some griculture and science universities are also supporting for research and extension in the country.

B. Research sector

Fisheries and aquaculture research was prioritized in the early 1990s, as a result of which, NARC - an autonomous public institution - was mandated to conduct fisheries and aquaculture research. NARC focuses on capture fisheries and conservation aspects due to the lack of facilities; while JICA supported a Natural Water Fisheries Development Project (NWFDP) in 1991-1998 that focus more on culture-based, applied and productivity related. NARC has three fisheries research institutions and working in the specific field: Fisheries Research Center Pokhara for lake and reservoir fisheries; Fisheries Research Center Trishuli on riverine fish species; and Fisheries Research Division Godawari on cold water fisheries.

C. Development sector

The Directorate of Fisheries Development (DoFD) under Department of Agriculture, Ministry of Agriculture and Cooperatives is an apex body, responsible for fisheries and aquaculture extension-related policy and implementation. It also coordinates with national and international institutions with focus on fisheries extension. There are some specific institutions such as National Inland and Aquaculture Development Program, Central Fish Laboratory, Fisheries Development and Training Center, Fisheries Development Centers situated in different districts and District Agriculture Development Offices under the supervision of Directorate which are responsible for fisheries and aquaculture extension in respective areas.

Challenges of fisheries extension

There are several challenges in promoting small-scale aquaculture in Nepal. The major challenge include identification of potential small-scale fishery areas, interested communities, technical feasibility of farming system in different areas, technical knowledge on fish farming and resource availability, local resource mobilization, increasing production and productivity, and marketing system.

Making use of the abundant water resources in Nepal, which would go wasted otherwise, is another challenges to produce nutritional food for the household consumption and also generate income by selling the surplus. Collaborative efforts among the communities, NGOs, the government, donor/development partners, private sector, and academic institutions are necessary to bring significant changes in the lives of rural people through the promotion community-based small-scale aquaculture.

Issues and constraints of small- scale aquaculture development

Small-scale aquaculture will be expected to be more compatible with its environment and other users of resources and has to become more sustainable. The constraints confronting fisheries and aquaculture development in the country are:

- Poor fisheries development policies: lack of comprehensive fisheries policies or appropriate fisheries legislation that is needed to promote sustained growth of the fisheries sector. Policy should address the issues of environmental protection, biodiversity conservation and livelihood rights of prime dependents (community water).

- Few fish farming traditions: lack of adoption of commercial farming with high potential fish species like Tilapia and catfishes. On the other hand, no traditional aquaculture knowledge exists among farmers in the country.

- Inadequate technologies and approaches: as aquaculture technologies did not exist in Nepal in traditional setting, these had to be introduced. Most of the introduced technologies were appropriate and suited to the needs of intended beneficiaries in due course of time of such introduction. However, at present there is lack of appreciation for the prevailing social, cultural and economic factors, as well as a lack of understanding of important supply and demand considerations, including competition for most production inputs.

- Inadequate participation of resource users: efforts on natural water fisheries are more effective and sustainable where the users assume the responsibilities and costs of management. The use of community based management strategies, whereby the responsibility for the fishery is developed to the local people, should also be considered as ultimate implementing agency for fisheries development program in natural water. Potential of local community control in development program will provide use of local knowledge, empowerment of poor, adaptation of technical input to local conditions and sense of program ownership by the community.

- Weak research and extension activities: research and extension activities are hindered by the general economic difficulties. Although there are few fisheries research centers in the country, the contribution of these centers to real development is limited, either because of inappropriate research targets or because of the absence of effective fisheries extension. As fisheries research and extension advanced worldwide, the main impediment in the country is lack of access to current knowledge and technologies.

- Limited coordination between research and development sectors: in many cases the research and development efforts carried out are not responsive to the needs of targeted stakeholders. For the needs to be appreciated in community settings, research and development should be used to evaluate (a) social aspects found in many rural areas that negatively affect the adoption of new technologies, (b) the role of gender, (c) labor supply and demand and (d) marketing.

- Inadequate information management system: access to fisheries information is inadequate, limiting the scope, quality and utility of fisheries research and development activities. There is a lack of information flow (networking) between institutions in the country.

- Inadequate human resources: the current lack of trained fishery and aquaculture human resources is a constraint that needs to be addressed in order to have an effective research and development in fisheries, and accurate impact assessment protocols. A critical mass of people with suitable postgraduate training is needed to maintain and generate research designs required to meet fisheries development needs.

Future potential of aquaculture

Mountain fisheries and aquaculture. Fishing plays an important role in providing food and income to the people in the mountain areas. Therefore, fish resources, people and their environment should be integrated for an overall ecosystem and rural development approach. In this regard an appropriate technology need to develop fisheries and aquaculture program in the mountain region, where natural water resource is abundant and also will support to provide job opportunity and support for income generation in that region, where most of the people are living with low income. Recently an introduction of cold water fisheries (trout farming) in hill region needs to be promoted to other potential areas of the country.

Intensive aquaculture in southern warm water region. Aquaculture provides subsistence employment and income generation to the nation. The existing pond aquaculture, which is mostly extensive, can be intensified for increased productivity. Research should be focused on increasing production by strengthening existing aquaculture practices. Fish species such as tilapia and catfish as well as freshwater prawn should be included for aquaculture production as these species are suitable for the warm water zone in the southern terai for their growth and production.

Study on the possibilities of riverine habitat for commercial aquaculture. The river systems, which are rich in fish biodiversity, should be studied and assessed for aquaculture potential.

Community based riverine fish conservation and sustainable development. Conservation and utilization of forest resources through community mobilization is a major success story in Nepal. Research on participatory exploitation of riverine aquatic resources, emphasizing conservation and utilization needs to be carried out. Community base riverine fisheries can be a better option for sustainable resource conservation and utilization.

Lacustrine fishery resources and their restoration. The lakes of glacier origin in the high mountains have not been studied yet from a fisheries perspective. Therefore, a review of lacustrine resources, their potential for restoration and use for community development, and their academic values also needs to be highlighted.

Recreational and ornamental fishery resources. Fish species that occur in Nepal are highly renowned for sport and recreational purposes, such as Sahar and Asala and culture technology should be developed accordingly. Similarly, many species possess considerable ornamental value for garden and aquariums. Such fishes of high value should be studied for income and employment generation opportunities.

Research on socio-economics aspect of aquaculture and fisheries. Socio-economic aspects of aquaculture and fisheries are one of the least developed topics in Nepal. Therefore, research on socio-economics perspective is highly desirable for identification of social values and issues of different aquaculture and fisheries related activities in relation to communities and group of people.

Community or group based rice-fish farming with carps and other species. Rice-fish farming is a promising item but communities/groups should be formed to run the program successfully. Research on the difference between isolated and community/group based rice-fish farming should be performed in near future to develop a "social shield" to avoid the social problems such as poaching and poisoning (Edwards, 2000). In addition there would be many other advantages of rice-fish farming in-group/community in terms of management, services and marketing.

Fish biodiversity and introduction of native species in culture practices. The area of fish diversity in relation to socio-economical perspective of community living in nearby water resources is prerequisite for the development fish diversity conservation strategies. Potential high value fish species should be studied for inclusion for commercial cultivation, which could be for ex-sito conservation of fish too.

Key Institutions for aquatic ecosystem and fisheries management. Aquaculture and fishery management in Nepal can make use of various technologies that have been used in other countries in Asia. Capacity building through technology transfer is required. This is a dynamic process that involves creating, mobilizing, utilizing, enhancing or upgrading, and adjusting the existing capacities of individuals, institutions and the country-level policy framework in which individuals and institutions grows, operate and interact with their internal and external environment.

Supporting agencies in small-scale aquaculture in Nepal

Various organizations and agencies have been involved to support and enhanced the livelihoods of resource-deprived poor community, the jalari and displaced communities through the promotion of fish culture in Nepal.

In 1972, floating cages were introduced by JOCV in Pokhara Valley. During 1975-80, Integrated Fishery & Fish Culture Project assisted by UNDP/FAO successfully demonstrated cage fish culture in the Lakes of Pokhara valley. In 1980, FAO through Australian FFHC (Food for Hunger Campaign) further assisted cage fish culture program in Pokhara. Revolving fund was established as credit scheme for securing loan to cage adaptor without collateral deposits.

Extensive limnological survey and feasibility study of cage fish culture was carried out in Kulekhani Reservoir with the assistance of IDRC, Canada during 1985 to 88. The outcome of the study became the foundation of cage fish culture in the reservoir for displaced community. During 1991-98, JICA assisted through a project Natural Water Fisheries Development Project (NWFDP) to strengthen fish seed supply in Pokhara valley. DFID through Hill Agriculture Research Program (HARP) assisted to empower women of jalari community in cage fish culture and community base rice-fish farming in a group approach.

Plan/Nepal supported the displaced community in Kulekhani Reservoir through supply of cage net materials and other accessories. World Vision through its local agency Swarup Nepal supported women group of Begnas Lake by providing cage material, fish seed and training

Conclusion

The existing gross national fish production, with its per capita fish consumption (2.0 kg), contributes less to AGDP (2.32%). This is due to inadequate priority for the promotion of the fisheries and aquaculture sector in national policies and implementation, inadequate skilled human resource, awareness and effective training mechanisms. Therefore, the main focus at present should be to increase total production through effective research and extension mechanism by involving the farmer, fisher community, planners, entrepreneurs, consumers and donors. In general, extensive orthodox farming systems seem to be the main backbone of present aquaculture enterprise in Nepal. Aquaculture production is known to increase by adding inputs such as feed, manure, and fertilizers. Therefore, further research and development should be focused on intensification of aquaculture production system in addition to mountain aquaculture and the above mentioned research areas.

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THE EMERGENCE OF THE CHEAPEST FARMED FRESHWATER FOOD FISH (BIGHEAD CARP *ARISTICHTHYS NOBILIS*) IN THE PHILIPPINES

Roy C. ORTEGA

Aquaculturist I, DA-Bureau of Fisheries and Aquatic Resources

Department of Agriculture

3rd Flr. PCA Bldg, Elliptical Road, Diliman, Quezon City, Philippines

In the context of aquaculture techno extension, this paper and accompanying presentation revealed how the Philippine government through the Philippine Fisheries Commission (PFC), now DA-Bureau of Fisheries and Aquatic Resources (DA-BFAR), in partnership with the UN-Food and Agriculture Organization Freedom from Hunger Campaign (FFHC) and UN- FAO World Food Program, initiated the farming and breeding of Asian and Indian major carps in the country between 1965 up to late 1970s. Emphasis is given on bighead carp *Aristichthys nobilis*, which as per 2011 and 2012 official agricultural statistics, ranked 3rd in freshwater aquaculture (17,464 MT) and 6th on inland capture fisheries output (12,119 MT). The bulk of these production values came from the 90,000 ha Laguna Lake.

The FFHC collaborative project compellingly envisioned to increase food fish production from the freshwater aquaculture sub-sector in the country using low-external input technology. The technical basis of re-invigorating Asian carps aquaculture in the country was founded on the review of Dr. Yun-ang Tang of UN-FAO to tap the underutilized natural food niche in freshwater systems. (Tang, 1964). According to the UN FAO expert, approximately 7,200 kg/ha can be produced from optimally managed polyculture of Asian carps in ponds. Thus, Asian carps of varying food niche were re-introduced for the project including: detritivore common carp *Cyprinus carpio*; phytoplanktivore silver carp *Hypopthalmichthys molitrix*; zooplanktivore bighead carp *A. nobilis*; and macrophyte-eating grass carps *Ctenopharyngodon idella.* The Philippines started working on Asian carps (i.e. various common carp varieties, silver carps and barbs) early in the 1960's, producing barely 30,000 fingerlings annually from two farms, Magsaysay Memorial Fish Nursery, Zambales and Central Luzon Demonstration Fish Farms, Rizal (PFC Annual Report, 1964).

Between 1966 to 1969, around two (2) million fry of different Asian carp species were imported from Taiwan by the PFC under the UN-FAO FFHC collaboration (Reyes, 1973). These stocks were distributed in 24 PFC farms, notable of which is the purpose built Central Luzon Fish Hatchery in Candaba, Pampanga, and eight (8) government-assisted private fish farms. The PFC and UN-FAO FFHC project experts and farmer participants conducted several induced breeding demonstration and applied hatchery technology refinement trials based on the Chinese hypophysis methods (Reyes, 1973). In 1969, the first successful bighead carp induced breeding was reported in a government-assisted private fish farm owned by a certain Mr. Alberto Celis in Dingle, Iloilo Province (Reyes, 1973). Soon, other government-assisted private farms succeeded in the mass production of common and rohu carps. Meanwhile, some of the introduced Asian carps which were stocked in communal waters exhibited excellent yields, for example in Candaba Swamp (Pampaga Province), additional 300 kg/ha of various carp species was realized in six (6) months after stocking (Gatus and Reyes, 1973). Remnants of these stocks were selected for broodstock development and further distributed to cooperating private and PFC farms. This two-pronged aquaculture technology demonstration proved to have encouraged farmer interest by showing (1) that Asian carps (e.g. bighead carp) grow at an impressive rate with practically low husbandry intervention and (2) mass production can be achieved using modern yet doable techniques.

The remarkable farm performance of Asian carps spurred university-level research which dealt with practical aspects of fishpond operations such as growth response under different fertilization regimes and polyculture combinations (Grover and Banacia, 1973). Furthermore, improving carp pond farming was integral in several foreign volunteer works (i.e. US Peace Corps). The PFC-Central Luzon Demonstration Fish Farm located in Tanay, Rizal Province (now DA-BFAR National Inland Fisheries Technology Center [NIFTC]) was later identified as the national carp gene-pool, training and technology center to expand carp aquaculture in the country.

Subsequent grow-out technology promotion of Asian carps was primarily using fishponds. To emphasize government support for this new fish commodity, a special "carp farming category" was launched by the PFC in the 1971 Green Revolution Award program, with the awards given by no less than the President of the country. Despite this aggressive and earnest technology promotion, farming of Asian carps in freshwater fishponds failed to gain substantial output, eventually over-taken by tilapias and other native freshwater species (i.e. snakehead *Chana striata* and catfishes *Clarias* spp.), owing to their familiarity to consumers. Nevertheless, the PFC's "Tanay Fish Farm" continued its carp technology promotion mandate up to the present.

Mr. Adolfo Villarin winning the carp category award from the Philippine President

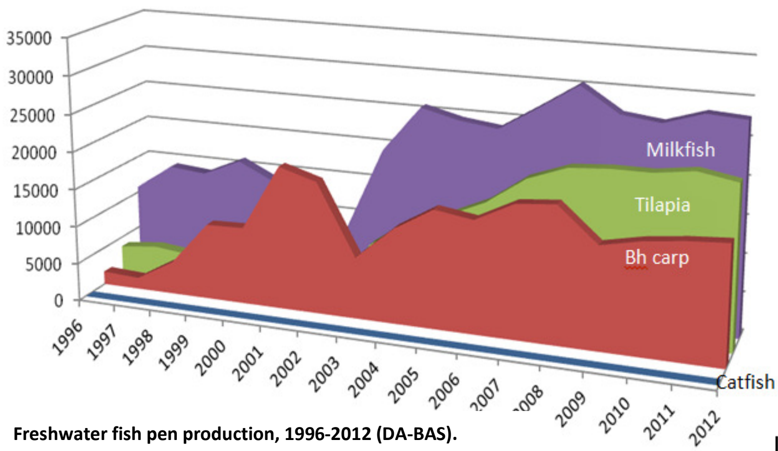
The second-wave of interest on the farming Asian carps, particularly on bighead carp, happened sometime in mid-1970s in Laguna Lake along the shores of Rizal Province. This development was an offshoot PFC "fish planting" initiatives in the late 1950's with a planktivore milkfish *Chanos chanos* and common carps. This intervention evidently complemented Laguna lake's endemic species (e.g. *Clarias macrocephalus*, *C. batrachus*, *Chana striata, Therapon plumbeus, Anabas testudineus, Arius manilensis*) which occupies mid- to upper- levels of the food web. After observing remarkable growth of milkfish in the euthrophic Laguna Lake, some enterprising farmers in Cardona, Rizal Province, with the technical assistance of PFC biologists, started farming milkfish in fish pens (Felix, 1973). It is noteworthy that bighead carp farming in Laguna lake was reported to have been initiated by one Sambo Santos, one of PFC's training alumni using fish pens in the shores of Cardona, Rizal (A.C. Gonzal pers. com.). His family was reported to have invested and successfully bred bighead carps among others, at their farm in Bulacan Province as a result of the said government sponsored technical training.

Mr. Sambo Santos, PFC/UN-FAO training alumni, bighead carp pioneer.

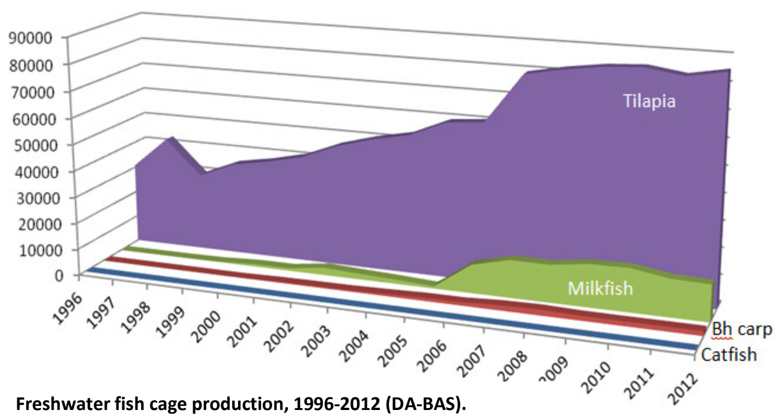
The creation of the Laguna Lake Development Authority (LLDA) in 1971 followed by the establishment of the Binangonan Freshwater Station (BFS) of SEAFDEC Aquaculture Department (SEAFDEC/AQD) in Rizal Province in 1976, introduced new players in managing fishery and aquaculture promotion in Laguna Lake. BFS followed-up the pioneering collaborative work of PFC and UN/FAO on bighead carp breeding which eventually produced commercial-scale hatchery technology package in 1985 and rolled-out hands-on training since 1987. Prior to this, SEAFDEC/AQD researchers validated the anecdotal farmer observation regarding the superior growth of bighead carps. They noted that bighead carp exhibited the highest growth at 7.0 to 10.0 g/d compared to milkfish at 2.0 g/d under polyculture with tilapia, common carps and silver carps in pens subsisting basically on natural food (Castro, et al., 1981).

Bighead carp finally became established in the Philippine local markets almost 25 years after its introduction and technology promotion, the production of which was mainly from Laguna Lake. Currently, it contributes about 5.69 % (17,464 MT) of the 306,932 MT total freshwater aquaculture output in 2011 (DA-Bur. Agricl. Stat., 2011), ranking third behind tilapia (243,055 MT) and milkfish (42,252 MT). Bighead carp production in the Philippines has been estimated to be increasing at around 862.72 MT (pens) and 120.03 MT (cages) annually from 1996 to 2012 (DA-BAS, 1996 to 2012), with corresponding estimated value of US$ 6.35 and 0.432 million, respectively.

Moreover, bighead carp ranked 6th (12,119 MT) in the inland capture fisheries sector (DA-BAS, 2012). In addition, annual contribution to inland capture fishery of bighead carp is estimated at 5,427 MT, valued at around US$3 million. There is no recorded natural spawning of bighead carp in Laguna Lake or in any freshwater bodies in the Philippines, thus the capture fishery output are derived from farm escapees and deliberate fish stocking activities by local government units, LLDA and DA-BFAR.

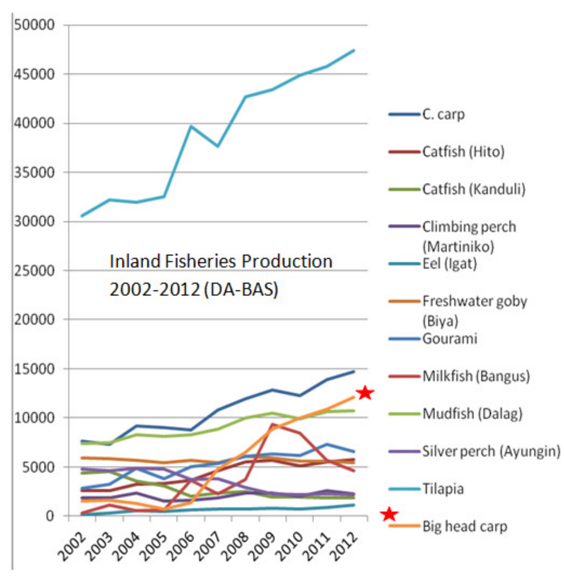


Freshwater fish pen production, 1996-2012 (DA-BAS).



Freshwater fish cage production, 1996-2012 (DA-BAS).

Survey of bighead carp aquaculture in the lake along Rizal Province shows that, polyculture with milkfish in pens is dominated by corporate players (44 ha ave. area/permit), and a meagre fisher cooperative participation (12 ha ave. area/permit). On the other hand, cage farming is primarily driven by small-scale operators (0.50 ha ave. area/permit), based on LLDA Clearance & Permit Division, 2012. However, a detailed socio-economic impact brought by bighead carp farming in the entire Laguna Lake remains to be assessed.



Inland fisheries production, 2002-2012 (DA-BAS).

Growing of bighead carps in fixed cages is done in polyculture with tilapias. A stocking density of 10,000 pcs (1.8 g/piece) for tilapias and 300 pcs (300-400 g/piece) for bighead carps are reared in 10 x 40 x 3 m cages. This set-up typically yields 1,500 kg. total biomass with 6-7 piece/kg tilapia and 1.5 kg/piece bighead carps, recovering 70 and 90 % of the stocks, respectively, after six (6) months culture. It must be emphasized that application of formulated feeds in Laguna Lake is not commercially viable since aquaculture products (tilapia and milkfish) from the this environment fetch lower farm-gate price, approximately US$0.25 to 1.0/kg compared to other sources (e.g. Taal Lake and fishponds in Central and Northwest Luzon) due to its unfortunate muddy taste. Farmers believe that tilapia excreta stimulate localized (within cages) zooplankton blooms which bighead carps subsists on.


Typical fixed fish cage and fish pen operations in Rizal Province Laguna Lake (Nov. 16, 2013).

Hatchery-nursery operations of bighead carps have significantly progressed over the years. Currently, there are two (2) government-funded (DA-BFAR NIFTDC and SEAFDEC/AQD Binangonan Freshwater Station) and nine (9) private bighead carp hatcheries, most of which are located in Binangonan, Rizal Province. Private hatcheries each have a capacity of 1.0 to 3.0 million fry per batch, using 30-50 kg total weight of female brood fish. Refined methods popularized by SEAFDEC/AQD using a double injection protocol with a combination of 20 ug LHRHa/kg fish and 2000 IU HCG/kg fish (female)/1000 IU HCG/kg fish (male) is adopted. Hatchery operations is all-year round with peaks from January to May obtaining survival rates from low 40% to high as 90% during warmer months. Current levels of competition between commercial hatcheries resulted to almost rock-bottom selling of five (5) day-old fry at US$2.2 cents a piece. Meanwhile, nursery enterprise was developed utilizing fixed cages or “hapas” fitted with of varying mesh size (B-net, CC net or size 17 mesh, GG net or size 14 mesh and SG net or size 12 mesh). Nursery operations sell bighead carp post-fingerlings (60-90 d post-hatched) with 10-15 cm TL and 300 g weight at US$15-25 cents a piece. This production segment relies on natural productivity of the lake, feed application if any, is very minimal.

The eventual success of bighead carp in the late 1990 was brought about by significant changes in the market development, externalities in the marine fishery sector and lake water quality. Bighead carp gained from innovative market and product development such as: 1) utilization as an extender in many fishery processed products, fetching from US$0.27 to 0.70/kg at wholesale landed at Cardona/Binangonan Fish Port; 2) supplementary ingredient in making fish sauce and low-grade fish meals [US$0.09 to 0.15/kg at fish processors end]; 3) niche marketing approach presented as “maya-mayang-tabang” or freshwater snapper sold as fresh/chilled portions (head [US$0.95/kg], tail [US$0.45/kg] and trunk and belly steaks [US$1.4-1.7/kg]) in wet markets; and 4) growing popularity of fresh/chilled bighead carp in major cities in the Philippines. The increasing (worsening) water turbidity in Laguna lake due to weakening annual salt water intrusion occurring between April to July proved to have expanded the farming of bighead carp at the expense of milkfish and tilapia in the area (DA-BAS, 2004, ADB, 2007 and stakeholder observations). Finally, as mentioned earlier, tilapia and milkfish produced from Laguna Lake suffers from lower (US$0.25 to 1.0/kg) farm gate prize due to metabolites of green algae blooms causing muddy flavour and other organoleptic concerns. This scenario forced farmers to diversify their crops that is highly adaptable to turbid, non-fed aquatic systems and at the same time whose raw material properties can be modified to counter quality issues thus ensure marketability, this species is no other than the bighead carp.

In summary, the following lessons can be gleaned from the emergence of bighead carp aquaculture development and technology extension in the Philippines:

1. Analysis of untapped niches within aquatic ecosystems and rural resources in general, provide critical clues on the selection of appropriate species for aquaculture development in the target community/region.
2. Other than desirable zoo-technical traits, the candidate species, should fit well with local gastronomy or its post-harvest/product development for mass consumption must be pursued with equal vigour alongside technology refinements. Creation of market demand stimulates technology adoption/refinement.
3. Hatchery development is a critical, long-term and high-impact aquaculture investment. Enlist all available knowledge providers in techno development/extension, but there has to be an institution who will take the lead for its long-term refinement & expansion. Government-private partnership from the start is the way.
4. Scope of aquaculture techno development and extension in open-water, multi-use systems (i.e. Laguna Lake) is evolving and can go beyond the mandate and capacity of production/research-oriented institutions. Sustained collaboration and close stakeholder cooperation is a real challenge.
5. Current bighead carp farming systems and its impact on local economy, family food security and livelihood and other services/goods generated etc. remains to be fully appreciated for aquaculture planning, policy formulation and technology refinement. But undoubtedly, it is the cheapest farmed freshwater food fish in the Philippines, to date.

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STATUS OF SMALL-SCALE AQUACULTURE IN ZAMBIA

Edward MANDA

Principal Fisheries Officer, Ministry of Agriculture and Livestock

P.O. Box 70232, Ndola, Zambia

Introduction

General

Zambia is a landlocked country with a surface area of 750,000 km^2. The country has a tropical to subtropical climate, having three seasons: a cool dry period from May to August when temperatures range from 14 to 21°C; the hot dry season from August to October; and a rainy season from November to April when temperatures range from 27 to 38°C (Archer, 1971; Mudenda *et al*, 2005). There are three distinct rainfall areas defining three agro-ecological regions. Region I receive less than 700mm of rainfall and include parts of Eastern, Lusaka, Southern and Western provinces. Region II receives between 700 mm to 1200 mm rainfall and includes parts of Eastern, Lusaka, Central and Western provinces. Region III receives more than 1200 mm annually and covers parts of Northern, Luapula, Copper-belt, North-western and Western provinces.

In all the agro-ecological zones, aquaculture is practiced, since availability of water is not a serious constraint. Kapetsky (1994) classifies Zambia as a country that has good conditions for fish farming. This assessment is based on soil conditions, availability of water and climate. However, availability of fish farming capital inputs, fingerlings and provision of extension services seem to be the major limiting factors to the expansion of fish farming in most parts of the country.

Population

The Zambian population is currently estimated at 13.8 million with an annual growth rate of 3.2% (CSO 2010). The country is highly urbanized mainly because it was originally designed as a mining state. Highest population densities are found in provinces where the old rail line and industries are situated, such as Central, Copper-belt, Lusaka and Southern Provinces.

Importance of the fishery sector in Zambia

Even though Zambia is landlocked, the fisheries are very important in the national economy and contribute significantly to employment and food production and the Gross Domestic Product. It is estimated that more than four hundred thousand households directly or indirectly earn part of the income from the fisheries sector making it the fourth largest after mining, agriculture and forestry.

Fish is also a major food item in the diet of Zambia. Over forty percent of the animal protein supply comes from fish. Fish is also regarded as a cheap source of protein among the low-income group. In most remote parts of the country, fish is often a major source of animal protein available. The consumption of fish on a per capita basis is decreasing as the population increases e.g. the per capita consumption was 12.1kg in 1970; 8.3kg in 1990; 6.8kg in 1997 and 6.2kg in 2000 (Mudenda *et al*, 2005). Since most capture fisheries are over exploited, the strategy for increasing fish production is aimed at putting emphasis on aquaculture development.

River basins of Zambia

There are three major basins in Zambia: the Zambezi; Luapula; and Lake Tanganyika. The Luapula Basin consists of the following major sections: the Chambeshi River; the Bangweulu Lakes and Swamps Complex; Luapula River; and Lake Mweru. The Zambezi catchment area is the largest and is composed of the following major sections: Luangwa River; Lukanga Swamps, Kafue River; Upper Zambezi; the Middle Zambezi, now dominated by Lake Kariba; and Lower Zambezi (Fig. 1).

The Lake Tanganyika basin in Zambia is the smallest and consists of a fish fauna with Nilotic affinities. The Mweru-wa Ntipa catchment could be considered to be another basin since it is an internal drainage system with no outlet. Geologically it has connections to the Mweru Luapula system.

Fisheries and fishery areas

Fisheries of Zambia may be divided into three categories: major fisheries; minor fisheries; and fisheries of small water bodies. Major fisheries are: Bangweulu Lakes and Swamps Complex; Kafue Flood Plains; Lake Kariba; Lukanga Swamps, Mweru-Luapula; Lake Mweru wa Ntipa; Lake Tanganyika; and the Upper Zambezi Floodplain. Minor fisheries include: Lake Itezhi-tezhi; Lake Lusiwashi; and the Lower Zambezi (Fig. 1). Fisheries of small water bodies include several small rivers, seasonal streams and small reservoirs scattered throughout the country. Aquaculture output could be considered as component under this category.

The fishery resources from lakes, swamps, rivers and flood plains have produced in recent years 65,000 to 70,000 T of fish annually (Mudenda *et al*, 2005). The fisheries and aquaculture are very important ventures to the national economy and contribute significantly to employment, income and food production. However, the natural fishery areas, in recent years have been fully and in most cases overexploited making it difficult to significantly increase fish production to meet local demand estimated at 120,000 tonnes annually and for export.

The small-scale (Artisan) fishers operating in the inshore areas using gillnets and small fishing boats dominate nearly all fishery areas of Zambia. Artisan fishers tend to be attached to the fishery sector by strong cultural and traditional values. They see very little prospects outside the fisheries sector. As a result, they continue fishing even when stocks are being depleted and profit margins declining. As a result, fish stocks that are exploited by artisan fishers are in most cases overexploited.

Present status of aquaculture sector

The current state of the aquaculture sub sector in Zambia is largely a product of: the fish culture projects implemented; strategies of the Department of Fisheries for Fisheries development; and availability of extension services (Mudenda *et al* 2005). Commercial aquaculture is not yet fully established even though efforts of cage culture are underway mainly on lake Kariba and this could be a result of combination of factors that include policy objectives for the fisheries sector as implemented in previous national development plans; availability of capital; and information or technical knowledge about fish farming.

There are currently 6,460 small-scale farmers with 13,910 fish ponds with total water surface area of about 342 hectares (DoF, 2004). These small-scale fish farmers are concentrated in Eastern, Northern, Copperbelt and North-western provinces which constitute 80% of the total and using mainly earthened ponds for fish production.

Table 1 shows that the largest percentage of aquaculture production comes from small- scale fish farmers. This is mainly because there are many small scale fish farmers compared to other categories. In addition small-scale fish farmers have the largest combined area of fishponds. In comparison to small-scale fish farmers, there are very few commercial or large-scale fish farmers' .This situation strongly suggests that one of the ways for effectively increasing aquaculture production is to improve fishpond productivity among small-scale fish farmers and commercialization of aquaculture production systems.

Table 1. Number, area and production of different categories of fish farm/water bodies in Zambia (Source: Department of Fisheries 2004).

Category	No. of ponds	Area (ha)	Production (T/year)					%
			1998	1999	2000	2001	2002	
Small-scale	13,910	342.0	1540	1549	1569	1561	1600	37.04
Medium	218	195.0	116	117	119	118	120	2.78
Large-scale	263	135.0	1343	1350	1372	1365	1400	32.41
Small water bodies	1,084	5,000.0	1060	1065	1080	1076	1100	25.46
DoF fish farms	280	32.8	100	100	100	100	100	2.31
TOTAL	15,755	5,529.8	4159	4180	4240	4220	4320	

Aquaculture practices

The most common type of aquaculture in Zambia is farming of species from the *Cichlid* family. The country does not have a strong aquaculture tradition as compared to agriculture that has been practiced over a long period of time. After several years of adaptive research, fish farming in Zambia has attained a high level of diversity ranging from extensive to intensive practices; and from multi-species to mono species culture. Currently there are a number of fish farming systems practiced in Zambia that include: extensive; semi- intensive; and intensive aquaculture practices.

Extensive fish culture

In this practice, one or more species are stocked into the water body. Levels of management are generally low. For this type of aquaculture there is very little control and regulation of environmental conditions compared to other types of aquaculture. Extensive fish culture is being carried out in private water storage dams/reservoirs throughout the country particularly in drier parts such as Southern, Central, Western and Eastern provinces where many reservoirs have been constructed to mitigate drought conditions.

Semi-intensive fish culture

This system is more capital and labour intensive than extensive culture. This practice involves construction of fishponds and greater control of environmental parameters of the water body through application of compost, agro by-products, organic manure or chemical fertilizers. In most parts of the country, supplementary feeding is done using agricultural by-products such as maize bran, rice bran, sunflower cake, brewery waste etc.

Ponds are stocked with one or more species selected for their favorable characteristics that include: rapid growth; large individual size; broad range of diets; and size at first breeding. As a result of higher capital and labour input, yields are higher and conducive for periodic harvesting. Semi-intensive fish farming is carried out in all provinces by small-scale fish farmers, private and public institutions such as schools, colleges, National Service Centres and the Prison Service.

Intensive fish farming

This is highly capital and labour intensive and entails construction of costly earthen ponds, concrete or plastic water holding facilities. Fish cages moored in streams or other running water environments also fall into this category. Stocking of aquaculture facilities (e.g. ponds; tanks; raceways) with single or multi-species are done at high density. Mono-sex or sex manipulated (sex reversed) fish is stocked to further improve yields. Production of fry and fingerings is often carried out in separate facilities with naturally or by induced spawning. A few commercial fish farmers practice intensive fish farming.

Species for aquaculture

Table 2 provides information on the number of species of fish that farmed in Zambia. Most fish species that are used in aquaculture are collected from the wild and bred in captivity. The fish is reared in artificial ponds for the production of fingerlings that are stocked in fishponds.

Oreochromis andersonii (the Three Spot Bream) is the most commonly farmed species in Zambia particularly in the commercial sector. Over 60% of aquaculture production is from this species (Table 2). Other Cichlid species such as *O. macrochir* (the Green Headed Bream) and *Tilapia rendalli* (the Red Breasted Bream) are also farmed. *O. andersonii* has demonstrated to have highest growth rate among the farmed species even though it does not grow to big sizes in comparison to the *O. macrochir*.

Table 2. Aquaculture production (T) by species in Zambia (Source: FAO 2002).

Species	1987	1993	1995	1997	1998	1999	2000	% for year 2000
Cyprinus carpio	100	175	227	275	217	220	220	5.2
Cyprinidae			10	12				
Oreochromis niloticus	50	105	165	133	219	220	220	5.2
O. macrochir	200	350	368	407	207	210	210	5.0
O. andersonii	1200	2100	2217	2680	2689	2700	2750	64.9
Oreochromis (=Tilapia) sp.	600	1155	180	200				
Tilapia rendalli	300	700	840	1010	827	830	840	19.8
Clarias garipienus	20	70	74					
Procamarus clarkia				1				
TOTAL	**2470**	**4655**	**4081**	**4718**	**4159**	**4180**	**4240**	

Issues and problems on small scale aquaculture development

Problems in Zambia for small scale aquaculture development include: inadequate quality fingerlings; insufficient animal manure; lack of affordable fish feed; lack of appropriate technology; lack of right type of fingerlings; poor rural infrastructure; lack of marketing strategy; insufficient comprehensive extension packages; insufficient extension staff; lack of data centre; inadequate operational funds for research; insufficient donor support to research; untimely Government support after project; and weak research extension link.

Extension systems for small-scale aquaculture and its challenges

The role of aquaculture extension has been to disseminate fish farming technology and offer support services such as fingerling distribution, (to actual and potential fish farmers) and to provide adequate and suitable advisory services to the industry through training and demonstrations (Ruch, 1965)

In Zambia, one of the prominent strategies used for improving adoption rates in small-scale aquaculture techniques has been through the production of aquaculture extension materials such as manuals, booklets, flip charts, slides, videos, pictures and posters. Some of the booklets have been translated into local languages so that aquaculture information can be available to a majority of the people. A list of pamphlets and documents that have been used to provide extension services in aquaculture is indicated below:

- Seed Production of Carp in Zambia (JICA, 1997 - limited copies available)
- Guidelines of Basic Fish Culture Extension Services in Northern Province (NORAD, 1995 - limited copies available)

- ALCOM Extension pamphlets 1, 2 and 3 (ALCOM, 1991 - limited copies of translations in Bemba and Nyanja)
- Manual for Fish Farming Production Units in Schools (FAO, 1987-limited stocks)
- Handbook of Practical Fish Culture for Northern Rhodesia (Game and Fisheries, revised 1965 - not available)
- Better Fresh water Fish Farming in Zambia (FAO, 1989 - out of stock)
- The Fish and Fisheries of Zambia (FALCON, 1965 - available)
- The Culture of *Tilapia niloticus* (available at Peace Corps)

These manuals were produced with a view to introduce the practice of fish farming among rural communities into three major categories based on the period. The first phase is from the 1950s to 1980 and the second is from 1980 to 1995, and the third is from 1995 to the present (Mwango et al, 2002).

First phase of extension services 1950 – 1980

During the first phase, aquaculture extension centred around the Department of Fisheries and to a large extent, this influence is still felt, in that the provision of extension services to the sector and fish farmers is still centred on the Department of Fisheries.

During this phase, the Department of Fisheries, with resources made available from the Government, provided a leading role in the provision of extension services. Extension officers used non-participatory approaches and fish farmers did not actively participate in problem identification and solving. Extension experts alone, on behalf of fish farmers, designed extension programmes (Mortimer, 1965). Consequently, adoption levels of appropriate technologies were low compared to efforts and resources made available to the sector.

Toward the end of this phase (late 1970s) the Zambian Government could not continue to provide adequate financial resources to the Department of Fisheries for extension services because of the decline in the economy. Regular visits to fish farmers by extension workers became difficult. Farmers were not able to continue farming fish on their own resulting in stagnation of aqua-cultural production.

Technical assistance development phase (1980-1995)

As a result of the deterioration in the economic conditions indicated above, Government was not in a position to continue providing extension services in the area of fish farming at the rate that the public were requesting. Donors were therefore called upon to assist and a number of them responded positively. This resulted in the implementation of a number of donor-funded projects which seem to have operated independently and selected extension strategies that suited them best in the area where they operated. While there is nothing wrong with such an approach, efforts should have been put to coordinate the technical assistance programmes so that experiences gained through the implementation of one project could be made available to others.

The establishment of the National Aquaculture Research and Development Centre was thus designed among other things to facilitate coordination of research and extension programmes in aquaculture. Prior to the implementation of the Agriculture Sector Investment Programme (ASIP), a number of aquaculture projects had started to collaborate with the Extension Branch of the Department of Agriculture in the provision of advisory services to farmers. This led to the notion that aquaculture is an integral component of Agriculture.

The ASIP policy was formulated at a time when the Ministry of Agriculture Food and Fisheries had too many projects. It was therefore envisaged that ASIP should establish an environment for the co-ordination and reorganization of the numerous projects that were being implemented. This among other things resulted in the establishment of a new organizational structure of the Ministry where both fisheries management and Aquaculture extension were merged and placed in the Department of Field Services. This resulted in the Department of Fisheries taking an initiative of training the department of agriculture frontline staff in basic fish farming techniques so that they could attend to the farmers at community level.

Currently, the Department of Fisheries has 19 fish culture stations throughout the country. It is considered that these stations are not designed to facilitate commercialization of aquaculture but demonstration centers for the commercial viability of aquaculture and this could be one of the reasons for the slow expansion of fish farming.

Good practices or successful cases in small scale aquaculture extension

The good practices in small aquaculture extension have been through the Rural Aquaculture Promotion (RAP). This is where we have USA volunteers who work directly with the farmers to promote earthen pond construction and management of the ponds with available and affordable inputs. The system has worked very well in that the volunteers are placed rite in the fish farming community as currently the department of Fisheries only have staff up to the district level.

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WORKSHOP REPORTS

SMALL-SCALE FRESHWATER AQUACULTURE IN ASIA AND AFRICA

Outcomes of the ASIA group deliberations

The Asia group was facilitated by Cambodia and Lao PDR, with Nepal and Philippines acting as Rapporteurs. The report was presented by Indonesia and the Philippines:

- Most countries in the region have significant experience in dealing with small-scale freshwater government. Government support frequently includes enabling policies, masterplans, logistics and facilities required by the industry.
- Capacity building is undertaken at several different levels, ie. nationally, locally and with individual farmers.
- Common extension mechanisms include farmer-to-farmer approaches, individual support and extension through a group approach where farmers form cooperatives and collaborate to varying degrees.
  - A key issue in farmer-to-farmer and group approaches is selecting individuals who have the right combination of skills and recognition within the community to become effective 'core farmers', capable of training others.
  - The supply chain can also play an important role in extension, for example feed and input suppliers providing technical advice to farmers through their regular interactions with them.
- Supervision and monitoring is a key issue in extension. It is important to monitor:
  - The number of farmers trained
  - The quality of inputs such as seed.
  - The success of fish farming operations over time.
  - Changes in stock productivity and farmer income.
- Farmers may at first require incentives to try new practices or technologies to help them overcome barriers such as capital cost or perceptions of risk, as successfully used in the GAWAD SAKA programme.
- Extension for small-scale farmers should focus on simple, practical technology and improvements to management practices, addressing issues such as:
  - Good pond selection and preparation techniques.
  - Good practices in stocking of fingerlings.
  - Improvements to feed inputs and feed management.
  - Turning low cost inputs into high income outputs.
- In addition to 'core farmer' approaches, the dissemination of aquaculture technologies can also be promoted at the national, local and farm levels through training courses and workshops; and through distribution of information through radio, print and other media commonly accessed by farmers.
  - Collaboration among sectors and with other elements of the supply chain are important.
- Countries in the region face a number of common problems and issues, such as:
  - A limited number of skilled extension workers and training facilities.
  - Limited budgetary support for extension and training.
  - Lack of culture facilities, i.e. access to individual ponds, power and other critical infrastructure may be limited in rural areas, or not affordable by small-scale farmers.
  - A lack of good quality broodstock and poor seed quality in general.
  - Disease outbreaks in ponds, including introduction of new serious diseases through

the movement of live aquatic animals throughout the region.
  - Use of pesticide in rice fields or other agricultural activities that affects the quality of the water in nearby ponds.
  - Weak implementation of extension mechanisms.
  - Adverse weather conditions; some countries and areas are frequently affected by hurricanes, flooding or drought etc.

Recommendations

The Asia group recommended that small-scale freshwater aquaculture be promoted through:

- Improvement of aquaculture products, ensuring that they adhere to relevant national and international standards and supporting farmers to meet such standards.
- Collaboration amongst both small- and large-scale farmers for the greater benefit of all.
- Providing small-scale farmers with access to insurance/compensation to help them recover from natural disasters, disease and other causes of crop failure.
- Providing small-scale farmers with access to loans and credit on reasonable terms.

The Asia group agreed that the way forward would be for government to strengthen the small-scale aquaculture sector through:

- Continuous technical and financial support (from the national government and international agencies) to help promote uptake of aquaculture technologies and better management practices in rural communities.
- Promotion and implementation of good aquaculture practices (GAPs) and better management practices (BMPs) via a group or cluster management system
- Genetic improvement of key aquaculture species.
- Continue increasing the number of target areas for small-scale aquaculture operations.

Plenary discussion

Comments on the Asia group's report were as follows:

- Collaboration among small and large-scale operators can be achieved for example large operators can maintain and supply quality broodstock or seed to smaller farmers who do not have the facilities or expertise to do this themselves.
- Government should strengthen its support for small-scale operators, for example through enabling policies, extension services and necessary infrastructure/services.
- Freshwater fish farming has been highly successful in Asia and governments of Asia-Pacific countries have done well in establishing enabling mechanisms for aquaculture, making significant investments in health and extension support.
- In Indonesia both small and large operators are present targeting both domestic and international markets. Small scale aquaculture often consists of unfed or semi-intensive systems. However, seed supply can be an issue. For example when growout farmers need a large number of fingerlings (eg. 250,000 for one pond) this is often beyond the capacity of small hatcheries to supply, so a farmer may have to source their seed from multiple hatcheries, receiving different quality from each.
- The success of tilapia in the Philippines is based in part on the improvement of strains (eg. nine strains of GIFT), which has substantially improved productivity. The free market system and growing populations have contributed to demand for tilapia as it is a low-cost animal protein.
- Sometimes development agencies do not realise what farmers really want, and such projects usually collapse once the funding runs out. Sustainable development projects

need to identify what the farmers want to do and what they are capable of doing and work within this context.
- Sometimes governments do not fully realise that aquaculture is one of the best options for improving livelihoods, need to invest more in this sector, where appropriate.
- Cambodia has strong policies to support small scale farmers, including annual awards for outstanding farmers given at national farmer workshops, conferred by the Prime Minister. This kind of recognition helps to establish local champions and raise awareness.
- GAP in Thailand is difficult for small farmers to do because of the cost and because they usually do not get a better price for their product, ie. there is limited incentive. However, better management practices can help farmers to become more profitable by reducing costs / wastage and increasing efficiency and productivity.

Outcomes of the AFRICA group

The discussion was facilitated by Madagascar with Benin and Madagascar as rapporteurs. The group reported as follows:

- African countries had gained experience in:
    - The transfer of knowledge to stakeholders
    - Strengthening technical capacity of extension agents and producers.
    - Technical aspects of production, for example hatchery production of *Clarias* fingerlings and monosex tilapia.
    - Following up with producers.
- Problems commonly experienced by African countries were:
    - Poor quality and prohibitive cost of feed and feed ingredients used in aquaculture.
    - Unavailability of essential inputs and materials.
    - Illegal importation of seed, new strains or species of fish and feeds.
    - Poor quality seed / non-performing strains of fish.
    - Inadequate and ineffective organisation of actors with regards to marketing of produce.
    - Limited financial capacity of stakeholders in the establishment and expansion of their facilities and activities.
    - A lack of synergism between the actors, in particular in the development of aquaculture projects.
    - Techniques used for building ponds were often rudimentary and expensive.

Recommendations

The Africa group made the following recommendations to promote small-scale freshwater aquaculture:

- Strengthening capacity in good aquaculture practices.
- Improving government regulation and enforcement with regards to the importation of aquaculture inputs, including facilitation of the process to reduce incentive for non-compliance.
- Allocation of funding for capacity building purposes of actors.
- Strengthening the organizational capacity of actors, particularly of small-scale farmers.
- Creation of a synergistic action between stakeholders with regards to project development for aquaculture in African countries.
- Providing training for actors and creation of zones for aquaculture development in rural areas.

The overall outlook or key needs were for:

- Government and projects to promote good practice aquaculture production.
- Governments to create national funding agencies to support small-scale or micro aquaculture projects.
- Governments to invest in training sufficient aquaculture specialists to meet the needs of the industry.

Plenary discussion

Comments on the Africa group's report were as follows:

- It is important to encourage interaction and cooperation amongst producers, core farmer networks and group approaches to extension are valuable.
- Common constraints in Africa include the cost of feed and agricultural materials and difficult importation procedures for seed and broodstock, which can encourage people to circumvent official procedures with consequences for health.
- The lack of capacity is still a problem in Africa. There is a lack of synergy and collaboration between actors. Knowledge of issues such as pond construction are rudimentary, it could be done more cheaply and effectively.
- Strong leadership is required to solve these problems in the African context.

The plenary made the following recommendations:

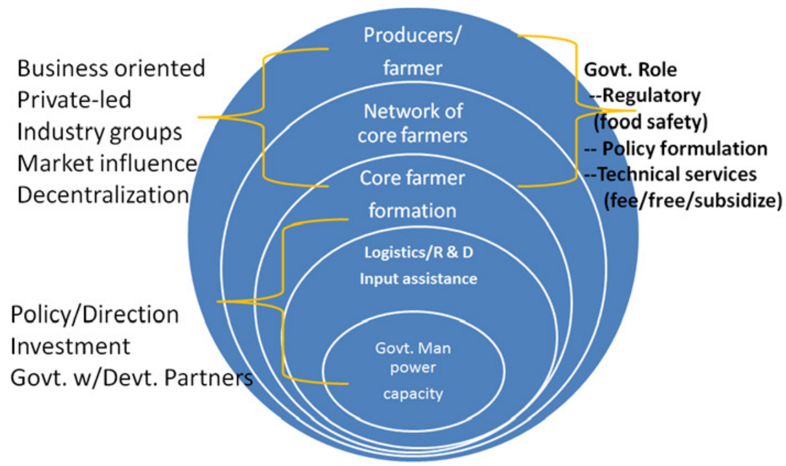
- There is a need to build capacity in good aquaculture practices and regulations and to improve law enforcement in relation to importation of seed and broodstock.
- Governments should facilitate importation of agricultural raw materials.
- There is a need to step up efforts in terms of financial capacity of actors, agricultural loans and banks, microfinancing for farmers.
- Capacity building is required in terms of rural planning and development.

SUSTAINABILITY OF SMALL-SCALE AQUACULTURE AND EFFECTIVENESS OF FARMER-TO-FARMER APPROACH FOR TECHNOLOGY EXTENSION

Report of Group 1

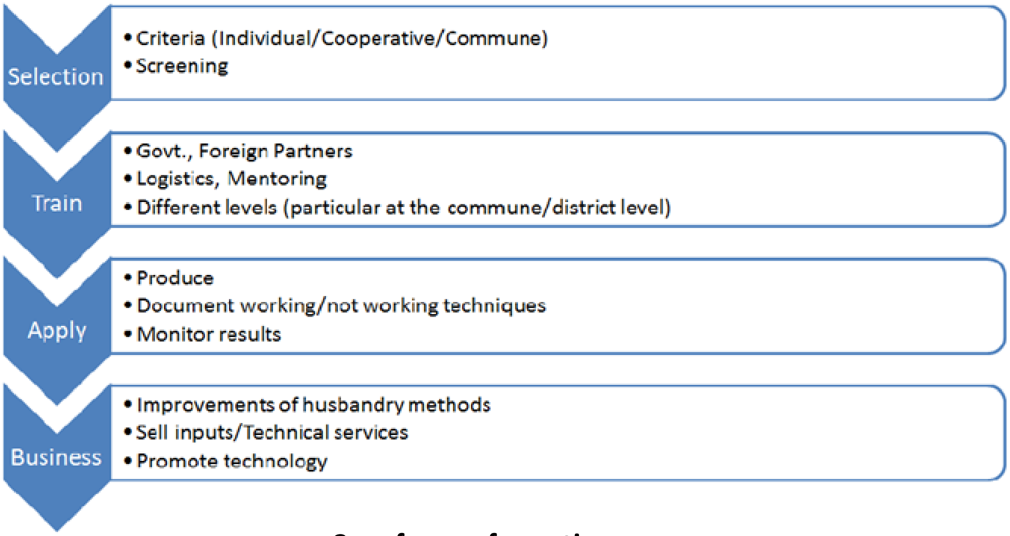
Members included participants from Bangladesh, Benin, Cambodia, Indonesia, Japan, Nepal, Philippines, Zambia and SEAFDEC.

- The group perceived small-scale aquaculture sustainability in the context of the technology-production environment, as per the following figure:



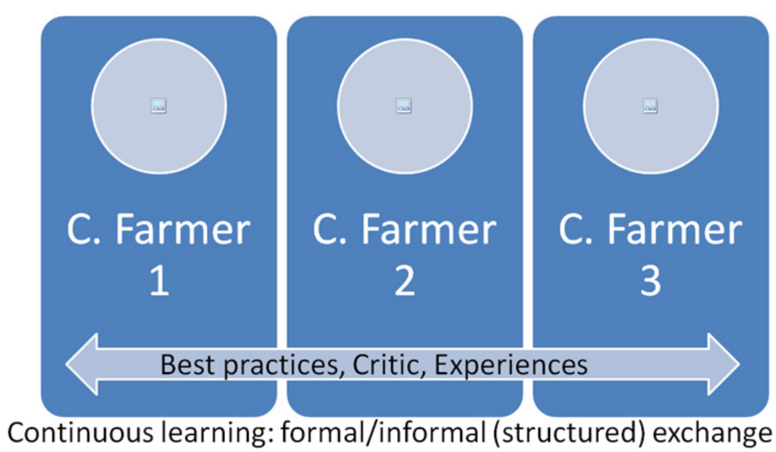
Aqua technology-production environment

- Governments, regardless of their development status, have a mandate to set policy and direction.
- In the context of aquaculture extension, quality government manpower is the key to any technology promotion. Government and development agencies also have a role here, for example investing in scholarships to permit local people to study aquaculture science and technology overseas.
- Government also has a role to play with regards to logistics and R&D input assistance. For example, individual farmers usually do not have the technical capacity or infrastructure to sustain the genetic integrity of broodstock over the long term or to engage in genetic improvement programmes. Government can fill this gap and assist in providing a reliable supply of seed to small-scale farmers.
- Governments and their development partners can promote adoption of viable technologies through enabling policies, setting directions, providing critical infrastructure and investing in human capacity building.
- Development of core farmers was visualised as per figure 2 below. Core farmers played a critical role in extending aquaculture technologies and better management practices to many more farmers than the government extension service could achieve on its own.



Core farmer formation

- Once core farmers have been established, they can be linked to others through a network or an industry group, so that they can continue to learn from each other and document their successes. Such farmer-to-farmer interactions are generally more effective in transferring information and experience, particularly in addressing practical issues. This is a business-oriented approach to extension.
- Government technical services are still required for many issues that farmers cannot deal with themselves, for example in addressing emerging diseases such as AHPNS, and regulation of key issues such as food safety and quarantine.
- Criteria for selection of core farmers should be carefully developed to increase the probability of success. The role of government and development partners is in training and mentoring core farmers until they develop the capacity and confidence to reach out to other farmers.
- The impact of core farmer approaches should be carefully monitored, evaluated and documented to increase the probability of success and allow transfer of lessons learned to other areas.
- The group envisaged the networking of core farmers as summarised in the figure below:



Networking/Cluster Core Farmer

- Core farmers should continuously communicate and learn from each other. Better practices and experiences are consolidated, shared and critiqued.
- This continuous learning process could be conducted in both formal and informal ways through meetings, training courses or meetings.
- Decentralisation of extension services has had mixed results in the group's experience. In the Philippines and Zambia there had been a net erosion of aquaculture extension capacity due to loss of skilled personnel and because of the low priority that many local government units had placed on extension. However, Nepal and Cambodia have had a positive experience in that the required funding was made available at the local government level and local communities had been able to clarify priorities, due to their greater opportunity for engagement.

Report of Group 2

Members were Cote d' Ivoire, Lao PDR, Madagascar, Myanmar and SEAFDEC. The group reported as follows:

- Improving seed production of important freshwater species was a key issue for sustainability of the sector:
    - Breeding technology needed to be improved through induced breeding techniques and the use of spawning agents, including for introduced fish species.
    - Facilities needed to be provided or set aside for breeding activities, for example separate pongs for maintaining broodstock and fingerling production.
    - Broodstock management and hatchery/pond management operations needed to be improved to assure an adequate supply of good quality seed to farmers.
    - Good site selection and water management practices were important.
    - Improving nursery technology.
    - Use of different techniques for fingerling production, as appropriate:
        - Use of hormone-containing feeds to produce mono-sex tilapia fingerlings.
        - Sex differentiation of advanced tilapia fingerlings.
        - Use of hapa and net cages to grade fingerlings according to size and the need of the farmers.
    - Good feed and feed management practices.
    - Good practices in harvesting, transport and packing of fingerlings.
- Improving grow-out production with regards to:
    - Culture systems, including appropriate use of extensive systems and polyculture where appropriate.
    - Providing a reliable supply of good quality seeds of suitable size.
    - Pond design, size, preparation and management.
    - Pond fertilisation, for example the use of organic fertilisers where appropriate to the situation of farmers.
    - Feeds and feed management, including good aquaculture practices and better management practices such as mixed feeding schedules to reduce costs.
    - Water quality management.
    - Disease prevention and control, including sustainable alternatives to antibiotics such as better management practices and probiotics.
- Decentralised market-oriented production and value chain:
    - Integration of fishery production and market orientation
    - Use of contract farming with pre-agreed price of stocking and harvesting arrangements to minimise competition and make income more predictable for farmers.

- Technical improvements, innovation and extension:
    - Assessment of different broodstock management schemes.
    - Improvement of seed production and grow-out techniques.
    - Promotion of aquaculture of indigenous species.
    - Trials to determine growth performance of native species and their suitability for aquaculture.
    - Assessment of the impact of climate change on all production stages (i.e. breeding season) and formulation of adaptation strategies.
    - Strengthen farmer-to-farmer networks and adoption of cluster management techniques for small-scale farmers.
    - Government funding support for the continuation of successful projects and/or their replication in other areas.

Plenary discussion

The key points of discussion were as follows:

- The consensus was that a farmer to farmer approach is an effective way to reach out to farmers and improve practices, and that both core farmer networks and cluster approaches are important ways to extend the reach of government extension services.
- It was generally agreed that main role of government is to support farmers by providing those technical services that farmers and third parties cannot provide independently. These services are generally provided free or for a minimal amount. Government also has a key role in regulation of important issues, such as health and food safety.
- Most projects have dealt with the issue of core farmer establishment working with individuals. However, in the case of Nepal and some other countries the government has found it more effective to work with collectives, one advantage being that it incorporates networking as part of the process.
- The selection of core farmers who have the necessary skills and influence within their community is a critical issue and governments/projects should develop criteria for selection to increase the probability of success.
- Core farmers should ideally be networked to facilitate continuous and ongoing learning and sharing of experience amongst them, with flow-on benefit to their local network of client farmers. This can be done in many ways, locally or nationally, and both through formal workshops and informal meetings.
- Participants did not have much feedback on the effects of decentralising extension services. However, Nepal had indicated that local feedback had proved useful in identifying local needs and priorities more accurately.
- Direct farmer-to-farmer exchange visits were seen as a useful way to share experience between farmers, and it was noted that it was often easier for farmers to adopt information that they had gained from interacting with their colleagues rather than from other sources. Farmers are motivated when they observe the success of other farmers, and will actively seek to learn from them.
- Providing training for children as part of their school curriculum is an effective way to boost skills in young people.
- The Philippines had observed an emerging gap between successful farmers and the government. Once farmers became successful they frequently became less interested in sharing their knowledge or time with officials. There was a need to sustain government-industry relationships over the long term. Careful selection of core farmers is key, it was important to choose people that were willing to share their successes and to give back to the community.

- One African project was making a documentary for dissemination via television, which was expected to be an influential step towards promoting the project goals. The documentary will be simple and in local language for accessibility to farmers.
- Linkages between national and provincial governments with local development partners and local government units such as communes were seen as an alternative extension mechanism. It was often the case that local government units had the best idea about which communities were most in need of assistance and most suitable for implementing extension activities.
- The group agreed that it would be valuable to meet again in future to follow up on discussions, share experience and progress.

Conclusion and Way Forward

Small-scale freshwater aquaculture in the region has long been existing and has provided diverse benefits to rural farmers including income generation, nutrition improvement, and sustainable aquaculture practices through integrated farming system. However, necessary developments and technology improvement has not properly reached nor disseminated to many rural/small-scale farmers. This has resulted in underutilization of the potential of aquaculture production in many rural communities especially in developing countries. The lack of access by many local farmers in the region to the developed yet simple technologies on seed production as well as on grow-out culture, has hindered the further development and adaptation available aquaculture technologies. JICA's initiative on the "farmer-to-farmer" approach of technology extension has proven to be a very effective way to transfer technologies to the rural poor farmers. The advantage of this approach is the exposure and training of local small-scale farmers from core farmers through practical application of the technologies developed, which the core farmers have tried and tested. The technology extension, moreover, is transferred to the farmers in their own dialect, thus resulting to highly efficient process of technology transfer. And most important, the transfer of technology is totally based on the local resources which can be easily accessed by the farmers.

The farmer-to-farmer approach can be initiated by proper training of selected core farmers, who will apply the technology to increase their own aquaculture production and augment family income. It is noteworthy that this system not only provides economic benefit to the core-farmers but also enhance their social role as local leaders and/or extension workers. Once the core farmers are trained and established, the technology is then transferred by the core-farmer himself to selected local farmers who are willing to try the technology. This process will continue from one farmer to another, thus benefiting many rural farmers and helping them to at least increase their production from their small aquaculture farms.

From the experiences shared by local farmers from the countries where JICA project was implemented during this International Symposium, it is worthwhile to note the success stories by each of the selected core farmers who voluntarily joined the project. From initially having few tanks and ponds for their culture operations, the farms usually expanded facility- and area-wise producing more fingerlings (from the hatchery and nursery) and more foodfish (from grow-out ponds). These core farmers were able to supply fingerlings to other local farmers (usually to the ones they trained through farmer-to-farmer approach) and sell some of the marketable sized fish to the local market for additional income. Their willingness to train other local farmers in their community and to share their experiences and assistance in helping these farmers also resulted in the overall improvement of the local fish production within the area or even at neighboring communes.

In some cases, local farmers that were trained by core-farmers have became core-farmers themselves, being able to train and extend assistance to other farmers. Despite some problems that have been encountered in the implementation of this approach (e.g. criteria for initial selection of core farmers; willingness of voluntary farmers to join the program), results obtained from the implemented JICA projects in some countries in the region, indicate the effectiveness of the approach in ensuring continuity of technology extension from one farmer to another.

By and large, results of the farmer-to-farmer approaches of technology extension in small-scale freshwater aquaculture can be potentially be applied to other small-scale aquaculture systems (e.g. brackishwater and marine). It is therefore recommended that a Guidebook on Farmer-to-

Farmer Extension Approaches on basic aquaculture technologies be developed based on the outcomes of the JICA projects. This guidebook can then be used to develop a Regional Training Course module, to train prospective core farmers involved in small-scale aquaculture (freshwater or marine) who are willing to extend assistance to other local farmers using this approach. This will ensure the effective dissemination and application of the different aquaculture technologies to the grass root level (the farmers themselves).

ANNEXES

ANNEX A: MEETING AGENDA

1 December (Sunday)	
Delegates Arrive Bangkok	
2 December (Monday)	
08.00 – 08.30	**Registration and assembly**
08:30 – 10:00	**Opening Ceremonies** ▪ Opening Messages (JICA, NACA, DOF-Thailand, TICA, SEAFDEC, FAO-RAP, AIT) ▪ Introduction of the Symposium (Dr. Eduardo Leano, NACA; and Dr. Satoshi Chikami, JICA)
10:00 – 10:30	**Keynote Speech (JICA) – Dr. Yamao (Hiroshima University)**
10:30 – 10:45	**Photo session; Coffee/Tea Break**
10:45 – 16:00	**Presentations by Partner Institutions** **Presentations: 30 minutes; followed by Discussions: 15 minutes)**
10:45 – 11:30	**Small-scale aquaculture development: Asia-Pacific Regional perspective (FAO-RAP)**
11:30 – 12:15	**Small-scale aquaculture development: Implementation of Better Management Practices through Farmer organizations and Clusters – NACA Experience.**
12.15 – 13.30	**Lunch**
13:30 – 14:15	**Small-scale aquaculture development: Experiences from the Philippines on milkfish and tilapia (SEAFDEC AQD)**
14.15 – 15:00	**Small-scale aquaculture development: Experience on community-based fisheries resrources management (SEAFDEC TD)**
15.00 – 15:15	**Coffee/Tea Break**
15:15 – 16:00	**Small-scale aquaculture development: AIT (Dr. Amararatne Yakupitiyage**
16:00 – 16:45	**Small-scale aquaculture development: TBD (DoF-Thailand)**
16:45 – 18:00	**General (open) discussion**
19.00	**Dinner Reception (hosted by JICA)**
3 December (Tuesday)	
08.00 – 08.30	**Registration**
08:30 – 09:00	**Recap Day 1 (JICA)**
09:00 – 10:00	**Country presentation* (Cambodia)**
10:00 – 10:15	**Coffee/Tea Break**
10:15 – 11:00	**Country presentation* (Benin)**
11:00 – 12:00	**Country presentation* (Lao PDR)**
12.00 – 13.00	**Lunch**

13:00 – 13:45	**Country presentation* (Madagascar)**
13:45 – 14:45	**Country presentation* (Myanmar)**
14:45 – 15:00	**Coffee/Tea Break**
15:00 – 17:00	**Country presentations (Indonesia, Philippines, Nepal, Cote d'ivoire, Malawi, Zambia)**
4 December (Wednesday)	
Field trip to DOF stations and fish farms (c/o DOF) TO be confirmed	
5 December (Thursday)	
08.00 – 08.30	**Registration**
08:30 – 09:15	**Recap of Day 2 and Day 3 (JICA)**
09:15 – 10:30	**Region-based workshop**
10:30 – 10:45	**Coffee/Tea Break**
10:45 – 12:00	**Presentation of the workshop results**
12.00 – 13.00	**Lunch**
13:00 – 14:15	**Issue-based workshop**
14:15 – 15:30	**Presentation of workshop results**
15.30 – 15:45	**Coffee/Tea Break**
15:45 – 17:00	**Plenary session****

6 December (Friday)
Delegates Depart Bangkok

* Country presentation consists of 1) small-scale aquaculture profile, 2) case study I, 3) case study II, and Q&A session.
** All presentations/workshop results will be synthesized in this session and policy recommendations will be formulated.

Annex B: List of Participants

Benin	
Mr. Makoto Sato Expert on Aquaculture Extension, Training and Public Relations	
Dr. D'almeida Arsene Project Manager/Coordinator Provac Republique de Benin	Tel No: +229 90902016 Email: almeida_arsene@yahoo.fr
Mr. Gandonou Justin Extension Officer Communal Sector for Agricultural Development Adjohoun Commune, Ouémé Department 02 BP 413 Porto-Novo Benin	Tel No: +229 97323493 Email: teknikpiscikol@yahoo.fr
Mr. Koucou Yaovi Guy Core Fish Farmer, Adjarra Commune, Ouémé Department Representative of Fish Farmer Cooperative 02BP413 Port-Novo (Benin)	Tel No: +229 97835789 Email: guyyaovikoucou@yahoo.fr
Mr. Goro Nezaki JICA Expert Benin Provac	Tel No: +81 993 76 2996 Email: nezaki@incomjapan.co.jp
Cambodia	
Mr. Seiichi Ouchi Coordinator of Freshwater Aquaculture Improvement and Extension Project Phase 2	
Mr. Chin Da Deputy Director (Deputy project manager) Department of Aquaculture Development, Fisheries Administration, Faiex-2, Jica Fisheries Administration,Phonom Penh, Cambodia	Tel No: +855 11 980990 Fax No: +855 23 996380 Email: chinda77@yahoo.com
Mr. Chhor Bunly Deputy Chief of Admin Aquaculture Officer (Charge of Seed Production) Department of Aquaculture Development, #101 Street 1928, Khan Sensor, Phnom Penh, Cambodia	Tel No: +855 012 892974 Email: chhorbunly@yahoo.com
Mr. Meng Sothai Chief of Fisheries Administration Extension officer, Fisheries Office Cantonmen Battambang Province, Cambodia	Tel No: +855 012 358565 Email: sothaimeng@yahoo.com
Mr. Prin Savin Director of Fisheries Cantonment Siem Reap Province	Tel No: +855 012 821584
Mr. Mith Phan Core Seed Farmer Representative of Seed Farmer Networking Group Battanbang Province, Cambodia	Tel No: +855 097 6897948
Cote d' Ivore	
Mr. Bamba Vakaramoko Technical Adviser of Aquaculture Ministry of Animals and Fisheries Resources Cab/Min des Resources Animals et Halieutiguly 06 Ba 6523 Abisjan06	Tel No: +225 07090717 Email: vakaramokob@yahoo.fr
Indonesia	
Mr. Cornelis Governor Government of West Kalimantan Provinces West Kalimantan Provinces, Ahwad Yani Street Poutidnak Indonesia	Tel No: +85 575 0116688 Fax No: +62 561 735226

Mr. Ichiro Nomura Fishery Policy Advisor Ministry of Marine Affairs and Fisheries Republic of Indonesia Jica, Sentral Senayan II Jl. Asia & Africa 8 Jakarta, Indonesia	Tel No: +62 21 3513296 Email: inomura75@gmail.com
Mr. Ir Maskur Director of Fish Health and Environment, Directorate General of Aquaculture Ministry of Marine Affairs and Fisheries Menara 165 Bldg., 15th Fl., Jl. TB Simatupang, Jakarta Selatan	Tel No: +62 812 9773474 Email: maskurfish@gmail.com
Mr. Gatot Rudiyono Directorate General of Aquaculture Sultan Syoknir Street No. 16 West Kalimantan, Indonesia	Tel No: +62 561 932521 Fax No: +62 561 735226 Email: rudy_gatot@yahoo.com
Japan	
Mr. Isao Koya Senior Advisor to the Director General, Rural Development Department, JICA Tokyo, Japan	Tel No: +81 3 5226 8413 Fax No: +81 3 5226 6338 Email: koya.isao@jica.go.jp
Mr. Shingo Takahashi Researcher Fisheries and Aquaculture International Co, Ltd 1130-20 Minato Minamiizu, Kamo-gun, Shizuoka, Japan	Tel No: +81 3 5919 0175 Fax No: +81 3 5919 0176
Mr. Masahiro Yamao Hiroshima University 1-4-4 Kagamiyama, Higashi, Hiroshima, Japan	Tel No: +81 82 424 7962 Fax No: +81 82 424 7962 Email: yamao@hiroshima-u.ac.jp
Mr. Seichi Ouchi Coordinator of Project (FAIEXII) INTEM Cousulting 201 Office K 7-22-18 Nishi-shinjuku Shinjuku-ku Tokyo 160-0023 Japan	Tel No: +81 3 5389 7055 Fax No: +81 3 5389 7263 Email: ouchi@interjapan.co.jp
Mr. Ikuo Hirono Tokyo University Marine Science and Technology Tokyo, Japan	
Lao PDR	
Dr. Satoshi Chikami JICA Chief Advisor, Livelihood Improvement Project for Southern Mountainous and Plateau Areas (LIPS) C/O JICA Laos office Vientiane Lao PDR	Tel No: +856 20 5461 7801 Fax No: +856 21 223732 Email: chikami.satoshi@jica.go.jp
Dr. Sano Kosuke Expert on Fisheries Technology and Extension, Livelihood Improvement Project for Southern Mountainous and Plateau Areas (LIPS)	Tel No: +66 912160283 Email: sano@faiaqua.com
Mr. Vannaphar Tammajedy Deputy Director Department of Livestock and Fisheries Namxouang Aquaculture Development Center P.O. Box 6644 Lao PDR	Tel No: +856 20 5560 6866 Email: vannaphar@gmail.com

Ms. Khouanchai Youtthabout Provincial Coordinator Livestock and Fisheries Sector Provincial Agriculture and Forestry Department Sekong Province, Lao PDR	Tel No: +856 20 5606 4986
Mr. Volasack Inthalapheth Provincial Coordinator Saravanh Province Livestock and Fisheries Section, Provincial Agriculture and Forestry Deparment, Sarawanh Province	Tel No: +856 20 2312 4280 Fax No: +856 34 211852 Email: livestocr14@yahoo.com
Ms. Lane Bounmychit Core Farmer for Seed Production Mekong Province, Beng Village Lamam District Sekong Province	Tel No: +856 20 9894 3398
Mr. Khamlay Phomvichit Provincial Coordinator Co-Farmer for Seed Production Nonsoung Village, Laongam District Salavanh Province Lao PDR	Tel No: +856 20 5544 8205
Mr. Sano Kosuke JICA Expert	Tel No: +91 216 0283 Email: sauo@faiaqua.com
Madagascar	
Mr. Oomizo Hirsohi Expert, Rural Development Project through the Diffusion of Aquaculture of TIlapia in the Region of Boeny (PATIMA)	Tel No: +81 993 52 3404 Email: omizo.hiroshi@icnet.co.jp
Ms. Raboanari Jaona Harilalao Zoelys Director of Aquaculture Ministry of Fisheries and Halieutic Resources Madagascar	Tel No: +261 328 758247 Email: rcharilalaozoelys@yahoo.fr
Mr. Miaretsoa Longondraza Extension Office, Patima, Madagascar	Tel No: +261 328 216763 Email: miaretsoa@yahoo.fr
Mr. Tondalh Jo Mana Core Fish Farmer, Patima Madagascar	Tel No: +261 325 713257
Malawi	
Mr. Hastings Zidana Principal Fisheries Research Officer National Aquaculture Center Department of Fisheries P.O. Box 44 Domasi, Malawi	Tel No: +265 881 070187 Fax No: +265 153 6203 Email: hastingszidana@yahoo.co.uk
Myanmar	
Mr. Shingo Takahashi Chief Advisor, Small-scale Aquaculture Extension for Promotion of Livelihood of Rural Communities in Myanmar Project (SAEP)	
Mr. Aung Khine Soe Fisheries Officer, Department of Fisheries, Ministry of Livestock, Fisheries and Rural Development Myanmar	Tel No: +9 451244877
Mr. Win Khine Core Farmer, Letpandan Township, Bago Region Myanmare	Tel No: +9 423663675

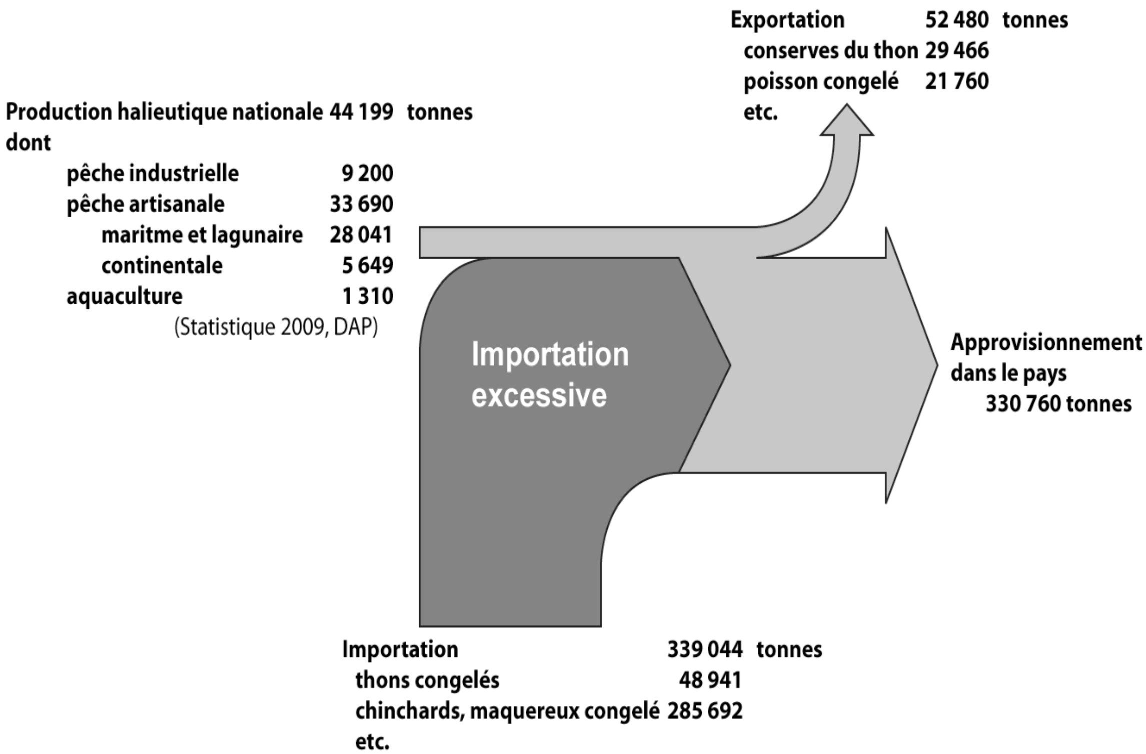
Mr. Kyaw Soe Fisheries Officer, Department of Fisheries, Aquaculture Department Head Office, Nay Pyi Taw Myanmar	Tel No: +9 49229298 Fax No: +67 418538 Email: kyawsoedof@gmail.com
Mr. Aung Soe Min Fisheries Officer, Department of Fisheries, Ministry of Livestock, Fisheries and Rural Development Myanmar	Tel No: +9 31674057
Mr. Saw Maung Maung Aye Farmer, Private/Aqua Farmer Monsaye Village, Hpaan Township, Kayin State, Myanmar	Tel No: +9 8730849
Nepal	
Mr. Jay Dev Bista Senior Scientist Fisheries Research Center Pokhara, Nepal P.O. Box 274	Tel No: +977 61 462004 Fax No: +977 61 560825 Email: jdbista@gmail.com
Philippines	
Mr. Roy C. Ortega Aqua culturist Bureau of Fisheries and Aquatic Resources 3rd Floor, PCA Building, Diliman Quezon City Philippines	Tel No: +63 2 9293439 Email: kaulayao@yahoo.com
Mr. Ronald Chug-e Agricultural Technologist Municipal Local Government Unit Mayoyao Ifugao, Philippines	
Ms. Juri Watanabe JOCV, Municipal Agricultural Office, Municipal Government Unit Mayoyao Ifugao, Philippines	Email: juri1214@gmail.com
Zambia	
Mr.Edward Manda Principal Fisheries Officer Ministry of Agriculture and Livestock P.O. Box 70232, Ndola, Zambia	Tel No: +26 0979181228 Fax No: +26 0212615603 Email: mechilolo20@yahoo.com
JICA Bangkok	
Mr. Shuichi Ikeda Chief Representatives JICA Thailand office	
Ms. Supaporn Langao Program Officer JICA Thailand office 31st Floor Exchange Tower, 388 Sukhumvit Road, Klongtoey, Bangkok 10110 Thailand	Tel No: +66 2 261 5250 Ext. 130 Fax No: +66 2 261 5262 Email: supaporniti@jica.go.jp
Mr. Nakahori Hiroaki Representatives, JICA Thailand office 31st Floor Exchange Tower, 388 Sukhumvit Road, Klongtoey, Bangkok 10110 Thailand	Tel No: +66 8 90051016 Email: nakahori.hiroaki@jica.go.jp

<table>
<tr><th colspan="3">NACA</th></tr>
<tr><td colspan="2">Office Address
Suraswadi Bldg, Department of Fisheries
Kasetsart University Campus
Ladyao, Jatujak, Bangkok 10900 Thailand
Tel No (66-2) 561 1728</td><td>Mailing Address
PO Box 1040
Kasetsart Post Office
Bangkok 10903, Thailand
Fax No (66-2) 561 1727</td></tr>
<tr><td>Dr. Ambekar Eknath</td><td>Director General</td><td>ambekar.eknath@enaca.org</td></tr>
<tr><td>Dr. CV Mohan</td><td>R&D Manager</td><td>mohan@enaca.org</td></tr>
<tr><td>Dr. Eduardo Leano</td><td>Program Coordinator</td><td>eduardo@enaca.org</td></tr>
<tr><td>Mr. Simon Wilkinson</td><td>Program Coordinator</td><td>simon.wilkinson@enaca.org</td></tr>
<tr><td>Dr. Derun Yuan</td><td>Program Coordinator</td><td>yuan@enaca.org</td></tr>
<tr><td>Mr. Surapong Chaocheawchan</td><td>ICT</td><td>surapong@enaca.org</td></tr>
<tr><td>Ms. Wella Udomlarp</td><td>Finance Officer</td><td>wella@enaca.org</td></tr>
<tr><td>Ms. Lynne Phothimon</td><td>Staff</td><td>lyn@enaca.org</td></tr>
<tr><td>Ms. Saowanee Rojanee</td><td>Staff</td><td>kae@enaca.org</td></tr>
<tr><td>Ms. Chomkamol Charoenrit</td><td>Staff</td><td>koy@enaca.org</td></tr>
<tr><td>Ms. Putchararut Ponglumyai</td><td>Staff</td><td>keng@enaca.org</td></tr>
<tr><td>Mr. Andriantafita Razakandrainy Loharano</td><td>Exchange Aquaculture Professional</td><td>loharano@gmail.com</td></tr>
<tr><td>Mr. Rafalimisy Karim Chadno</td><td>Exchange Aquaculture Professional</td><td>karimchadno@gmail.com</td></tr>
<tr><th colspan="3">DOF Thailand</th></tr>
<tr><td colspan="2">Mr. Chirdsak Vongkamolchoon
Deputy Director-General
Department of Fisheries
Kasetsart University Campus
Ladyao, Jatujak, Bangkok 10900 Thailand</td><td></td></tr>
<tr><td colspan="2">Dr. Thavee Viputhanumas
Inland Fisheries Expert,
Department of Fisheries
Kasetsart University Campus
Ladyao, Jatujak, Bangkok 10900 Thailand</td><td>Tel No: +66 85 0706496</td></tr>
<tr><th colspan="3">SEAFDEC-AQD</th></tr>
<tr><td colspan="2">Dr. Frolan A Aya
OIC and Associate Scientist
Binangonan Freshwater Station
Tapoa Pt, Brgy Pipindan
Binagonan, Rizal 1940
Philippines</td><td>Tel No: +63 92 04671753
Email: faya@seafdec.org.ph</td></tr>
<tr><th colspan="3">SEAFDEC</th></tr>
<tr><td colspan="2">Ms. Rattana Tiaye
SEAFDEC Training Department (TD)
97 Phrasamutchedi, Samutprakarn Province 10290
Thailand</td><td>Tel No: +66 2 425 6100
Fax No: +66 2 425 6110
Email: rattana@seafdec.org</td></tr>
<tr><td colspan="2">Mr.Hidenao Watanabe
SEAFDEC Secretariat
Department of Fisheries
Kasetsart University Campus
Ladyao, Jatujak, Bangkok 10900 Thailand</td><td></td></tr>
<tr><td colspan="2">Mr.Tadahiro Kawata
SEAFDEC Secretariat
Department of Fisheries
Kasetsart University Campus
Ladyao, Jatujak, Bangkok 10900 Thailand</td><td>Tel No: +66 2 940 6326 Ext. 115
Fax No: +66 2 940 6336
Email: kawata@seafdec.org</td></tr>
<tr><td colspan="2">Mr. Aung Toe
SEAFDEC Secretariat
Department of Fisheries</td><td>Tel No: +66 91 1793823
Email: aungtoe123@gmail.com</td></tr>
</table>

Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900 Thailand	
Mr.Leng Sam Ath SEAFDEC Secretariat Department of Fisheries Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900 Thailand	Tel No: +66 89 2322151 Email: samath@seafdec.org
Ms. Hotmaida Purba SEAFDEC Secretariat Department of Fisheries Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900 Thailand	Tel No: +66 81 4730631 Email: hotmaida@seafdec.org
Mr.Tran Van Hao SEAFDEC Secretariat Department of Fisheries Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900 Thailand	Tel No: +66 90 5738656 Email: tranhao@seafdec.org
Mr. Neil Kenneth P. Catibog Rfpn-Phils, SEAFDEC Secretariat Department of Fisheries Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900 Thailand	Email: neil.catibog@gmail.com, neil@seafdec.org
Mr. Hajime Kawamura DSG, SEAFDEC Secretariat	Email: dsg@seafdec.org
Mrs. Sumitra Ruangsivakul Socio-Economic Section Head SEAFDEC Training Deaprtment P.O. Box 97 Phrasamutchedi, Samutprakarn 10290, Thailand	Tel No: +66 2 425 6157 Fax No: +66 2 425 6110 Email: sumitra@seafdec.org
Ms.Imelda Rantty SEAFDEC Secretariat Department of Fisheries Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900Thailand	Tel No: +66 916254959 Email: imeldarantty@gmail.com
Mr. Yuttana Theparoonrat SEAFDEC Training Department P.O. Box 97 Phrasamutchedi, Samutprakarn 10290, Thailand	Tel No: +66 2 425 6157 Fax No: +66 2 428 6110 Email: yuttana@seafdec.org
AIT	
Dr. Amararatne Yakupitiyage Associate Professor Aquaculture and Aquatic Systems Asian Institute of Technology P.O. Box 4, Klong Luang Pathumthani 12120 Thailand	Tel No: +66 2 524 5456 Fax No: +66 2 524 6200 Email: amara@ait.ac.th
FAO RAP	
Dr. Weimin Miao Aquaculture Officer Food and Agriculture Organization FAO, 39 Phra Atit Road, Bangkok, Thailand 10200	Tel No: +66 2 697 4000 Fax No: +66 2 697 4445 Email: weimin.miao @fao.org
TICA	
Mr. Wattanawit Gajaseni Director, Countries Partnership Branch (Bilateral and Trilateral)	
Ms. Angsana Sihapitak Deputy Director General	

Other Participants	
Mr. Mohammed Tarique Sarker Director (R&D) Fishtech (BD) Ltd. H #02, R#07, Sector #05 Uttara, Dhaka-1230 Bangladesh	Tel No: +88 1926990500 Email: tarique_fc@yahoo.com, fishtech_bd@yahoo.com

Annex C: Distribution of Fish Production by Source and Destination



ANNEX D: THE APPROACH OF LOCAL DEVELOPMENT

This approach has three components:

a. Participatory diagnosis or concerted

It puts the fish farming candidates at player position; it favors the expression and understanding of beneficiaries onto themselves, their socio -economic activities of production (including fish farming) and their environment. Participatory diagnosis is coupled with technical studies and investigations of the project team[17]. These technical studies and investigations are only limited to the collection of accurate data, that are used to feed the reflection of the villagers during the participatory diagnosis; then they are used to verify the feasibility of actions that the villagers are planning to implement. Both diagnoses are updated periodically. The purpose of the exercise is to achieve describe and characterize the functioning of the environment. This allows define the actions of the project team taken as an operator and to harmonize these actions with projects and behaviors of others stakeholders, which become partners.

b. Community information

Following diagnosis, the intervention of the project team is presented as a service offering; this assumes that the beneficiary communities know the contents of the fish farming program and receive interest. Start working with a community is so done from the information on the possibilities of support and mutual commitments in four steps: know each other, think, organize, evaluate and act.

c. Outline a plan for the fish farming project implementation in the locality

It is to: i) order information and proposals collected during diagnostics in order to show the main ideas, the general guidelines, the zonal and sectorial specificities, ii) identify the objectives and priority actions, iii) Interpret the solutions proposed in reference to the requirements of local development (that is to say what is or is not the conditions for a controlled development by the population giving priority to its own needs). In this context, we note seven principles:

1. Maintain and increase the productive potential through better management of water and soil (these two elements representing the entire capital base of the rural economy).
2. Increase the performance of production systems to better meet the needs of the population and, as a priority, food and health.
3. Promote accumulation to the community benefit in order to empower people to create and strengthen the common services. The primacy of the collective benefit on the individual profit ensures control of the resource, and it also avoids too uneven accumulation detrimental to the balance of the group and its relationship with the environment.
4. Diversify the local economy through a more complete control of the production process, including:

[17] Studies and surveys include: patterns of land ownership and management, the social organization of work and its evolution, existing infrastructure, economic activities and the integration of the village into the local economy, means of production, family economic stability, agricultural cropping systems and farming systems.

- Production of the means of production on site (seeds, tools, wells, for example);
- Enhancement of primary site to increase their value added products;
- Control of marketing.

5. Search the diversification of avoiding their accumulation in clusters which then would create a socio-economic imbalance.
6. Reply to agro -ecological priorities (protection and regeneration of natural resources, not predatory exploitation) and human (food, health).
7. Strengthen management capacity by structuring the society into decision-making center in farming and rural organizations, adapted to different functions:
    - decision making, coordination;
    - Information, support, technical training;
    - Orientation and objectives monitoring, evaluation and sanctions

ANNEX E: EVALUATION OF THE RESULTS OF PPCO

The positive results of the Pilot Project PPCO must not make forget the key issues on which the project could not formulate operational proposals. These questions are fourfold :

1. The unfinished reflection on peri-urban models
The necessary reflection that was to accompany the efforts of fish farmers in peri-urban areas was quickly abandoned in favor of the rural models. Many farms in semi- intensive type still operate in these areas independently. They are showing stability and amazing competitiveness to compete for lake fish. Proper monitoring of these experiments would have to fertilize the overall General Discussion and propose a model of sustainable development, additional to achievements in rural areas. The project has rather folded so as doctrinaire about its achievements in rural areas. This decline is reflected also by a strong censorship exchanges with other fish farming projects up to systematic rejection of any option or development model.

2. The unfinished professionalization of training groups
Training groups that were to serve as a support for the establishment of a functional and independent sector, have not progressed beyond the first installation needs of focus zone of production (pooling of building materials and of labor force, etc.). In fact, usually after 2-3 years of operation, the planners were regularly destabilized by the reluctance of the project. The project objectives were to make emerge autonomous social control around ponds construction planners. This was to ensure responsible management of pooled material (including topographic glasses), to maintain a good price and good quality of service.

However, the assessment criteria set unilaterally by the project remained very subjective, as any breach of the participatory approach. So ponds construction planners have felt this as a flange to the initiatives of groups and an obstacle to their own autonomy, voluntarily maintained by the project. They were demobilized in their role as catalysts of training groups dynamics. The privatization of their services and the organization of the profession which should guarantee the sustainability of the achievements have not been brought to completion.

At the end of the project, out of the 19 ponds construction planners trained, there were only 3-4 truly operational. They have started businesses in surrounding himself with a team of jobbers. They still continue to install new fish farmers at the rate of about 10 farms per year. One year after the completion of the project, production increased by 6.7 %, thanks in large part to the quasi-autonomous activity of ponds construction planners and jobbers.

Two associations have been created to support fist the legacy of PPCO, and secondly to implement the aim of structuring the industry: the first, APDRA-CI[18] is supposed to take over and develop the acquired of the PPCO and the other, the Association of Fish Farmers Supporters of APDRA-CI must

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[18] APDRA: Association for aquaculture and Rural Development in Tropical Africa. The APDRA-CI is the section in Côte d'Ivoire and APDRA-F, is the France section.

unite the activities of training groups. A third association, APDRA-F, was created to provide various forms of support to the first two and promote the achievements of PPCO off the Ivorian border. Despite the stated objectives, the operation of APDRA -CI, and of the "Fish Farmers' Association Supporters (APS) was not satisfactory.

3. Marketing systems

Thinking about marketing systems would allow better management of production cycles and marketing support. It has been limited to intuitive unstructured actions. Until now, mainly the annual nature of craft production still brings fish farmers to match the cycle ends with the end of holiday periods.

We are witnessing a massive production from November to January or even March. During these periods, the demand for fresh fish is high when the fish of the lake, which are the main substitutes for farmed fish, are rare on the market. This strategy for the business aimed to facilitate selling of fish into major cities and get good prices.