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AQUACULTURE ASIA

Pond aquaculture taking off in Nepal

Culture-based fisheries in Lao PDR and Cambodia

Polychaete fishery, India

Pond sediment for gardens

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NACA

An intergovernmental organisation that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

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Special session on Regional Cooperation for Improved Biosecurity.docx

Early last year NACA was privileged to have Prof. Roger Doyle visit our office, where he gave a lecture on what we think is going to be a hot topic in the near future. His lecture was entitled “Artisanal tropical aquaculture in a genetic plunge towards extinction?” His hypothesis was that there is a relationship between high levels of inbreeding and susceptibility to disease. We recorded the lecture and you watch a video of it at:

http://www.enaca.org/modules/podcast/soundtrack.php?soundtrack_id=144.

Since the topic appeared worthy of investigation, NACA followed up later in the year by convening an Expert Consultation on Genetic Erosion Risk Analysis for Shrimp Diseases in Asia. This consultation was perhaps the first of its kind to bring together a balanced group of experts from diverse fields – epidemiology, microbiology, disease diagnostics & surveillance, aquaculture genetics, fish breeding, and evolutionary biology – to take a fresh, in-depth, and wider perspective on the possible interaction between genetic side-effects of broodstock management and the looming threat of aquatic animal diseases, in particular the contemporary shrimp disease crisis. The proceedings from the meeting are available for download at:

http://www.enaca.org/modules/library/publication.php?publication_id=1129

To bring this and related issues before a wider audience, NACA, with financial assistance from ACIAR, will convene a half-day special session on Regional Cooperation for Improved Biosecurity at the World Aquaculture Adelaide Conference and Trade Show, 7-11 June 2014. The session will address three topics:

1. Regional cooperation for minimising risks from transboundary aquatic animal diseases.

2. Dealing with emerging diseases, with a focus on shrimp acute hepatopancreatic necrosis syndrome (AHPNS).

3. Implications of domestication programmes and health management.

The third component will largely deal with the genetic erosion issue, and will feature a presentation from Prof. Doyle which will include material from the expert consultation.

We heartily commend this session to those attending the conference (recordings will also be made available later). We have known for quite some time now that the aquaculture industry needs to start paying some serious attention to genetic management; this is yet another reason why. Turn up and participate in the discussion if you can!

Simon Wilkinson

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Peter Edwards writes on

Rural Aquaculture

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Pond aquaculture is taking off in Nepal

During my brief stint as Adviser to NACA's Sustainable Farming Systems programme, I joined a three man team on a 10 day scoping mission, 'Identification of Potential Opportunities to Enhance the Contribution of Aquaculture to Sustainable Rural Livelihoods, Farm Incomes and Food Security in Nepal', in March 2013. The other two members of the mission were Dr Ambekar Eknath, Director General of NACA and Dr Ram Bhujel, Senior Scientist, Aquaculture and Aquatic Management Program, Asian Institute of Technology (AIT), a Nepali citizen who spent an inordinate amount of time helping to organise the mission as well as the National Seminar on Aquaculture that was held over a two day period at the end of the mission. We were privileged to be accompanied for much of the field trip by the two most senior aquaculture officials in the country, Rama Nanda Mishra, National Program Chief of the Fisheries and Aquaculture Development Program, and Rajendra Kumar, Fisheries Program Director of the Directorate of Fisheries Development (DoFD), who provided much insight into aquaculture development in Nepal, past, present and future apirations.

A fish shop in the Terai.

Pond aquaculture was visited in the central area of the subtropical Terai region of the country, the major area for the production of fish in the country. Visits were made to a government fisheries station, several fish farms of varying scale (small, medium and large-scale) as well as fish markets in the Terai and the capital city, Kathmandu located over 100 km away and linked by a narrow and tortuous mountainous road.

Rohu and striped catfish in a Kathmandu fish shop.

Background

Developmental context

Nepal is one of the least developed in the world according to the World Bank Agriculture and Food Plan for the country, ranking 142 out of 177 countries in the UNDP Human Development Index (World Bank, 2010). The average household owns 0.8 ha of land but a majority of households own less than 0.5 ha, with a trend of decreasing average household farm size. Most agricultural holdings are subsistence family farms with only a very small percentage actual commercial farming operations.

Poverty in the country is widespread with a third of the population below the national poverty line of about USD 100/caput/year). The Human Poverty Index rates Nepal 84th out of 108 developing countries with malnutrition rates among the highest in the world. It is estimated that 50% of children under 5 years of age are stunted and 24% of all women are undernourished and in the Terai, this figure is 33%. More than 50% of all Districts in Nepal are food-deficit.

Carps in a fish retail shop in the Terai.

This dire situation was reconfirmed during the mission by an article in a local Kathmandu newspaper entitled 'Nepal ranks low in human development group' based on the just released UNDP report, "The 2013 Human Development Index's (HDI) Multi-dimensional Poverty Index" which revealed that 44% of Nepalis live in multi-dimensional poverty.

Fisheries and aquaculture

The DoFD estimated total fish production (catch and culture) to be 45,000 tonnes in 2008 (Bhujel, 2008). Annual per caput consumption of fish of less than 2 kg is extremely low and far below most other Asian countries, many of which have per caput fish consumption of at least 20 kg. Fish provides only 18% of the national animal protein supply. This low fish consumption is not due to low demand which is increasing markedly but to low fish availability because of declining wild fisheries and the relatively low state of development of aquaculture in the country. A recent survey showed that about 60% of the fish consumed in Nepal is imported from India. An indication of the scarcity of fish was a comment from a fish retailer in the Terai, the main aquaculture area of the country, who told us he had to travel 50 km to obtain fish to sell in his shop from a fish farm. However, aquaculture

Chaddhi made from farmed rohu on a market in Kathmandu.

is becoming a highly profitable business; farmed fish in the Terai, mainly carps were retailing for US$2.9-3.3/kg, slightly lower than chicken at US$3.3/kg and much lower than goat at US$6.1/kg.

Hetauda Government Fish Station.

Aquaculture development in Nepal began over 50 years ago. According to Rama Nanda Mishra, carp seed was first transported from Bihar in India, 60 km south of the Nepali border and subsequently transported on foot to Kathmandu. As this was in the pre-artificial hormonally-induced spawning days, significant progress was not achieved until 1968-1973 when the famous Hungarian aquaculture specialist, Elek Woynarovich, as an FAO consultant advised on fish farm construction, bred Indian major carps and Chinese carps and introduced pond fertilisation and integrated farming with ducks (FAO, 1974) into the country. Woynarovich (1975) also wrote a seminal book on fish culture in Nepal.

Fish farm cluster at Lathar

Two Asia Development Bank (ADB) projects further stimulated fish culture between 1988 and 1994. The First Aquaculture Development Project upgraded existing government aquaculture stations and built carp hatcheries to provide seed in five districts and was said to have been very successful. However, the Second Aquaculture Development Project to attempt to expand fish production in the country by medium and large-scale farmers with land holdings of 2-3 ha (GON/ADB, 1985) was considered to have been less successful, probably because of relatively limited demand for cultured fish and constraints in marketing fish in a country with very poor infrastructure at that time. According to Rama Nanda Mishra, the project was ‘before its time’. Some of these farmers had been organised in clusters in the Terai e.g. Bodhban ‘fish village’ in Bara district which the mission visited.

Cooperative farmers meeting the Mission, Bodhban Fish Village.

A government programme, ‘Fish Mission’ in its 5th year at the time of the visit was leading to major increases in fish production through upgrading ponds built through the Second ADB Project as well as the construction of new ponds. The four aims of the programme are to subsidise pond construction to increase the area of fish culture, to intensify production through mechanisation (provision of small-scale pelleting machines and aerators), to provide market support, and capacity building. Subsidies were also being provided to hatcheries to facilitate an increase in fish seed. The Government was providing loans to farmers for construction of fish ponds with an annual interest rate of only 9% compared to the usual 13-14% bank rate, with the Government making up the difference if the bank would not agree. A circular had been sent to all banks as a directive from the Bank of Nepal that at least 20% of all loans should be for agriculture, including aquaculture.

However, 10-20 times as many farmers were investing in aquaculture than those receiving government subsidies. Large-scale farmers reported that they had visited India, especially Andhra Pradesh, the ‘fish bowl ‘of the country to gain first-hand experience of carp and striped catfish culture, as well as to purchase small pelleting machines.

A major distinguishing feature of aquaculture in Nepal compared to most countries in South and Southeast Asia is an almost total lack of small-scale ponds with extremely limited involvement of small-scale farming households in aquaculture. While the ADB Second Aquaculture Development Project led to an increase in fish production in the country, small-scale farmers were effectively barred from participating in the project because the Project Implementation Procedure stipulated that credit was not to be extended to ponds smaller than 0.2 ha (GON/ADB, 1985), far too large a pond size for new entrant small-scale farmers to be able to construct and manage.

A success story of the development of small-scale aquaculture for the rural poor is the collaborative AIT/ Institute of Agriculture and Animal Science (IAAS) Women in Aquaculture Project launched in 2000 in Chitwan and Nawalparasi districts in the Terai. Small-scale aquaculture has been integrated into the existing farming system through the formation of women's groups, now organising as cooperatives. The conceptual Model (Shrestha et al. 2009; Bhujel et al. 2008) includes formation of fish farming groups (15-20 farmers/ group), a small fish pond (about 200 m^2) close to the house, fertilisation of the pond water to enhance natural food through production of 'green water', use of kitchen wastes and on-farm by-products as supplementary feed, and growing vegetables for human consumption on pond dikes using fertile pond water. An average of 40% of the fish is consumed by the farming household with the remaining 60% sold to provide income. The model has been highly successful with an increase in size of many of the ponds as well as the construction of new ponds in project areas both during and after the project period. More recently, the model has been successfully introduced into Lamjung and Gorkha districts in the Mid Hills supported by the NGO Aquaculture without Frontiers (AwF) (overviews of both projects in Edwards, 2011) and into Western Nepal by USAID with over 1,000 family fish ponds constructed and another 1,000 ponds planned (Pandey and Khatiwada, 2009). The proven model, tested in both the Terai and the Mid-Hills, should be expanded

Pigs integrated with fish, Lathar.

Harvesting chhadi, Benauli.

Layer chickens integrated with fish, Kathar.

Scaled-up fish ponds, Kathar.

throughout the country to increase the welfare of poor farming households through provision of fish as food and as a source of income.

Farm visits

Hetauda Government Fish Station

The 48 ha station was built in 1968 as a commercial fish farm through the World Food Programme to supply fish to Kathmandu although fish are now marketed in the Terai with growth of local demand. Some grow-out of fish is still being carried out on the station but its main purpose is to produce and distribute fish seed to local farmers although the private sector is reported to be now supplying almost 80% of the nation's fish seed, reflecting the accelerating development of aquaculture in the country.

Seven species of fish are cultured, three Indian major carps (catla, *Catla catla*; mrigal, *Cirrhinus mrigala*; and rohu, *Labeo rohita*), three Chinese carps (bighead carp, *Hypophthal-michthys nobilis*; grass carp, *Ctenopharyngodon idella*; and silver carp, *Hypophthalmichthys molitrix*) and common carp (*Cyprinus carpio*). Ponds are fertilised with mainly cow and buffalo manure, with rice bran and oil cakes moistened and made into balls as supplementary feed. As production in grow-out ponds is only 3.5 tonnes/ha, improved fertilisation with higher quality feedlot chicken manure could improve yields. Such manure is available locally but is transported to mountainous fields for crop production.

Nursing was reported to be very poor with only 20% survival from hatchling to fingerling. Nursing in hapas in the pond rather than pond nursing would lead to increased efficiency.

Small-scale Chinese pelleting machine, Bodhban.

Small-scale Indian extruded pelleting machine, Kathar.

Coversion of rice fields to fish ponds.

During the Woynarovich era, 2,000 ducks and 200 pigs were integrated with fish but it was not economic. Demand for ducks is still only high during a religious festival in October.

Bodhban Fish Village

This cluster of 1,200 farmers managing 1,400 ponds with a total water surface area of 100 ha started under the Second ADB Project. Progress was slow in the earlier years but aquaculture has expanded over the past 10-15 years. The 'fish village' as it is known functions as a cooperative for input supply and marketing of fish but the farmers work independently. Ponds were developed initially from a low-lying swamp within a forest although more recently rice fields have been converted into ponds.

As for the majority of fish farms in the Terai, seven species of carps are raised in polyculture although grass carp, mrigal and rohu dominate production as these species fetch the highest prices. Urea (0.5 kg/333 m^2 and DAP (1kg/333m^2) are used as fertilisers at 15 day intervals with rice bran and oil cakes as supplementary feed although the cooperative recently purchased a Chinese pelleting machine with a capacity of 50 kg/hour for US$ 1,000. An impressive yield of 6 tonnes/ha was reported with live fish sold through their own shop in Kathmandu.

Lathar

This cluster of 20 farmers managing 49 ponds with a total water surface area of 13 ha was developed through the Fish Mission programme from 2007. The area is located alongside a river with the former seasonally water-logged rice fields permitting only a single annual crop of rice converted into fish ponds.

Although chemical fertilisers are used for the carp polyculture, many ponds are integrated with pigs. Yields were reported to range from 3.0 to 7.5 tonnes/ha.

In contrast to the previous farm, the dominant species is the lower value (farm-gate price US $ 1.7) silver carp because, according to the farmers, it grows the fastest compared to the other species although they fetch a higher price of US $2/kg. The cooperative has a series of small holding tanks near the road for marketing fish although most are harvested by middlemen who charge 10 % of the value of the fish for their services.

Conversion of rice fields to fish ponds.

Conversion of rice fields to fish ponds.

Benauli

A relatively new type of aquaculture has been developed over the past decade in this village by the farmers, producing a dried or smoked fish known as chhadi. The traditional source of chhadi, small native species of carp from rivers in the Terai has become depleted. Most stocked fish were stolen from ponds during the recent civil war as it was not safe to guard them at night. Thus, farmers stocked fish at high density and harvested them when still small so they would be able to get at least some financial return from the ponds, leading to the development of farmed chhadi aquaculture. Consumers are unaware whether the chhadi are wild or cultured fish. Mrigal is the most commonly raised species as it resembles small wild indigenous carps although silver carp is sometimes used.

In this village 70 farmers, each with 3-4 1.0 -1.5 m deep ponds, produce chhadi from a total water surface area of 80 ha. The scale of production was reported to be even higher in the neighbouring village of Simraungadh with a total of 300 ha of larger ponds, the largest being 28 ha.

Pesticides are used in pond preparation. Water is supplied by tube wells. Hatchlings are stocked at very high densities of 1 million/ha (100/m^2) with the farm visited reporting an annual production of 540 million hatchlings. Ponds are fertilised with DAP and urea, and rice bran and mustard oil cake are used as supplementary feeds. Harvesting starts 3 months later, each pond being harvested four times per year, producing chhadi of 15-100 g in size, although survival was reported to be highly variable from low to high. Nursing fry in hapas would probably increase the survival rate of what are essentially fingerlings in more conventional aquaculture.

Kathar

The last fish farms visited were in and around Kathar, one of the villages of the small-scale aquaculture 'Women in Aquaculture' collaborative project between AIT and the Institute of Agriculture and Animal Science (IAAS), Chitwan (recently upgraded to the University of Agriculture and Forestry) more than a decade ago. I was pleased to see that most of the small-scale fish ponds are still in operation as well as some having expanded so that aquaculture has become a major livelihood (as also reported in a previous column, Edwards, 2011).

We visited a 5 ha fish farm in the village that had started 2 years earlier. It has 30 ponds ranging in size from 200 m^2 to 0.78 ha, an amazing 'scale-up' from the previous project as I was informed. Nile tilapia (*Oreochromis niloticus*) is being stocked in the usual 7 species carp polyculture. Trials are also being carried out with the native carp, Himalayan or golden mahseer (Tor putitora), an endangered species that fetches more than US $6/kg.

An 8 ha fish farm was in the process of being constructed by a group of six investors, again from rice fields. Several small-scale rice farmers had leased their land to the fish farmer for conversion as they were not interested in continuing small-scale rice farming. The ponds are irregular in shape as they had to follow the shape of the original leased individual rice farms. The farmers had purchased a small-scale Indian extruded pelleting machine from India called 'Dolly' for use on the farm.

We visited another farm, one pond constructed under the Fish Mission programme, consisting of two ponds with a total water surface area of 1.25 ha. Fish culture is integrated with 1,350 chicken layers although feed is also given to the fish leading to an impressive production of 8 tonnes/ha in the aerated ponds. The fish ponds were converted from rice fields five years ago because the farmer reported that gained little profit in rice farming. The farmer still has 3 ha of rice fields but could not convert these into fish ponds because they are too small and located elsewhere.

A large farm belonged to four management graduates, again constructed on rice fields, who told us that they acquired fish farming knowledge from farmer relatives. They had also visited Andhra Pradesh and are using perforated sacks containing a mash of rice bran and oil cake to feed the polyculture of seven species of carp (see my previous column on carp culture in Andhra Pradesh, Edwards, 2008). The carp ponds, fertilised with relatively high-nutrient dairy cow manure, are very green. They are also raising striped catfish (Pangasianodon hypophthalmus) on extruded pelleted feed purchased from a feed mill located 150 km away.

Striped catfish culture is expanding in Nepal. I was reminded that I had visited a catfish farm on a previous visit that was feeding the fish with chicken entrails (see my previous column, Edwards, 2012). However, there are risks in raising a tropical fish species in the subtropical Terai. We were informed that a 30 ha farm had lost their crop of striped catfish from temperature shock when the temperature plunged to less than 10 degrees centigrade.

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Introduction of culture based fishery practices in small water bodies in Cambodia: issues and strategies

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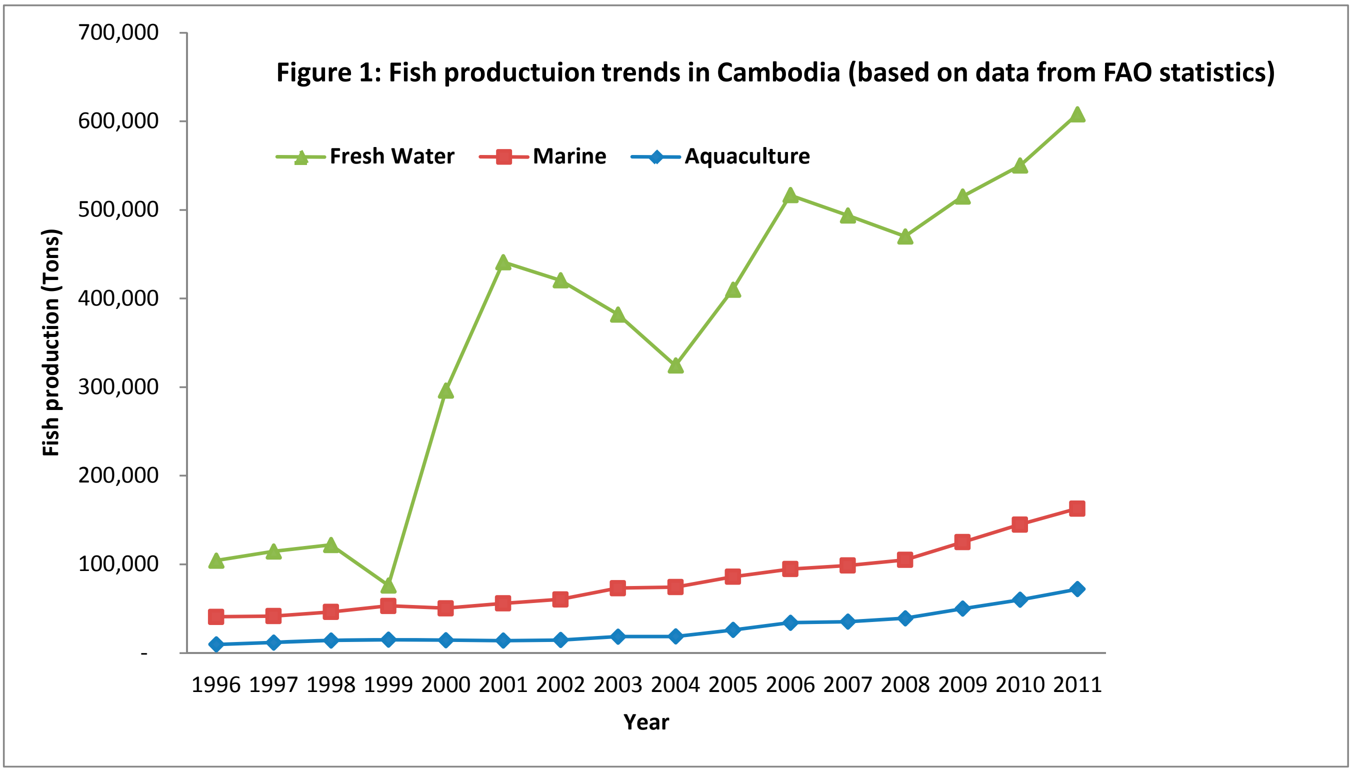
Seed stocks are blessed by Buddhist monks prior to release, in compliance with accepted custom in Cambodia.

Cambodia, bordering Thailand, Vietnam and Laos has an area of 181,035 km^2, with a coast line of 443 km bordering the Gulf of Thailand. It is a country that is blessed with a relatively large amount of inland waters, estimated at 4,520 km^2 (CIA 2013). The population of Cambodia is approximately 15 million (as of 2012). Its climate is tropical characterised by a rainy monsoon season (May to November) and dry season (December to April). Cambodian people are among the highest fish eaters in the world, perhaps reflection of the relative availability, particularly of freshwater fish and other aquatic animals, at an affordable price.

Fish is the most important source of animal protein for human consumption in Cambodia. On average it makes up more than 75% of animal protein and in some areas of the country aquatic resources make up 90% of the available animal protein. According to Ahmed et al. (1998) on average aquatic organisms make up more than 80% of the animal protein consumed in the country and, 90% in fishing dependent provinces such as Siem Reap. Overall, fish consumption is estimated to be around 52.4kg/person/year (MRC, 2007) (whole fish equivalent) and is many times greater than the global average, reflecting the importance of the fisheries sector to the diet and culture of Cambodian people. Processed fish, particularly in the form of fish paste and fish sauce, provide a daily source of fish for the national diet throughout the year and smoothen out the seasonal fluctuations in landings.

The main inland fisheries in Cambodia, until very recently, were the fishing lots in the Great Lake (Tonle Sap) (see for example, Chadwick et al. 2008) and the dai fishery in the mainstream of the Mekong River. The latter is a very seasonal and an intense fishery in which very large quantities of fish in their migratory route(s), primarily carp species, such as *Henicorhynchus* spp. are caught (Adamson et al. 2009). The latter fisheries provide the raw material for the preparation of the various types of fish sauces and pastes that form a crucial component of the Cambodian cuisine. In the recent past changes in the fishery regulations resulted in the prohibition of the establishment of fishing lots in the Great Lake, and thereby opening vast areas of the lake for fishing by individuals on an open access basis (FiA, 2013).

In Cambodia the great bulk of fish production is from the inland capture fishery (Figure 1). This sector has maintained its dominance over the last few decades but there are signs that the levels are plateauing. On the other hand, production from the marine capture fishery and aquaculture has increased only slightly, over the years, and the latter at higher rate. Notably, aquaculture production upsurge began



Regular community consultations are an important entity in culture-based fisheries practices.

Cambodian rural communities fish for edible aquatic food types on a daily basis for family consumption.

around 1998-2000 and has been increasing steadily. With the Government of Cambodia encouraging aquaculture developments such a trend is likely to continue, albeit slowly.

In the wake of the production almost plateauing in capture fisheries and in order to cater to the increasing demand for food fish by a growing population (1.75% per year), the Royal Government of Cambodia is making a concerted attempt to meet the gap between demand and supply through aquaculture development (Government of Cambodia 2010). Accordingly, one of the plausible strategies is to develop culture based fisheries (CBF) in small water bodies located in rural areas; a strategy that is known to be highly successful for example in Sri Lanka, Vietnam and Laos (Nguyen et al., 2005; Wijenayake et al., 2005; Saphakdy et al. 2009; Lao PDR, Ministry of Agriculture & Forestry 2010; Pearce and Templeton 2011, among others).

Culture-based fisheries

Culture-based fisheries are a form of aquaculture that utilise small water bodies, both perennial and non-perennial, which cannot support a fishery through natural recruitment processes, for food fish production through a stock-recapture strategy. Culture-based fisheries are environmentally friendly as the only external input is seed stock. It also engages a co-management approach utilising the downstream farming communities—in most instances already organised into functional entities for dry land agriculture—as the principal beneficiaries (De Silva 2003).

Accordingly, culture-based fisheries have been accepted as a significant development strategy, needing minimal capital outlay, for increasing food fish production and improving rural community wellbeing by most countries in Asia, including Cambodia and Laos (Government of Cambodia 2010; Lao PDR, Ministry of Agriculture & Forestry 2010) and also globally as an avenue for increasing inland fish production (Beard et al. 2011). Culture-based fisheries are an attractive development strategy as it mobilises dry land farming communities (e.g. rice farmers) to use existing water bodies for the secondary purpose of food fish production. Where successfully adopted, culture-based fisheries bring about communal harmony and synergies within farming communities. The strategies to optimise benefits from culture-based fisheries, however, vary in detail from country to country and across climatic regimes.

Application of culture-based fisheries in Cambodian waters

Initiation of the trials

The application of culture-based fisheries in Cambodian waters commenced with the initiation of a project under the auspices of the Australian Centre for International Agricultural Research (ACIAR Project FIS/2011/013), coordinated by NACA. For the initial trial 16 small reservoirs located in four provinces were selected (Table 1). These reservoirs differed from each other in surface area, mean depth and the catchment land use features, the latter evaluated using GIS software. In choosing the reservoirs initial consultations with the village communities responsible for the water regime management were held and their agreement obtained for monitoring and cooperating through the trial period. One common feature in all the reservoirs selected, and for that matter in all water bodies in Cambodia, is the provision of a “conservation zone”, generally in the deeper areas of the water body, where fishing is prohibited.

Catchment land use patterns (detailed in De Silva 2013) were used to estimate the optimal stocking densities for each reservoir. This was based on the principle that catchment land use patterns impact on fish yield in perennial reservoirs (see De Silva et al. 2001) and application of this principle in the absence of any other plausible ways to computing the stocking densities. Based on these computations the reservoirs were stocked with *Pangasius* spp. and *Punitus gonionotus* (silver barb) fingerlings and post larvae of *Macrobrachium rosenbergii* (giant freshwater prawn) in November-Dececember 2012. A total of 1,518,000 seed were used. The choice of species to be stocked was based on preferences of the individual stakeholder communities. In this regard the provincial community groups were requested to indicate the most preferred species, and based on the biology and availability of seed stock of each a rank order was developed. The first five preferred species were used for stocking the water bodies in each province.

Although there was general agreement with the village communities in the immediate vicinity of each water body to refrain from fishing after stocking, for a period of four to six months, it could not be avoided fully. This is because Cambodian fishery laws permit free access to any water body, and secondly the rural poor often fish daily for their food fish needs, often catching very small sized, naturally recruited fish. The weed/forage species most commonly caught belonged to ten families of which those of the Cyprinidae were the most common: *Mystus nemurus*, *M. wolffi* (Family Bagridae), *Channa striata* (Family Channidae), *Clarias meladerma* (Family Clarridae), *Cirrhinus microlepis*, *Cirrhinus*

Table 1. The reservoirs and the surface and catchment areas of each used in the culture-based fisheries trial in each of the provinces (T. = Tumnop - the Cambodian term for Reservoir).

Province/area	Reservoir			
Siem Reap P.	T. Makak	T. Trapeang Toteung	O Kandol	Travkaud
Lake area (ha)	16.9	11	36.30	22.24
Total catchment (ha)	180,376	10,462	5,911	5,478
Kampong Thom P.	Boeung Krochap	Boeung Meas	Boeung Leas	Boeung Trapeang Russey
Lake area (ha)	7.77	20.4	12.5	23.6
Total catchment (ha)	7511	7230	2343	5794
Uddor Meanchey P.	Boeung Lorlom Vean	T. Ta Mok	Boeung Rolom Taneat	Trapeang Ampil
Lake area (ha)	9.5	24	10	44.5
Total catchment (ha)	34231	2034	11859	13581
Preah Vihear P.	T. Trapeang Prey	Srey Snam	T.Meun Reach	T. Kav Pram
Lake area (ha)	2.30	12.2	7.8	54.4
Total catchment (ha)	72.5	1247	664	4666

Table 2. The number of species caught, the number of active fishers and the monthly total estimated catch May 2013) during the CBF trial in each of the reservoirs in each of the provinces.

Province/area	Reservoir			
Siem Reap P.	T. Makak	Toteung T. Trapeang	O Kandol	Travkaud
No. of species caught	14	10	12	11
No. of active fishers	15	5	16	5
Estimated catch (May)	562.5 kg	150 kg	621 kg	150 kg
Kampong Thom P.	Boeung Krochap	Boeung Meas	Boeung Leas	Boeung Trapeang Russey
No. of species caught	13	16	13	10
No. of active fishers	5	15	10	15
Estimated catch (May)	112.5 kg	445 kg	270 kg	600 kg
Uddor Meanchey P.	Boeung Lorlom Vean	T. Ta Mok	Boeung Rolom Taneat	Trapeang Ampil
No. of species caught	11	14	11	12
No. of active fishers	15	12	7	7
Estimated catch (May)	562.5 kg	360 kg	140 kg	105 kg
Preah Vihear P.	T. Trapeang Prey	Srey Snam	T.Meun Reach	T. Kav Pram
No. of species caught	8	10	8	12
No. of active fishers	5	16	6	15
Estimated catch (May)	40 kg	720 kg	180 kg	900 kg

molitorella, *Cyclocheilichthys apogon*, *Dangila* sp.cf.*cuvieri*, *Dangila spilopleura*, *Hampala dispar*, *Henicorhynchus* spp., *Osteochilus hasselti*, *Osteochilus schlegeli* , *Hypsibarbu* spp., *Leptobarbus hoeveni* , *Puntioplites falcifer, Puntius brevis*, *Rasbora tornieri*, *Thynnichthys thynnoides* (Family Cyprinidae), *Oxyeleotris marmorata*, (Family Eleotridae), *Notopterus notopterus* (Fam: Notopteridae), *Trichogaster pectoralis* (Family: Osphronemidae), *Pangasius larnaudiei* (Family: Pangasiidae),

Acantopsis (Family: Percophidae), *Pristolepis fasciata* (Family: Pristolepididae), *Boesemania microlepis* (Family: Sciaenidae), and *Hemisilurus mekongensis*, *Micronema bleekeri*, *Ompok hypophthalmus*, *Wallago attu* (Family: Siluridae).

Needless to say among these catches were stocked species, caught under-sized, long before attaining a marketable size, which would result in obtaining sub-optimal yields from the culture-based fisheries activities. However, the results thus far indicated that the yields have risen considerably over pre-stocking levels and the mean size of fish caught was also considerably higher. Table 2 provides information on catches in May 2013. It is evident, and as expected the yield varied considerably among the different reservoirs. Attempts to ascertain for the reasons for this wide range in yield will be made later at the end of the study when a complete data set for two growth cycles are obtained. Importantly all indications are that the fish production in all the reservoirs have increased considerably and the communities are satisfied with the outcome thus far. However, if the culture-based fisheries practices could be improved as considered in the following sections the gains could be increased significantly.

Issues associated with optimisation of returns from culture-based fisheries

The best results in culture-based fisheries are obtained when:

- The natural productivity (e.g. chlorophyll content, and nutrient loads) are relatively high, often brought about from the runoff from a catchment with considerable proportion of forest/grass cover etc.
- Forage fish and other predatory aquatic organisms are eliminated and or minimised.
- Correct species combination is utilised at stocking.
- Seed stock is of good quality and of appropriate size (larger fingerlings generally have better survival).
- The water level recedes at a suitable rate.
- Poaching is curtailed.
- Fish sanctuaries are established in all project sites.
- Fishing does NOT take place for a four to six month period after stocking.

Overall management of the water body, including the maintenance of suitable water regimes in the grow out period is effective and efficient.

It is seen from the above that yield optimisation will depend on the nature of the water body as well as on some management criteria, such as for example use of the correct species combination and prohibition of fishing for four to six month period after stocking. The question therefore is to what extent do the Cambodian water bodies, in general, comply to the above criteria. Obviously, one would not expect each and every water body to satisfy all of the criteria.

Aspects that negatively impact on the practice of culture-based fisheries in Cambodia

Firstly, culture-based fisheries are new to Cambodia. In the past with an abundance of fish from the Great Lake and also in the Mekong and associated waterways there was no dire need to adopt culture-based fisheries and the like. However, as previously stated the situation has changed and there is an urgent need to step up food fish production to meet the shortfall in demand. The water levels in small water bodies in Cambodia, unlike most other Asian countries where culture-based fisheries are practiced, do not recede to a great extent. As such the former are mostly perennial. This makes it difficult, if not impossible, to eradicate weed/ forage fish and other predators prior to stocking. On the other hand, the continued fishing helps to keep weed/ forage fish abundance in check, and also provides an important food fish source.

Perhaps the most detrimental aspect is the continued fishing, even immediately after stocking, which does not provide sufficient time for the stocked fish to reach a marketable size. The communities in the immediate vicinities of the trial sites, when explained, understand the need to refrain from fishing for a few months after stocking. Because of this understanding the fishing pressure in the immediate post stocking period has decreased and hence the increased size of the landed fish and the overall increased yields. However, it is desirable to adopt strategies, within the framework of the Cambodian fishery regulations, and the rural cultural habits to further enhance the fish production.

Plausible strategies to enhance the outcome from culture-based fisheries in Cambodia

It is evident from the foregoing sections that in spite of the negatives practices in Cambodia are beginning to yield favourable results and are likely to take root throughout the country. One of the plausible strategies to further optimise the outcome from culture-based fisheries practices will be to utilise the “conservation zone” in each water body, in an effective manner.

Cambodian people adhere strictly to avoid fishing in the conservation area in a water body; this is ingrained into the public mind set. From a culture-based fisheries view point it will be desirable to increase the conservation area by a further 10 to 15 % and then cordon off this area with a net or bamboo fencing. Always introduce the seed stock into the conservation area and the netting it off would minimise the movement of the fish to the rest of the water body, thereby giving a higher probability for them to grow to a bigger size and avoid predators later on. The netted fish may be released after four to five months and the normal fishing activities could resume. It is also suggested that the catches two days after the netting is removed be designated a "communal catch', and this catch be sold in the open market and all the proceeds be used for the purchase of seed stock for the next growth cycle. In this manner it is expected not only a significant increase in fish yield but also ensure the sustainability of the process and become independent of external sources to fund the cost of seed stock and expenditure incurred on improving the physical structure of the water body.

The above strategy has been accepted in principle by all the communities engaged in the present trial. Indeed, in the consultations the communities were of the view that this strategy is easily implementable. The next growth trial will estimate the impact of this strategy and if the results are positive will advise the Government to follow this path in extending culture-based fisheries to other provinces. It is important to note that this proposed strategy does not interfere with the Cambodian fishery regulations and nor does it interfere with the rights of access to fish in water body.

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A case study on polycheate fishery by the Irular tribal fishing community on the Tamil Nadu Coast

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The Irulars are a non-traditional fishing community living in the Pitchavaram region, primarily harvesting the fishery resources of the mangroves for their livelihood. Historically their ancestors migrated from Andhra Pradesh and engaged mainly in a hunter-gatherer lifestyle. As the years rolled by some of them started serving in the casuarina and coconut plantations of local farmers as bonded labourers, eventually developing their own unique fishing methods and transitioning into fisheries as a mainstay occupation. Most Irular fishers eke out a living capturing shrimp by hand from mangrove areas. This activity is principally conducted by women.

Fishers sit on their knees in shallow mangrove waters, stretching out their arms and moving their hands across the surface of the mud from the sides to the front. If they feel they have made contact with a shrimp, they grasp it and bring it to the surface to be washed and placed in a pouch, which is held between their teeth. Repeating this process the fishers move forward until they reach deeper waters. They may fish for shrimp in this method for five to six hours at a stretch until the end of the low tide period with a break in between. They cannot fish during the high tide. Almost the entire Irular population depending on the Pitchavaram mangroves practice this method of fishing with great difficulties.

This method of fishing has been practices for many years. In the past both men and women were involved, but the men mainly switched to other methods of fishing once boats and gear were introduced. Hand fishing generates a very meagre income that is not sufficient to meet their daily needs, so fishers must either supplement their income from other sources or borrow from money lenders to purchase boats and gear, which is not affordable by everyone. Thus, some of the fishers have switched to fishing for polychaete worms along the intertidal region of mangrove environment.

Polychaete fishery

Polychaetes ("many hairs") are bristle-bearing worms and the most diverse class of Phylum Annelida with approximately 12,000 described species. These worms are multi-segmented and many species are found living on the sandy or silty bottoms of intertidal or sub-tidal regions, since they can tolerate low saline and poor oxygen levels in the water. Polychaete worms are commonly called as omega worms due to their high content of omega-3 polyunsaturated fatty acids (PUFA) (Lytle et al, 1990; Olive et al., 1992). During the nineties, the coastal polychaete fishery peaked and it was ignored afterwards in view of the report stating that these worms may be passive vectors of white spot virus to *Penaeus monodon* broodstock (Vijayan et al 2005). However, after the introduction of *P. vannamei*, an exotic shrimp species often thought (incorrectly) to be resistant to white spot this fishery regained popularity. Hatchery owners feel that the maturation of *P. vannamei* is faster when they are fed on polychaete worms and the egg to nauplii recovery is also increased about 60 to 65% compared to only at 20 to 25% in shrimp fed on other live feeds.

Worm collection is particularly popular amongst the Irular communities who reside in Pitchavaram and Palaverkadu regions of Tamil Nadu state. As stated above, this community was primarily engaged in fishing including hand capture of shrimp in mangrove areas. They also had previous experience in worm collection to use as bait while fishing with hook and line. However, it was only after being approached by shrimp hatcheries that worm collection became a major livelihood and source of income for this community. Now there are about 200 families involved in worm collection on a semi-regular basis. The worms are found to occur commonly on the edges of forest areas, near shrimp farms, mangrove regions and river mouths. Regular collection of worms takes place in the Vettuvaikal, Mandathuraivaikal and Kutchipalaiyam in Pitchavaram mangrove regions. Other areas where worm fisheries occur include Karaikal, Karukalacheri, Tranquebar, Poombhuhar, Pazhayar, Kottaimedu, Madavaimedu, Cuddalore, Marakanam, Kadapakkam, Muttukadu, Ennore creeks and Palaverkadu.

Use of polychaetes in shrimp aquaculture

Polychaetes are commonly used as component of the maturation diet of *Penaeus* shrimp brood stock in hatcheries all over the world due to their high nutritional value (Bray & Lawrance 1992). In India, almost all shrimp hatcheries use polychaetes to promote maturation and spawning of shrimp broodstock. Furthermore, polychaetes constitute prominent zoo benthos in shrimp farming systems and have been recognised as an important prey item of several Penaeid species (Nunes et.al 1997). Their lipid contents may provide a source of essential polyunsaturated fatty acids (PUFA) especially the n3–C22 and n3-C20 classes of fatty acids which are essential for the production of high quality of seedlings of fin fishes and crustaceans (Murugesan et al., 2009). Inoculation of polychaetes in shrimp ponds is a common practice in many countries (Nunes et al 2000), although given the possibility that the worms may be a vector for whitespot virus **this practice should not be followed in the interests of biosecurity**. In India, polychaetes collection has emerged as an artisanal fishery in many coastal states and the annual consumption of polychaetes by shrimp hatcheries is estimated to be about 6 tonnes to 20 tonnes (Vijayan et al 2005). As there is no polychaete aquaculture in India, the entire polychaete biomass used in shrimp aquaculture is collected from natural habitats.

Before the introduction of *P. vannamei*, *P. monodon* were also provided with polychaetes, but it required only minimal

Polychaete collection site near Pitchavaram - marshy land.

Polychaete collection site - back water near Kalpakkam.

Polychaete worm burrow identification.

Irular pairs collected polychaete near Pitchavaram.

quantity of feed due its low stocking density compared to *P. vannamei*. Polychaete worms are fed to shrimp during the night hours since it is thought to facilitate spawning and maturation process (Luis and Ponte, 1993; Gopakumar et al., 2001; Ignatius et al., 2001., Murugesan et al 2011). Each tank is about 110 square metres and holds 300-400 broodstock. Hatcheries formerly met demand by contracting local people to collect the required amount of worms. However, with the introduction of *P. vannamei*, which is said to be fast-growing species, at least 10 kg of worms is needed each day to sustain about 600-800 shrimp. Therefore, the hatcheries heavily depend on Irular community because of their unique skill set and ability to do the taxing physical work which is necessary to collect large amounts of worms. In fact, agents from the hatcheries reported that the hatcheries tried other ways to collect the worms initially, but later turned to the Irular community, whom they considered to be “specialists” in this type of work.

Method of worm collection by Irular fishing communities

The materials used in collecting worms include a spade and two plastic boxes, one with water and another without water. The method of collection begins with the identification of worm burrows. If there are worms underground, the soil will be peppered with small holes and small balls of dirt. Once a likely worm burrow is identified, pairs of two will work together to collect the worms, mostly husband and wife. A spade is used to quickly heave up the soil while the second person breaks up lumps of earth and collects the worms before they can escape. Worms are first put into the plastic box with water to be quickly washed before they are put into the second empty plastic box.

After removing all the worms that they can find after the initial hacking of the ground, the process is repeated until the holes are roughly the 5-6 feet deep. One such pit will usually produce about half to one kilogram of worms. Irulars usually start the work between 9 and 10 am. If the site is teeming with polychaete worms and everything goes well, they may finish their work by noon. However, if the collection is not proceeding as productively, they will often work until the early evening to gather the required amount of worms.

Marketing of worms

The shrimp hatcheries approached the Irular community of Pitchavaram region after experiencing an increased demand for polychaetes due to the fact that this community has the necessary skills to carry out large scale collections of the worms. The system now in use by most hatcheries is composed of main agents, sub agents and sometimes suppliers who act as middle men between agents and the hatcheries. The shrimp hatcheries inform either the main agents or the suppliers as to their requirement and when it will be needed. When a supplier is responsible, he has to provide live or wet feed including squid and oyster in addition to worms and thus use their own agents to pick up the worms from the Irular community. The agents sent from either the company or the supplier will stay in constant touch with a sub-agent who operates at the village level. These sub-agents are responsible for communicating with the community and informing how many families are needed for each order contracted by the hatchery and accompanying them to new locations for collection. After collecting the worms from a particular area, worms will not be available there in sufficient quantity for next six months. For this reason, the sub-agent is also responsible for explaining new locations where sufficient quantity of worms are available in order to fulfil the hatchery’s demand. One-way travel expenses and accommodation are usually arranged by the hatcheries since the villagers stay at least a week at a stretch to finish the collection in new locations. However, food and other expenses to travel back home are borne by villagers themselves. During the collection period, the agents sent by suppliers and hatcheries will come daily to the collection site to transport the worms to the hatcheries. The worms need to be transported immediately in order to keep them fresh and will be used as part of the night feeding routine. When the agents arrive, they weigh the worms collected and pay for the amount they take with them on the spot. The value of 1kg of worms is around 500 rupees

Collected worms from the pit.

Above, below: Women cleaning collected worms for marketing.

Table 1. Polychaete collection sites for Irulars in the coast of Tamil Nadu and Puducherry.

District	Place of collection	Nature of the site
Thiruvallur	Pulicate Lake	Brackish water
Chennai	Ennore creek	Creeks, area of shrimp farm discharges
Kancheepuram	Muttukadu, Kadapakkam, Mahabalipuram	Lagoon receiving shrimp hatchery discharges, brackish water areas
Vizhupuram	Marakanam	Areas near salt pan and Marakanam creeks
Cuddalore	Cuddalore, Pitchavaram	Brackish water area and area of shrimp farm discharges Vettuvaikkal, Mandathurai Vaikkal, Kuchipalayam wetland areas
Nagapattinam	Pazhaiyar, Madavamedu, Kottaimedu, Poombuhar, Tharangambadi	Brackish water areas, wetlands near sea shore, area of shrimp farm discharges
Karaikal	Karaikal and Karukalacheri	Arasalaru river beds, wet land area where mangrove patches available

(US$8). Paired young couples can collect 2-3 kg of worms per day. The collection of a typical day averages from 20-25 kg of with around 15-20 families involved.

Conclusion

There are several obstacles and negative aspects about this new industry. The most prominent drawback is that this industry relies completely on the demand of the hatcheries, and these hatcheries are in complete control of the dynamics of the worm collection. Without an order placed by a hatchery, the Irular community will have no other source to market the worms to, making the work temporary and unstable. This community continues to rely only upon its traditional livelihood of fishing as a source of steady and reliable income. While worm collection is relatively lucrative and perhaps temporary it is beneficial for the short term.

Worm collection offers to the Irular community concerns regarding travel requirements. Migration to new locations is necessary after the worm supply at nearby locations is exhausted, which creates travel-related challenges for the community. Since worm collection is most commonly done in pairs of two with a husband and wife sharing the work, difficulties arise particularly when a couple has kids at home, then they cannot leave for long periods in far off locations. In regards to the physical difficulty of this work, there are many obstacles. Since they do not use gloves, the sand particles and rough soil damages their hands. In addition, the initial hacking of the ground with the spade is especially back-breaking. However, the alternative job of crouching for long periods of time while segregating the clumps of soil to retrieve the worms can also be physically taxing. Since all of this work is also done under the hot sun, dizziness is often experienced by the collectors. Women-headed households are also particularly disadvantaged in this new industry since it is most common for a husband and wife to go together for the collection of worms and the labour is too difficult to perform without a partner to help.

Although the work of worm collection is tough and physically taxing when compared to other fishing methods they are traditionally involved in, the worm collection poses fewer dangers as well as higher economic returns. In addition to the high amount paid for worms, the fact that payment is received on the spot is another benefit. Since the Irular community had previously been involved in small scale worm collection, they already possessed the skill set necessary and were practiced in the method. This made it easy for them to adjust to the demand as well as gave them the advantage over any other groups in providing this service. Since it is also a fishery, the resource is limited and subject to potential overexploitation.

Therefore, realising the increasing demand of these marine worms in the aquaculture industry, this is the right and opportune time to perfect the culture technology for the mass production of polycheate worms.

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Use of pangasius pond sediment for rooftop bag gardening: potential for rural-urban integrated aquaculture-horticulture

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Densely populated Asia, the home of most of the world's poorest people, needs new solutions to ensure their food security that builds on traditional reuse and recycling. Urbanisation is both an important cause of lost arable land but also a major demand driver for more and better quality food (Roy, 2009). Bangladesh has a rich food culture based on rice, fish and vegetables. Improved irrigation and other technologies have supported tremendous growth in both rice and vegetable production in recent decades, but there has been a true revolution in fish production over the same period as Bangladesh has increasingly moved up the rankings of global aquaculture producers (currently ranked 5th) (FAO, 1012). This is a seismic change; thirty years ago most of the country's fish production was captured from the open water bodies but it is believed that aquaculture now supplies around half all fish consumed (DoF, 2013). Nationally, cultured fish are still dominated by carps but the high yielding, exotic striped catfish pangasius (*Pangasianodon hypophthalmus*), locally called pangas, that was introduced in the early 1990s, is having a major impact. Fast growing and responsive to artificial feed, pangas is in high demand in both rural and urban markets (Ali et al., 2012). Pangas is also more affordable than many other fish species and is making a significant contribution to the diet of all social classes of people throughout Bangladesh. Estimates of annual production vary but it is believed that it is within the range of 300,000-400,000MT. This level of production has facilitated a large number of employment opportunities both in farming and in upstream and downstream activities (Haque et al., 2009). Growth in demand for feeds have mirrored this rise and a major issue is if the high nutrient flows into pangasius farming can be better integrated with food production as a whole (Belton et al., 2011). Bangladesh continues to have very high levels of landless poor that depend on employment for their livelihoods; a major challenge is if aquaculture value chains can be developed specifically to ensure benefits to this group of people.

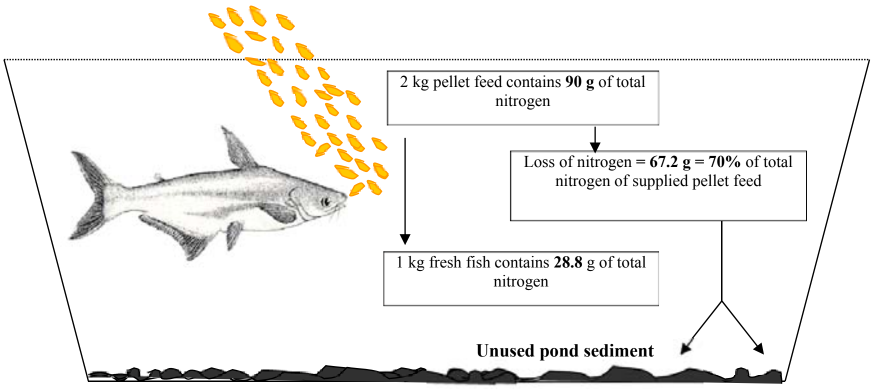
Pangasius farming in earthen ponds has developed as the main intensive form of aquaculture in Bangladesh. Stocking density (50,000-60,000/ha) and annual productivity (50-60 MT/ha) are much higher than for other species. Intensive feeding is required to support such production, with each kilogramme of fish requiring 2 kg of pellet feed. Accordingly, the total amount of feed used per hectare is about 100,000-120,000 kg/year, which results in significant volumes of waste that accumulate as sediment - estimated to be around 15-20 cm over a 2-3 year period. A simple model based on FCR and crude protein content of pangasius suggest that only 30% of the total nitrogen provided in the feed is used in fish growth with the remaining 70% being deposited as waste in pond sediments.

Total nitrogen deposition was estimated from feeding and then cross validated by an analysis of pond sediments. The total nitrogen deposited in two different one hectare ponds after two years was estimated at 17,527 and 14,660 kg. The modest difference between these two estimates is explained by losses through seepage, drainage during the rainy season, and possibly volatilisation. Regardless, the equivalent value of this nitrogen derived from using urea fertiliser is more than BDT 300,000 (US$ 3,750).

A poor woman skilled in the manufacture of shopping bags, prepares a grow-bag for the trial.

Pangasius farming was developed in converted rice-fields. Currently, the cost to pangasius farmers of removing sediment from their ponds is an

Loss of nitrogen from commercial pellet feed under current culture conditions in catfish ponds (adapted from Rahman, 2004).



important part of their production costs amounting to BDT 250,000 every 2-3 years. As profit margins from pangasius farming have been estimated at BDT 350,000 to 400,000/ Ha over the average production cycle of one year, sludge removal costs are significant.

If sediments are not removed on a regular basis, water quality declines and fish production suffers. The concept of dike-pond cropping is well established in Asia but in previous studies it was found that pangasius farmers showed a limited interest in following this sort of practice. The returns from dike cropping are relatively modest and clearly not attractive to the well-financed entrepreneurs that dominate catfish farming; they would rather keep pond dikes accessible for regular management. However, the valuable nutrients are clearly more interesting to other types of farmers. For instance, the use of sediments and effluent water for fertilising para grass production by rice farmers located next to catfish farms is currently being trialed as part of a research project supported by IFS. Another opportunity for nutrient recycling, however, arose as an outcome of a colleague's interest in growing vegetables in bags using inorganic and organic fertilisers. As Bangladesh is urbanising, interest in producing some of the household's own vegetable needs is growing. Although most urban homes have limited gardens, they typically have flat roofs suitable for container gardening and so, a potential market for pangasius pond sediment was investigated.

Piloting sediment use in bag gardening

The growth of summer tomatoes (variety BARI-14) in bags containing sediment from pangasius ponds placed on the rooftop of the Faculty of Fisheries building, Bangladesh Agricultural University (BAU), Mymensingh was explored. Bag gardening is commercially established in many European and African countries where bags filled with formulated growing medium are sold in the market. Pangasius pond sediment was collected from catfish ponds located in Trishal, a sub-district of Mymensingh, dried under shade and ground up

Pond sediment accumulates rapidly in intensively-fed pangas ponds but its removal provides employment opportunities for local manual labourers.

The production of tomatoes in a re-designed grow-bag filled with sediment from Pangasius ponds.

before being used in the growth trial. For this, the old pangas feed bags were filled with either (1) sediment alone; (2) with 50% sediment and 50% virgin soil; or with (3) a conventional formulation used in container growing (60% virgin soil, 40% cow dung, 50 g TSP and 50g MP fertilisers. Analysis of each growing media, indicated that the major required nutrients, NPK, were found at very high levels. The total nitrogen content of the sediment was 0.30%, which was double that found previously in the sediments of carp polyculture ponds. Moreover, this level of nitrogen content was similar to that found (0.4-0.5%) in traditionally composted animal waste and crop residues. The organic carbon content was also very high in the sediment.

The growth of summer tomatoes were piloted in these bio-bags. Plants flowered 18 days post-transplantation in to the bags containing pangas sediment (i.e. treatments 1 and 2) with a high overall performance when compared to the bags containing a conventional growing medium (i.e. treatment 3). Within a month, fruit on the plants grown in the bags containing the pangas sediment, had ripened and produced an average of 3 kg fruit / bag.

Re-designing the bag – how can the poor be involved?

The findings of the present study indicated that bags containing pangasius pond sediment have promise for commercialisation, however, the design of both the bag and the formulation of the growing medium based on the use of pangas sediments requires attention. We have taken forward these ideas with a view of how poorer landless people can be involved and benefit from potential value chains based on sediment reuse. Old pangas feedbags are typically sold for BDT 4-5 and made into shopping bags by local homeworkers in the area. We identified some of these people and commissioned them to produce a conventional grow-bag design. Feed bags were fashioned into a long rectangular shape and holes were cut to allow for the planting of tomatoes, chilies or other suitable crops.

Table 1. The estimated amount of nitrogen and urea in pangasius pond sediments per hectare

Nitrogen content	Estimation	Estimated amount
Indirect estimation from the feeding	The amount of artificial feed required for 1 kg of live pangasius production	2 kg
	Total loss of nitrogen in pond bottom from 2 kg of feed	67.2 g
	Estimated total feed required per square meter of pond is 12 kg, accordingly loss of nitrogen in a square meter	403 g
	Accordingly, loss of nitrogen per hectare (ha) per production cycle	4,032 kg
	Total nitrogen from 2 cycles / 2 years of production	8,064 kg
	Urea contain 46% nitrogen, accordingly to get 8,064 kg nitrogen, the required amount of urea	17,527 kg
	Currently total estimated retail price of 17,527 kg of urea	BDT 392,642*
Direct estimation from sediment analysis	Total amount of sediments from 1 ha pond after 2 years of deposition	2,000 m^3
	Total weight of 2000 m^3 sediment	2,247,283 kg
	Total amount of nitrogen per ha	6,743 kg
	Urea contain 46% nitrogen, accordingly to get 6,743 kg of nitrogen, the required amount of urea	14,660 kg
	Currently total estimated retail price of 14,660 kg urea	BDT 328,354*

* 1US$ = 80 Bangladesh Taka (24 March 2012)

This design of bag makes them easier to handle and to transport; our initial trials also demonstrate that the tomatoes planted in these bags grow well and produce a good crop of fruit. The concept is that poor people, once supported and provided with the required skills, could produce, distribute and service grow-bag vegetable production among wealthier urban populations (Haque, 2011). Further development is now required to ensure consistency of growing medium formulation and performance of the bags with a range of horticultural crops. Branding (the 'BAU Bio bag') to ensure recognition and confidence among customers is expected to be critical for the concept to become established and we are seeking partners to take this idea forward.

Conclusion

Densely populated Bangladesh with its increasing population in both rural and urban areas needs to consider the challenge of meeting food security across the food chain. Intensification of fish production without regard to the option of reusing the wastes is a missed opportunity in a country where inorganic fertilisers are increasingly expensive. Pangasius pond sediments from farms in rural areas have the potential to generate livelihoods for both rural and urban people through this value-chain approach.

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Culture-based fisheries development in Lao PDR and Cambodia proceeding well

Under the ACIAR-funded project *Culture-based fisheries development in Lao PDR and Cambodia*, a monitoring team recently visited both countries to observe progress by participating community groups and to provide guidance for the next stocking season. The project is working with rural villages to implement culture-based fisheries as a community activity, where the work, management and benefits are shared by local residents.

Cambodia

The monitoring team travelled to Oddar Meanchey and Preah Vihea provinces to meet with communities at the trial sites. The team assessed activities to be undertaken in the upcoming stocking cycle, in particular the stocking and harvesting plans and strategies to increase community awareness to optimise the returns from culture-based fisheries activities.

The team was comprised of Prof. Sena De Silva, Lead Consultant; Dr. C.V. Mohan, R&D Manager, NACA; Srun Lim Song, Country Project Leader; representatives of the Research Team, Hort Sitha, Ou Sary, Ouch Vutha; and representatives from the provincial fishery authorities Hunong Dalya (Kampong Thom Province), Pen Verna (Preah Vihea Province) and Heng Sen (Oddar Meanchey Province).

It was evident in all reservoirs visited by the team that culture-based fisheries activities being undertaken by the communities were contributing directly to food and nutritional requirements of the local people. Harvested fish were not being sold or marketed. Rather, whenever a household's catch exceeded its daily needs the excess was preserved for future use by processing it into a paste or sauce for future consumption.

Juvenile tilapia.

Culture-based fisheries are being undertaken as a community activity.

The highlight of the visit was the team's participation in two community meetings, held in Oddar Meanchey and Preah Vihea on 25 and 27 September, respectively. The meetings were well received, with some people travelled more than 100 km (three hours by motorbike) to attend. Ideas and concerns were freely shared and new strategies for increasing the returns from the culture-based fisheries activity were discussed. There was consensus that species such as silver barb, catfish and others that could reproduce in the reservoir environment added benefit to production, a request to increase the numbers stocked. The communities also suggested that giant freshwater prawn (*Macrobrachium rosenbergii*) be included in the stocking programme.

The meetings discussed ways to improve the survival rate of the seed stock delivered to each site. As Cambodian law allows open access to reservoir fisheries there is no mechanism to prevent households fishing, even immediately after stocking. Accordingly, a suggestion by Prof. De Silva to enhance the returns on stocked fish by increasing the conservation area in each reservoir and netting it off to confine the stock for four to five months, allowing a greater proportion of the stocked seed to grow near capacity, was accepted by the stakeholders. The suggestion also included that one or two days of community fishing immediately after removal of the net would allow the whole catch to be marketed with some of the proceeds used for purchasing seed stock for the next cycle. The community representatives agreed to implement these strategies during the next crop, and it is believed that these changes in the practice will significantly increase the return from stocking.

Illegal fishing, in particular the use of prohibited gear such as electro-fishing, was also a common concern amongst most communities, the situation being exacerbated by the fact that military personnel also engage in such activities, making it difficult to stop. However, the Project Leader undertook to consult local authorities to request their assistance in reducing illegal fishing.

There was general agreement that inter-community and inter-provincial exchanges will be useful for encouraging exchange ideas and bringing about an overall improvement in culture-based fisheries activities.

Lao PDR

The project activities in Lao PDR, where culture-based fisheries is at a more advanced stage, having been introduced under a previous ACIAR project, is trialling the establishment of Communication Centres to support community culture-based fisheries activities. Eight centres have been established to date at sites accessible to farmers, covering the communities that have been drawn into the project since 2011. The centres are located at:

- Department of Agriculture & Forestry Office, Saythani District, Vientiane Capital.
- Provincial Livestock & Fisheries Section, Vientiane Capital.
- Namxuang Aquaculture Development Centre, Vientiane Capital.
- Department of Agriculture & Forestry, Pakasan District, Boirikhamxay Province.
- Boirikhamxay Provincial Livestock & Fisheries Office.
- Lao – Singapore Hatchery.
- Nam Ngum Fisheries Management Centre.
- Pa Bo Hatchery, Savannakhet Province.

In general farmer inquiries are brought to the attention of the relevant communication centres by village leaders, who are the main contact point between the regional/ provincial authorities and partners. To date, on average in for example, Saythani District, all five reservoir heads visit the communication centre once per week and place their inquiries. Based on the nature of the inquiry the communication centre staff may visit the community obtain "on ground" information and provide first line extension support. Where specialist intervention is required the staff will forward the inquiry to the Head Office of the Department of Livestock and Fisheries for advice. Most of the enquiries to date have been regarding technical issues concerning seed procurement, health management and predator control.

The initial plan for linking the Communication Centres was to make use of Skype to support voice and video interaction over wireless 3G data connections. However, 3G coverage proved to be inadequate for Skype in nearly all rural sites and so the centres now make use of instant messaging services (preferred) and email, which can operate over low-speed connections. The Department of Livestock and Fisheries also plans to establish a Facebook group to enable project participants to interact and share photographs (important for health, environmental concerns) online. However, as Facebook is still relatively unknown to people outside the capital they plan to hold a training course to introduce to project participants in November.

Communities have requested the setting up of centres at each culture-based fisheries site. As this will require considerable training and support, the most capable communities will be piloted first; a process which is expected to be extended gradually through more communities throughout the course of 2014. The proposed target is about two communities per district, including communities involved in the Van Vien and Tulakhom Districts.

The Lao project team, in collaboration with Australian project personnel, has developed a manual on artificial propagation for culture of silver barb (pa phia) whilst a manual for better management practices drafted by Prof. De Silva, is being further scrutinised by the Lao team. The pa phia manual is presently being translated into Lao and will be published together with "farmer friendly" versions by the end of 2013.

An exchange visit of a Laotian farmer group to Cambodia will be held in April - May 2014. A regional workshop will also be held to discuss the outcomes of the project in Siem Reap in October 2014 (dates to be advised).

www.enaca.org

National aquatic animal disease surveillance programme launched in India

The Department of Animal Husbandry Dairying and Fisheries (DAHDF), Ministry of Agriculture, Government of India has approved a national project on aquatic animal disease surveillance for five years and funding of INR 320 million (about US$ 6 million) has been allocated through the National Fisheries Development Board (NFDB). A national consultation on aquatic animal disease surveillance held last April 2012, attended by NACA, made a strong recommendation for the need for a national program on surveillance. This was followed up by the development of a project proposal by the National Bureau of Fish Genetic Resources (NBGFR) in consultation with national partners and NACA. The project was presented to the Ministry and was formally approved in February 2013 and the NBFGR was chosen as the nodal coordinating agency.

The national surveillance program will be undertaken by 21 leading national institutions in close collaboration with respective state fisheries departments covering fourteen key Indian states with passive and active surveillance in more than 100 districts. Shrimp, carp, catfish, tilapia, ornamentals, cold water species, freshwater prawn, and molluscs will be covered. During the first 6-12 months of the project, the focus will be on collection of baseline information and passive surveillance from the selected districts of fourteen states. The project will gradually evolve to include active targeted surveillance based on the requirements and purpose.

At the national level a Technical Advisory Committee (TAC) has been constituted to oversee the implementation of the project and NACA is included as one of the special invitees for TAC meetings. At the project implementation level, NBFGR has constituted a core scientific committee (CSC) to assist NBFGR in running the project and NACA has been included as one of the members of this core scientific committee.

A one day pre-launch consultative meeting was held on 27th May 2013. This event was attended by 41 delegates representing 21 leading national institutions of ICAR (CIBA, CIFA, CIFE, CICFRI, NBFGR, CMFRI, DCFR) and Fisheries colleges of State Agricultural Universities (Mangalore, Tuticorin, Kerala, Andhra Pradesh, Tripura, Assam, West Bengal, Srinagar, Ratnagiri, Verawal, Orissa). The delegates were the designated PIs or Co-PIs of the national project. Welcome remarks were provided by Dr Jena, Director of NBFGR. Introductory remarks on surveillance and implementation mechanisms were provided by Dr CV Mohan of NACA. The Executive Director of NFDB provided remarks on the need to consider environmental issues in the national surveillance work. Dr Gajendragad from PD-ADMAS provided brief insight into surveillance in livestock sector in India and the importance of national database. Formal opening session was followed by a detailed presentation by the Director of NBFGR on the project, proposed activities, role of partner institutions, expected outputs, allocation of budget, logistics and administrative matters. This was followed by presentations from 21 institutions covering the following topics:

- State, district and ecosystem to be covered for surveillance by the institution.
- Background on aquaculture in the identified state.
- Species to be covered.
- Diseases to be covered.
- Extent of surveillance (passive / active) to be carried out.
- Capacity of the institution.
- Linkages with the respective state fisheries departments.

Participants in the launch workshop.

- Budget requirements.
- Other issues of relevance to the national program.

Formal launch workshop of the project was held on 28 May 2013. Key dignitaries included Dr Ayyappan (Director General of ICAR and Secretary of DARE), Dr Meena Kumari (Deputy Director General of Fisheries, ICAR and NACA Governing Council Member), Dr Vishnu Bhat (FDC, DAHDF), Dr Madhumitha Mukherjee (Executive Director, NFDB), Dr Jena (Director, NBFGR) and Dr CV Mohan from NACA. This launching event was attended by 41 delegates representing 21 leading national institutions of ICAR and Fisheries colleges of State Agricultural Universities.

Dr Jena provided the welcome address. Under the Guest of Honour, Dr CV Mohan from NACA provided a speech on importance of national surveillance for disease management, compliance to WTO SPS, enhancing credibility of the nation among trading partners and stressed the fact that surveillance is the basis for all disease management strategies. Dr Mukherjee of NFDB highlighted the various programs of NFDB and their support to state fisheries departments for health management. She urged the project to work closely with the state fisheries departments. Dr Vishnu Bhat, Fisheries Development Commissioner from the DAHDF explained how the project came about, and stressed the need to consider mechanisms to sustain the program after five years by the respective state fisheries departments. He also appreciated the role of NACA in supporting the national surveillance initiative from the very early stages of project conceptualisation. Dr Meena Kumari expressed her happiness that the project has finally come through and now the country has a program to support national surveillance. She called upon all the ICAR and SAU institutions to ensure commitment to the project. Dr Ayyappan in his address expressed happiness and thanked NBFGR and NACA for pursuing the concept and finally getting the project approved. He also thanked the Joint Secretary of DAHDF for his sincere efforts in supporting approval of this project and funding through NFDB. Dr Ayyappan elaborated on the importance of national surveillance, need for building our credibility amongst trading partners, lessons we can take from the livestock sector in India, lessons we can draw upon from Asia Pacific, and the need for strong commitment from all the national institutions. NACA's role in regional aquatic animal health management was appreciated and NACA was asked to continue to assist the project by provision of technical assistance and in supporting capacity building activities.

A national training workshop on the national surveillance program for aquatic animal diseases was held at the National Bureau of Fish Genetic Resources, Lucknow, India, 17-20 September 2013.

The workshop was attended by 46 delegates representing 21 leading institutions of the Indian Council for Agricultural Research, namely CIBA, CIFA, CIFE, CICFRI, NBFGR, CMFRI, DCFR; the fisheries colleges of the state agricultural universities of Mangalore, Tuticorin, Kerala, Andhra Pradesh, Tripura, Assam, West Bengal, Srinagar, Ratnagiri, Verawal and Orissa.

The work commenced with a formal opening ceremony with the lighting of the lamp. Welcome remarks were provided by Dr Jena, Director of NBFGR. Remarks were also delivered by Prof. Kenton Morgan (University of Liverpool), Dr Jiraporn (Thailand Department of Fisheries). Dr Vishnu Bhat, FDC, provided presidential remarks and Dr P. Ponnia provided the vote of thanks.

Lectures provided by the technical experts covered concepts and principles of surveillance, the role of epidemiology, sampling issues, risk analysis, and experiences from Thailand and from the Indian livestock sector.

The highlight of the workshop were group planning exercises to develop comprehensive, cost-effective surveillance systems for different scenarios using abstract models concerning to avoid introducing species-specific or geographic biases. Over the four days the scenarios became progressively more interesting and complicated. Participants presented and discussed their solutions.

The feedback from participants was very encouraging. For most of them the workshop was a new learning experience and they appreciated the scenario solving exercise through which they learnt the concepts and principles of surveillance. The contribution of Prof. Kenton Morgan and Dr Jiraporn was highly appreciated by all concerned.

The networking and collaboration resulting from this project would be of significant value for aquatic animal health management in the country. Through the implementation of this project, the national surveillance team will be able to respond to disease emergencies and also provide scientific information to the national Competent Authority for taking informed policy and trade related decisions.

Report on early mortality syndrome / acute hepatopancreatic necrosis syndrome of shrimp

A new FAO Fisheries and Aquaculture Report, *Early Mortality Syndrome (EMS) or Acute Hepatopancreatic Necrosis Syndrome (AHPNS) of Cultured Shrimp*, focuses on this emerging disease that has devastated the shrimp industry of China, Malaysia, Thailand and Viet Nam over the last three years.

FAO project TCP/VIE/3304 "Emergency assistance to control the spread of an unknown disease affecting shrimps in Viet Nam", implemented by Viet Nam's Ministry of Agriculture and Rural Development, organised an FAO/MARD Technical Workshop on EMS/AHPNS last June.

Sixty-three participating international experts and local stakeholders from the shrimp farming sector discussed the outcomes of the work carried out under the TCP project and the current state of knowledge on EMS/AHPNS in the affected countries. The Workshop agreed on a list of specific and generic actions and measures that may help reduce and manage the risks of EMS/AHPNS, directed to various shrimp stakeholders (public and private sectors).

The report is available for free download from FAO at: http://www.fao.org/docrep/018/i3422e/i3422e.pdf

International Symposium on Small-scale Freshwater Aquaculture Extension, 2-5 December, Bangkok

World population is projected to increase drastically in the coming decades, threatening the food and nutritional security of the masses and particularly of the poor. Greater attention on agricultural resource management is essential. Among the different sources of animal protein, freshwater fish are considered to be one of the most promising commodities that can contribute significantly to food security and nutrition. Moreover, small-scale aquaculture, common in the Asia-Pacific region, provides additional benefits to rural communities including income generation, nutritional improvement, and sustainable practices through integrated farming systems.

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 demonstrate the effectiveness of “farmer-to-farmer extension” approaches in rural aquaculture. In these TCPs, core farmers who produce fingerlings are motivated to teach grow-out to others using simple techniques so that they can acquire patronage of clients and expand market outlets. It is noteworthy that such system not only provide 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. However, the experiences, lessons learned and findings from these JICA-implemented TCPs on small-scale aquaculture are worth sharing with other stakeholders, and as a reference for better management practices.

In this context, an international symposium is being organised for stakeholders involved in the JICA-assisted projects in Cambodia, Lao PDR, Myanmar, Benin and Madagascar. This symposium, which will be held in the Centara Grand Hotel Ladprao (Bangkok) is also open to other interested stakeholders in the region who are involved in small-scale aquaculture operations. JICA, NACA and DOF-Thailand are co-organising this symposium, with support from key partner institutions including the FAO Regional Office for Asia and the Pacific, SEAFDEC, the Asian Institute of Technology and the Thailand International Development Cooperation Agency. Presentations as well as discussions during the symposium will be summarised in the form of proceedings for distribution to relevant organisations.

The main objective of the symposium is to provide a venue for information sharing on extension of small-scale aquaculture, specifically targeted to those individuals and relevant organisations 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.

For more information please download the prospectus. If you wish to participate please email info@enaca.org:

http://www.enaca.org/uploads/announcements/international-symposium-freshwater-aquaculture-extension.pdf

‘Perfect’ food for ‘perfect’ prawns

Australian researchers have developed a food additive for farmed prawns that will mean prawn lovers will have access to more sustainable prawns that still taste great.

After 10 years of research, CSIRO scientists have perfected the Novacq™ prawn feed additive. Farmed prawns fed with Novacq grow on average 30 per cent faster, are healthier and can be produced with no fish products in their diet, a world-first achievement in sustainability.

CSIRO’s Dr Nigel Preston has been working with the A$75 million Australian prawn farming industry for over 25 years, and says this is a game changer for the industry.

“We fed Novacq to black tiger prawns, and it made them even better for consumers, the environment and prawn farmers,” Dr Preston said.

“This is a major achievement for the sustainability of Australia’s aquaculture industry as prawns fed this diet are not only a top quality product and reach market size faster, they also no longer need to be fed with any products from wild fishery resources.”

“This means that Australian prawn aquaculture, already a world leader in sustainability and environmental management, is now set to become even better, and really solidifies aquaculture as a sustainable source of protein to help meet the ever growing demand for food.”

Until now, Australian prawn farmers have needed to feed their prawns with a pellet that includes some sustainably sourced fish meal or fish oil, in order to ensure that the prawns grew fast, and were a healthy and high quality product for consumers.

“When we are talking about relieving pressure on our ocean stocks of fish, every little bit helps. Novacq will mean that the Australian prawn farming industry could potentially no longer be reliant on wild-caught fishery products,” Dr Preston said.

CSIRO and Australian owned and based Ridley AgriProducts have announced that Ridley AgriProducts has taken a licence to produce and distribute Novacq in Australia and several South-East Asian countries. Mr Bob Harvey, General Manager Aquafeed from Ridley AgriProducts said this means the Australian industry will soon have the opportunity to use the Novacq feed additive to boost domestic prawn farm productivity.

“We’ve seen this product in action and we know how great it is. We’ve conducted multiple laboratory-based trials, and in conjunction with CSIRO and a great customer of ours, Australian Prawn Farms, we have proven the effects of Novacq when commercially grown, added into a commercial prawn feed and fed to black tiger prawns in multiple full-scale commercial sized ponds,” Mr Harvey said.

“Adding Novacq into even the best performing prawn diets on the market, we proved a significant incremental growth rate and food conversion rate improvement.

“We are really excited to now be able to start the process of commercialising Novacq, so that Australian prawn farmers will soon be able to benefit from it. Over the next twelve months we will be upscaling production, performing additional tests and further farm-scale trials, and then to move into full-scale commercial production.”

The effectiveness of Novacq has already been demonstrated on one Australian prawn farm, with Mr Matt West, Operations Manager of Australian Prawn Farms based at Ilbilbie in Northern Queensland, getting a chance to see the results over a period of four months testing the feed additive on black tiger prawns.

“What I saw on my farm was a clear incremental growth compared to the high quality diets that were used as a control for the large-scale trials we recently conducted at our farm,” Mr West said.

“Apart from the improved growth rate I observed, what is really exciting to me about Novacq is the very real possibility for Ridley to ultimately be able to produce a great performing prawn feed without using any marine sourced proteins in the diet. This will, of course, mean an even more sustainably produced prawn crop being farmed at Australian Prawn Farms.”

Novacq is an entirely natural food source based on the smallest organisms in the marine environment, the marine microbes which are the foundation of the marine food pyramid. It is based on over 10 years of CSIRO research to understand the natural marine microbial processes that occur in prawn farm ponds and natural marine estuaries, and the role of microbes in prawn nutrition.

Production of Novacq relies on the controlled production of these marine microbes. CSIRO researchers have discovered how to feed and harvest them, and convert them into a product that can then be added to feeds as a bioactive ingredient, like a dietary supplement for prawns.

Including Novacq in the diet of farmed prawns has shown for the first time that fish meal and fish oil can be completely replaced in the prawn diet, potentially freeing the prawn aquaculture industry from reliance on wild fishery resources. CSIRO has substantiated this through dozens of tests over the past five years, both in Australia and throughout Asia. These results will be presented today at the 2013 Ridley AquaFeed Australian Prawn and Barramundi Farmers Conference in Queensland.

Reproduced with permission from CSIRO:

http://www.csiro.au/en/Portals/Media/Perfect-food-for-perfect-prawns.aspx

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Aquaculture without Frontiers Special Session

Videos of the presentations given at the AwF Special Session at Aquaculture 2013 are available for online viewing at the link below. The presentations and speakers were:

- Aquaculture without Frontiers: Past, present and future
  Dave Conley, AwF Director, Canada

- Aquaculture without Frontiers: Farmer to farmer programs
  Kevin Fitzsimmons, University of Arizona

- Possibilitiies of AwF collaboration with Brazillian organizations working on poverty alleviation
  Patricia Moraes-Valenti, Universidade de Santo Amaro

- Tilapia hatchery strategies in Asia - spanning the intensity continuum
  David Little, University of Stirling

- Low resoure tilapia culture in Haiti, limitations, opportunities and possible strategies for intensification
  William N. Mebane, marine Biological Lab

- AwF’s role in developing Myanmar’s aquaculture potential
  May Myat Noe Lwin, CNN Soft Shell Mud Crab Farms, Thailand

- Marketing AwF into the future
  Roy Palmer, AwF Director, Australia

Available from: http://aquacomgroup.com/Page_sections/Multimedia/AwF_AA2013/AwF_AA2013_main.html

We asked CSIRO: Gold Coast Tiger Prawns

Nick Moore, Gold Coast Marine Aquaculture

It was back in the '90s we realised that to be successful we needed to domesticate the black tiger prawn, in other words, breed them in captivity. Now we knew most of that, but we couldn't do it all on our own.

So we asked CSIRO to give us a hand and basically what they've come and helped us with is the health screening of them, and now, as we've got to the end of the whole road, the genetics.

We can now truly breed them in captivity very successfully and very commercially. Every year our prawns are improving.

We've got a prawn that we consider to be as good as anyone in the world and that's been attested to recently when we've won the gold medals at the recent Royal Easter Show and have now been nominated for the Presidents Medal, which is the top six of all of the champions.

The results that we're getting now from our domesticated stock is probably three times more than we'll get from any East Coast of the wild.

But it's more than that, not only do they grow faster and eat less food, and obviously create a far better economic return for us, it's a matter of getting your animals into the ponds when you require them and that's priceless.

The relationship with CSIRO has been very beneficial to the whole industry, we've got a situation now where we can guarantee to stock our ponds on the week, almost to the day that we require and that's something you can't do when you go to the wild. I think, going back, some years ago, we realised you'd need as many as 12 ducks to line up in a row and CSIRO's given us the last two ducks.

They're great to work with, they're professional, but I think what stands them out, more than anything else, is they have true desire and a wish to succeed, the same as we do and when we succeed they get just a bigger kick as we do.

Video transcript reproduced with permission of CSIRO. You can see Nick's presentation on CSIRO's website at:

http://www.csiro.au/news/transcripts/YouTubeTranscripts/2013/Sep/We_asked_CSIRO_Prawns.htm

Understanding the sex of salmon

Producing only female salmon is critical to the success of the AUD$408 million Atlantic salmon aquaculture industry in Australia. Our researchers are developing a genetic test to distinguish the sex of young salmon.

Australia's salmon industry relies on female salmon being grown for consumption because during the last year of growth in the sea males reduce muscle production, lose condition and are more vulnerable to disease, which can result in significant productivity losses for farmers.

There is an industry-wide need for a fast, cheap and reliable method to correctly identify the sex of salmon breeding stock in order to achieve this all-female production with greater efficiency and certainty.

CSIRO researchers, together with colleagues from the Simon Fraser University in Vancouver, Canada, have been using genetic markers known as microsatellites and gene sequencing technology to understand more about how sex determination works in salmon.

The researchers needed to develop a better test for salmon sex because distinguishing between the sexes is difficult, particularly at a young age.

A DNA-based genetic test is needed to distinguish them because salmon don't have visually distinguishable sex chromosomes like the human XY chromosomes. Instead they have a genetic region containing the genes that determine sex.

The researchers discovered the sex-determination region was located on three different chromosomes in different families of the Tasmanian Atlantic salmon population they examined. With this information the researchers developed a way of determining the sex of a fish from a particular family. The researchers are currently developing the test further for commercial use.

These findings have implications for how Atlantic salmon breeding programs will be managed in the future. The research is an important part of the Sex Ratio and Sterility

Cluster research program, which aims to understand and manage sex and sterility in farmed animals to improve productivity, profitability and animal welfare.

Reproduced with permission of CSIRO, http://www.csiro.au/en/Organisation-Structure/Flagships/Food-Futures-Flagship/FFF-update-2013-08/Salmon-need-omega-3.aspx

Overcoming smallholder challenges with biotechnology

From breeding to bugs, a new FAO publication looks at biotechnologies at work in small-scale crop, livestock and fish production

The publication, Biotechnologies at Work for Smallholders: Case Studies from Developing Countries in Crops, Livestock and Fish, asserts biotechnologies can help smallholders to improve their livelihoods and food security.

Biotechnologies at Work for Smallholders covers 19 case studies in crops, livestock and fisheries, written by scientists and researchers worldwide. It describes the practical realities and experiences of taking biotechnology research and applying it in smallholder production of bananas, cassava, rice, livestock, shrimp and more, in different parts of the developing world.

The case studies encompassed a wide range of biotechnologies. They included older or “traditional” ones like artificial insemination and fermentation, and cutting-edge techniques involving DNA-based methodologies - but not genetic modification.

The publication was prepared by a multi-disciplinary team at FAO as part of an agricultural biotechnologies project partially funded by the Government of Canada.

“With the right institutional and financial arrangements, governments, research institutions and organisations can help to bring biotechnologies to smallholders, improving their capacity to cope with challenges like climate change, plant and animal diseases, and the overuse of natural resources,” said Andrea Sonnino, Chief of FAO’s Research and Extension Unit.

Case studies

Four case studies were from India, two from China and one each from Argentina, Bangladesh, Brazil, Cameroon, Colombia, Cuba, Ghana, Nigeria, South Africa, Sri Lanka, Tanzania and Thailand.

Researchers used their knowledge of DNA markers to develop a flood-tolerant rice variety in India with a potential yield of 1-3 tons per hectare more than previously used varieties, under flood conditions. After being released in 2009, the new variety, Swarna-Sub1, spread rapidly and was used by three million farmers in 2012.

“In summary, submergence-tolerant varieties provided opportunities for improving and stabilising yields in flash flood-affected areas, significantly contributing to national food security,” stated Uma Singh and colleagues from the International Rice Research Institute (IRRI) who prepared the case study.

In China, the Jian carp was developed using within-family genetic selection and gynogenesis (a reproductive technology resulting in all-female offspring that have only received genes from their mother). The Jian carp is now grown on about 160,000 fish farms and makes up over 50 percent of common carp production in China.

In northern Cameroon, the use of DNA-based diagnostic tools in the field allowed veterinary authorities to quickly diagnose outbreaks of Peste des Petits Ruminants, a highly contagious viral disease affecting goats and sheep. Rapid and accurate disease diagnosis meant that the authorities could stamp out these outbreaks and stop the spread of the fatal disease to other flocks.

“Without this rapid response, thousands of sheep and goats would likely have succumbed to the disease during these outbreaks, leading to millions of CFA francs in losses,” affirmed Abel Wade and Abdoulkadiri Souley from the National Veterinary Laboratory (LANAVET) in Cameroon.

The editors say biotechnologies can improve crop-, livestock- and fish-related livelihoods by boosting yields and enhancing market access. Introducing new and traditional biotechnologies on family farms can also keep production costs down and improve sustainable management of natural resources.

Lessons learned

The publication offers lessons from the case studies which can be used to inform and assist policymakers in making decisions on programs involving biotechnologies. High up on the list was the need for national political commitment to improving smallholder productivity and livelihoods; financial support from non-governmental sources to supplement national efforts; and, long-term national investment in both people and infrastructure linked to science and technology.

The publication also found international and national partnerships were vital for achieving results, as was the sharing of genetic resources, techniques and know-how across national and continental borders.

Biotechnologies at work for smallholders also underlines the importance of involving smallholders in the process at all stages, taking into consideration their knowledge, skills and own initiatives.

Source: FAO. Download this free book from the FAO website at:

http://www.fao.org/docrep/018/i3403e/i3403e00.htm

Coordinated efforts in aquaculture needed to meet global demand

Global partnership to find sustainable solutions 'imperative', FAO says

The creation of a global partnership to help ensure that the world's fish supplies can keep pace with booming demand has received a green light from FAO's Sub-Committee on Aquaculture.

Over 50 countries endorsed the Global Aquaculture Advancement Partnership (GAAP) programme, which will bring together governments, UN agencies, non-governmental organisations and the private sector to find sustainable solutions to meeting the need for fish products.

Aquaculture already supplies nearly 50 percent – or nearly 63 million tonnes – of fish consumed globally, and with production from wild fish stocks levelling off, it will fall to fish farmers to supply the estimated 50 million additional tonnes required to feed the rising world population by 2030.

But while aquaculture is one of the fastest expanding food sectors in the world with a current growth rate of around 6.1 percent a year, recent trends predict a gradual decline which might see the sector fall short of bridging the gap between projected supply and demand.

"This is an alarming situation and urgent concerted efforts to build a strong private-public partnership are imperative to maintain the current rate of growth of aquaculture over the coming years," said Árni M. Mathiesen, FAO Assistant Director-General for Fisheries and Aquaculture.

The partnership will be tasked with overcoming obstacles to the expansion of the sector, which include the increasing scarcity of land and water for the development of inland fisheries and the need to step up aquaculture activities in the world's seas and oceans.

This in turn will require strict governance to safeguard aquatic animal health and conserve biodiversity.

"GAAP will also help tap the huge potential of aquaculture to help reduce poverty, unemployment and socio-economic inequalities through proper planning and development," Mathiesen said, recalling that around 80 percent of fish farmers are small-scale.

Some 55 million people are directly employed by the fisheries and aquaculture sector, of whom 85 percent live in Asia.

The initiative will now go for approval to the Committee on Fisheries when it meets at FAO headquarters in Rome in June 2014.

Certification benchmarking

A tool to help countries assess whether public and private aquaculture certification schemes are in line with FAO's global guidelines for certification has also received a nod from the sub-committee, which is the only global intergovernmental forum discussing aquaculture development.

Covering animal health, food safety, the environment and worker welfare issues, the FAO aquaculture guidelines were approved in 2011 after four years of consultation among governments, producers, processors and traders.

"It is overwhelmingly positive that consumers want to see a label on a product showing that it is sustainably produced. The challenge is to ensure certification provides adequate incentives to small producers and eventually contributes to overall sustainability of the sector," said FAO Senior Aquaculture Officer Rohana Subasinghe.

"Many schemes claim they are within the FAO guidelines, but this new evaluation framework will allow them to self-assess whether that's true," he said.

The evaluation framework will also now pass to the Committee on Fisheries for approval in June next year.

Source: FAO.

Network of Aquaculture Centres in Asia-Pacific

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NACA is a network composed of 18 member governments in the Asia-Pacific Region.

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FAO - APFIC - NACA Regional Consultation on the Sustainable Intensification of Aquaculture in Asia-Pacific
The objective of the consultation was to develop a regional strategic policy framework to guide national governments and regional organisations in promoting sustainable intensification of aquaculture in the Asia-Pacific region. The consultation specifically focussed on intensifying aquaculture through more efficient use of resources and environmentally sound practices. Farm productivity and environmental performance must be improved through a combination of forward-looking policies, better management practices and technological improvements, rather than by increasing inputs to the system.

Emergency regional consultation on acute hepatopancreatic necrosis syndrome
Recently, an emerging disease known as acute hepatopancreatic necrosis syndrome has caused significant losses amongst shrimp farmers in China and Vietnam (2010), Malaysia (2011) and Thailand (2012). The disease affects both Penaeus monodon and P. vannamei and is characterised by mass mortalities during the first 20-30 days of culture, an abnormal hepatopancreas, corkscrew swimming, loose shells, pale colouration and slow growth. The cause is unknown at this time. Considering the severity of the disease, NACA and the Australian Department of Agriculture, Fisheries and Forestry convened an emergency consultation in Bangkok, 9-10 August 2012, involving international shrimp health experts, regional governments and industry to share information on this emerging disease, its occurrence, pathology and diagnosis, and to develop a coordinated regional response to the issue. The recordings in this collection are the technical presentations made at the consultation.

Global Conference on Aquaculture 2010
The conference was the third in a series of aquaculture development conferences, following on from the Conference on Aquaculture in the Third Millennium held in Bangkok 2000, and the FAO Technical Conference on Aquaculture, held in Kyoto 1976. The programme included seven regional and global reviews on aquaculture development, nine plenary and invited guest lectures, and twenty expert panel discussions across six thematic sessions. This audio collection represents the entire conference proceedings.

Expert Workshop on Inland Fisheries Resource Enhancement and Conservation in Asia
FAO and NACA convened an expert workshop to review inland fisheries resource enhancement and conservation practices in Pattaya, Thailand, 8-11 February. Experts from 10 Asian countries attended the meeting to share experiences and lessons learned.

Free to download or listen/watch them online!